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ORIGINAL RESEARCH

Short pedagogical training in supporting university teachers' professional vision: A comparison of prospective and current faculty teachers

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Abstract
This study investigates the effects of a short pedagogical training on university teachers' professional vision and (mis)conceptions concerning teaching and learning, utilizing a mixed-methods approach. Participants' written interpretations of a video-based teaching–learning situation were analyzed and comparisons were made between prospective and current faculty teachers. Before the course, participants missed almost half of the pedagogically relevant incidents in a classroom. Generally, the short pedagogical training was successful in supporting all participants' professional vision development. The training successfully provided all teachers' with more in-depth reasoning skills as a result of the course. Thus, improvements in participants' reasoning skills were identified, but interestingly not in their noticing capability. In addition, prospective teachers had more misconceptions concerning teaching and learning both before and after the training. Finally, the study discusses the implications for research on how teachers' beliefs and conceptions are related to professional vision.

Keywords Higher education · Teacher expertise · Pedagogical expertise · Professional vision · Mixed-methods approach

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Introduction

Teaching–learning situations are fraught with complex phenomena in which teachers must have an ability to pay attention to events that foster or constrain student learning (Sherin et al., 2008; van Es & Sherin, 2002). Noticing these important events requires high-quality pedagogical expertise from teachers. To improve the quality of higher education, more attention needs to be paid to the level and quality of university teachers' pedagogical expertise. University teachers' pedagogical expertise requires adequate conceptual understanding of pedagogical concepts and theories, and a situation-specific ability to notice and interpret significant interactions during teaching–learning situations to support student learning as effectively as possible (Sherin, 2007; Sherin et al., 2008; van Es & Sherin, 2002; Wolff et al., 2017), that is to say, professional vision (Goodwin, 1994). Recently, teachers' professional vision has been increasingly studied, but not yet among university teachers.

To contribute to research how pedagogical training affects learning by higher education teachers, this study investigates the impact of pedagogical training targeted at developing teacher expertise, as operationalized by their professional vision and (mis)conceptions concerning teaching and learning. This study aims to answer the questions, how do university teachers' professional vision and (mis)conceptions develop due to pedagogical training? Moreover, are there differences between prospective and current faculty teachers before and after their training?

Theoretical framework

Teachers' professional vision

A teacher's ability to be sensitively present in complex and rapidly changing teaching–learning situations is a necessary factor in applying adaptive teaching practices (van Tartwijk et al., 2017). Even short teaching–learning situations include numerous relevant events, which may support or hinder student learning. Teachers need to connect their practical knowledge with their personal experiences and dispositions to more successfully make observations, interpretations, and active decisions (Blömeke et al., 2015), meaning that teachers must possess appropriate professional vision capability (Goodwin, 1994; Seidel & Stürmer, 2014).

Seidel and Stürmer (2014) argue that professional vision consists of two main subprocesses: (1) noticing, and (2) knowledge-based reasoning. Hence for teachers, professional vision consists of situation-specific skills that reconcile their pedagogical knowledge with their teaching performance (Blömeke et al., 2015). This allows them to identify crucial events in complex teaching–learning situations (noticing), interpret the observed events by linking them together with theoretical understanding (knowledge-based reasoning), and appropriately support a student's learning processes (Sherin & van Es, 2009). In other words, noticing entails processes of selective attention or the act of observing classroom events (e.g., Sherin & van Es, 2009) and whether teachers pay attention to events that are of importance for teaching and learning. The ability to interpret important events requires knowledge-based reasoning (Seidel & Stürmer, 2014; Todorova et al., 2017), which represents a combination of three interrelated processes: (1) description, (2) explanation, and (3) prediction (Berliner, 2001; Seidel & Stürmer, 2014; van Es & Sherin, 2008).

Teachers can only meaningfully intervene with things that they notice, and which are appropriately interpreted. Thus, teachers are unlikely to react appropriately to classroom practices that they do not know about or understand. Well-developed professional vision helps teachers to provide more effective learning opportunities to students and to teach in a responsive way that supports student learning more effectively (Chan et al., 2020). Professional vision can serve as an indicator of the more sophisticated opinions about learning required for teachers to respond flexibly to students' understanding and reasoning (Meschede et al., 2017). However, studies related to university teachers' abilities to notice and interpret relevant incidents in teaching–learning situations are still lacking.

Development of teachers' professional vision

Teachers' professional vision is particularly influenced by experience (Jacobs et al., 2010). Thus, professional vision is not an innate quality but is a capability that can be learned and developed (Berliner et al. 1988; Carter et al., 1988; Jacobs et al., 2010; Lee, 2021; Stürmer et al., 2013b), and its development is strongly guided by teachers' knowledge and beliefs (Blomberg et al., 2011; Stürmer et al., 2013a; Wolff et al., 2016). Comparisons between novice teachers and more experienced teachers in previous studies indicate that professional vision develops according to the development of a teacher's experience (Berliner, 1991; Gegenfurtner, 2020; Lehtinen et al., 2020; Wolff et al., 2016; Wyss et al., 2020). Hence, professional vision is typically considered a skill possessed by more experienced teachers (Berliner, 1991), although more evidence is needed in higher education contexts.

Teaching experience is especially influential in the way teachers process information in teaching–learning situations (e.g., van den Bogert et al., 2014; Wolff et al., 2016, 2017), and interpreting teaching–learning situations is more challenging for novice teachers than for more experienced teachers (Stahnke et al., 2016). For instance, more experienced teachers tend to be better in identifying relevant features in teaching–learning situations compared to novices, but also in processing noticed information more quickly (Wolff et al., 2016). Novice teachers are often unable to direct their attention toward relevant events in the teaching–learning situation, whereas more experienced teachers are able to notice and interpret events that novice teachers are unable to describe (Seidel & Prenzel, 2007). Novice teachers may also miss some information, which more experienced teachers tend to focus on (Chi, 2006; Wolff et al., 2016).

The more knowledge teachers have about both students' learning and possible relevant events related to teaching and learning, the more knowledge teachers have to understand and interpret different phenomena in teaching–learning situations (Carter et al., 1988). Novice teachers' reasoning skills are usually limited and more descriptive; they tend to focus on reporting what they see, while more experienced teachers can integrate the meaning behind their descriptions with more diverse explanations (Wolff et al., 2017). More experienced teachers also engage in more knowledge-based reasoning than novice teachers (Gegenfurtner, 2020; Gegenfurtner et al., 2020; Meschede et al., 2017). The more teaching experience a teacher possesses, the better the teacher will be at interpreting a given situation or student learning processes in general rather than just deriving overly simplistic conclusions based on the observed situation (Wolff et al., 2017). More experienced teachers' interpretations are more elaborate, including accurately predicting how upcoming events will impact teaching–learning situations (Wolff et al., 2017). In addition, novice teachers tend to produce more fragmented and inconsistent interpretations and may not understand the connections between teacher and student activities in the classroom compared to more

experienced teachers (Wolff et al., 2015). Thus, high-level professional vision helps teachers to support students' learning processes more effectively. However, there have been few studies related to higher education teachers' professional vision capability (but see Seidel & Stürmer, 2014).

Since professional vision includes both selective attention and knowledge-based reasoning, professional vision can be seen as an indicator of integrated teacher knowledge, and its development is strongly guided by a teacher's prior knowledge and beliefs (Blomberg et al., 2011; Pajares, 1993; Stürmer et al., 2013a; Wolff et al., 2016), meaning they are interrelated (Meschede et al., 2017). Therefore, teachers observe, interpret and act in teaching situations based on their own beliefs and conceptions related to teaching and learning (Ericsson & Pool, 2016; Meschede et al., 2017). Teachers may only pay attention to events that correspond to their existing beliefs about teaching and learning (Meschede et al., 2017). Hence, also in teaching, it is about the relationship between conceptual understanding, interpretations and action (Borko & Shavelson, 1983). Previous studies have also shown that teachers, and student teachers in particular, may have misconceptions (i.e., a conception that is not in unison with current scientific understanding) related to educational psychology phenomena (Dekker et al., 2012; Grospietsch & Mayer, 2018; Stofflett, 1994; Vosniadou et al., 2020). For example, previous studies have found that novice teachers tend to have more transmissive beliefs than more experienced teachers, who tend to hold more constructivist beliefs about teaching and learning (Meyer, 2004). Previous results also indicate that transmissive beliefs may hinder a teacher's professional vision (Meschede et al., 2017). Though teachers admittedly tend to observe and interpret teaching situations based on their own beliefs and conceptions related to teaching and learning (Ericsson & Pool, 2016; Meschede et al., 2017), such practices have rarely been studied in higher education, nor have researchers assessed the conceptions university teachers have about teaching and learning.

Pedagogical training in support of university teachers' expertise development

Universities differ remarkably from schools as a study context. Universities are highly research-intensive institutions compared to primary and secondary education. University teachers are multidisciplinary experts who need to combine research and teaching, and sometimes other professional tasks, such as clinical work or administration (van Dijk et al., 2020). Formerly, the scholarship of teaching in higher education was not fully recognized, since teaching at university was understood to be strongly linked to the teacher's research competence (van Dijk et al., 2020), and research publications have even been used as factors in teaching effectiveness evaluation (Simons & Elen, 2007). University teachers are usually strongly committed to research, while teaching can be seen as an obligatory duty and therefore a less important part of an academic career path (Murtonen & Vilppu, 2020). In addition, in some countries it is even irrelevant to the career advancement of teachers how skillfully teachers perform their teaching duties. However, research and teaching are now considered to be tightly intertwined but separate areas of a university teacher's expertise (Berbegal-Mirabent et al., 2018). Previous studies focusing on teachers' professional vision have mainly been conducted in primary and secondary education contexts. Universities are very different study contexts considering that: (a) there are teachers, who start their teaching duties with no pedagogical training (Murtonen & Vilppu, 2020) and (b) teachers, particularly at research-intensive universities, need to cross the boundaries between their own subject expertise

and pedagogical expertise (Akkerman & Bakker, 2011), which is not an easy task. For university teachers to understand and support their students' learning processes effectively requires pedagogical knowledge, and pedagogical training is therefore needed.

Usually, teachers come to pedagogical training programs with many prior beliefs and preconceptions related to teaching and learning. Most university teachers who participate in pedagogical training have no or limited knowledge of pedagogical theories or educational psychology phenomena (Postareff et al., 2007, 2008). A lack of pedagogical training may even have certain damaging outcomes for teachers' conceptions concerning teaching and learning (Postareff & Lindblom-Ylänne, 2008). Thus, teachers often need to modify their own conceptions and beliefs, and pedagogical training has the potential to affect their misconceptions concerning teaching and learning (Södervik et al., 2022; Vilppu et al., 2019). Therefore, this study explores the potential misconceptions that university teachers might have and improves understanding of how pedagogical training supports them in adopting more learning-centered conceptions. In addition, more evidence is needed whether misconceptions influence a teacher's professional vision.

In many universities worldwide, the availability of pedagogical training has recently increased among university staff. However, many university teachers still teach without any pedagogical training (Murtonen & Vilppu, 2020). Pedagogical training is usually offered to teachers who already have some practical teaching experience, which means that novice teachers are often excluded from receiving pedagogical support. Previous findings indicate that novice teachers benefit greatly from even light pedagogical support (Vilppu et al., 2019). The main goal of pedagogical trainings is to support teachers in developing pedagogical expertise and to foster teachers' professional vision skills. Interest in studying the impact and effectiveness of higher education pedagogical training has grown of late (see, e.g., Norton et al., 2005; Ödalen et al., 2018; Stes et al., 2012; Stewart, 2014; Trigwell et al., 2012). However, research on the effectiveness of pedagogical training in higher education is still quite limited. More evidence is needed on whether short pedagogical training in universities is able to advance the development of university teachers' pedagogical expertise among both novice and more experienced teachers.

Aim of the research

The aim of this study was to investigate university teachers' level and quality of professional vision. In addition, teachers' initial conceptions and potential misconceptions concerning teaching and learning were a subject of interest. We also investigated whether a short pedagogical training program can affect participants' professional vision and (mis)conceptions concerning teaching and learning. In addition, the relationship between professional vision and (mis)conceptions was examined. The research questions of the study are as follows:

1. What initial professional vision do teachers with different levels of teaching experience possess, and are there differences in
    a. what they pay attention to (noticing)?
    b. how they interpret the situation (reasoning)?
    c. their (mis)conceptions concerning teaching and learning?

2. How does pedagogical training affect prospective teachers' and current faculty teachers' professional vision and (mis)conceptions concerning teaching and learning?
3. What is the relationship between prospective teachers' and current faculty teachers' professional vision and (mis)conceptions concerning teaching and learning?

Methods

Participants

A total of 70 (women $n=33$; men $n=33$; unknown $n=4$) life science university teachers from one Finnish university participated in this study. Previous research has identified disciplinary differences related to beliefs and conceptions about teaching and learning (Lindblom-Ylänne et al., 2006; Lueddeke, 2003; Trigwell, 2002). For instance, life science university teachers generally tend to understand teaching as the transmission of subject knowledge (Lindblom-Ylänne et al., 2006). Thus, the faculty members included in this study represented six different life science departments: biological and environmental sciences, agriculture and forestry, pharmacology, veterinary medicine, applied science, and biotechnology.

Teachers attended a basic university pedagogy course (5 ECTS) held in spring 2020. Every ECTS (The European Credit Transfer and Accumulation System) credit point is a European standard for higher education purposes and represent student workload (1 ECTS = 27 study hours). A total of 84 teachers participated in the training. Of the 84, three declined to participate in the study, seven were not university life science teachers, one had already participated in the piloting phase of the study, and background information was missing for three of the teachers, so their answers were removed from the data. Thus, 70 teachers participated in the study's pre-test, and of these, 64 participated in the post-test.

To evaluate professional vision and conceptions between teachers with different levels of pedagogical expertise, two comparison groups were formed based on the teachers' previous teaching experience from a teachers' expertise development perspective (Boshuizen, 2016): (a) prospective teachers ($n=22$) and (b) current faculty teachers ($n=48$). Prospective teachers had no previous teaching experience at the university, but they presumably would be involved in teaching duties in the near future, based on their academic career positions (e.g., doctoral students). In contrast, current faculty teachers had previous and/or current teaching duties, and/or teaching experience from at least one academic course.

Before the study, all the participants were asked to sign an informed consent form, and they were informed about the terms of the study's privacy statement. Voluntary participation and anonymity were ensured throughout the research process. At the university where the study was conducted, university pedagogical courses are voluntary and all teachers can enroll and participate in them.

Study procedure and context

The study procedure is depicted in Table 1. University teachers, who participated in the study attended a short, basic university pedagogy course (5 ECTS) in which they familiarized themselves with basic educational theories and concepts concerning teaching and learning. This course is the first university pedagogy study at the University of Helsinki that provides the foundation for further pedagogical study. For this reason, participants

Table 1 Design of the study

Pre-test (in the first lecture of the course)	Pedagogical training	Post-test (in the last lecture of the course)
- Background variable questionnaire + - A tailor-made video on a teaching–learning situation and a written annotation task measuring professional vision + - Likert-scale (1–5) questionnaire measuring (mis) conceptions about teaching and learning: - Beliefs that learning is an innate quality (5 items) - The role of pedagogical theories in supporting learning and developing one's own teaching (5 items) - Teachers' perceptions of pedagogical expertise (5 items) - Teaching as transmission of subject knowledge (6 items) - The role of prior knowledge in learning (6 items) + - True/false items with open-ended explanations: - Misconceptions (7 items)	- Six-week course (5 ECTS) in spring 2020	- Repetition of the pre-test video annotation task and the questionnaires

have not usually undertaken any pedagogical study. Employment with the university or enrollment in a doctoral degree program is a requirement for participation in the course. In many universities, including the University of Helsinki, university teachers teach without any formal teacher training, which is likely to cause some challenges, especially for novice teachers who are transitioning to teaching (Murtonen & Vilppu, 2020). Instead, in Finland, in primary and secondary education, pedagogical training (60 ECTS) is a prerequisite for a teacher to work. Thus, for university teachers, taking part in pedagogical training is important in terms of developing their teaching expertise.

The course lasted six weeks and included four face-to-face meetings at the university. Each meeting lasted three hours, including two 15-min breaks. The themes of the course meetings were: (1) introduction to university pedagogy including conceptions and theories of learning, (2) learning and teaching at the university, (3) development of university teachers' expertise, and (4) using reflection as a tool to develop one's expertise as a teacher. Active learning methods were applied in the course, and individual and group assignments were included, as well as e-learning. Before the course meetings, participants familiarized themselves with the upcoming content by reading articles that were provided. Course

meetings were used for active and collaborative learning activities, such as discussions, but they also included traditional lecturing. To complete the course, participants needed to attend all four course meetings and complete all the course requirements.

At the beginning of the first course meeting, a pre-test was conducted to measure the participants' preliminary knowledge. First, all participants provided background information and signed an informed consent form and completed a paper–pencil questionnaire. Background information consisted of questions about the participants' age, gender, faculty, previous teaching experience at the university, and previous pedagogical study experience. Second, a video annotation task was completed individually in the classroom. Participants watched the video at their own pace using their own technical equipment, and handwritten answers were then collected. After watching the video, a paper–pencil questionnaire about teaching and learning was administered. The data collection process took up about 45 min of the course meeting.

A pre-test / post-test design was utilized, so the video annotation task and questionnaire were repeated in an identical form during the last lecture of the course. The video annotation task and completing the questionnaire at the beginning and end of the course were included in the mandatory course tasks. However, the participants had the opportunity to choose whether they wanted to allow their responses to be used as a data source for the study or not.

Measures

Video annotation task

There is a long tradition of using classroom videos in teacher education research and expertise research (see e.g., König et al., 2014; Blomberg et al., 2011). To indicate teachers' ability to analyze relevant events in classroom situations, videos of teaching–learning situations can be used in a standardized manner, to see where teachers direct their attention when observing and interpreting such situations (Brophy, 2004; Goldman et al., 2007; Kersting, 2008). Interpreting a video-based example of a teaching–learning situation serves as an indicator of the quality of a teacher's professional vision: high reasoning abilities and noticing relevant incidents in the video indicate differentiated and integrated knowledge with a flexible application to various teaching situations. In contrast, low reasoning abilities and focusing on irrelevant incidents in the video indicate fragmented and sparse knowledge structures without the ability to use such knowledge flexibly.

The main research materials of the study consisted of a tailor-made video on a teaching–learning situation depicting an activating university lecture, including group work and discussions. This represents one of the more typical teaching methods in life sciences at the university of Helsinki. The video was approximately 12 min long and included 15 predefined incidents (Table 2), that is, pedagogically significant events that were as authentic as possible, which represented typical classroom events. In addition, the incidents were designed to represent traditional learning-related theories and educational psychology phenomena, which were addressed during the pedagogical training, such as understanding constructivist teaching activities and being able to activate and consider students' prior knowledge in one's own teaching. During the pedagogical training, teachers were not trained in professional vision, and video incidents or similar case examples were not discussed in the course contents. The pedagogical background

theories discussed in the course were linked to video incidents. Professional vision is mediated by teachers' conceptions and high-level professional vision acts as an indicator of more sophisticated opinions about teaching and learning. Therefore, teachers' prior knowledge and pedagogical development during the course presumably influenced what they found relevant in the video. Thus, interpreting the video of these typical teaching–learning situations can mirror teachers' ideas and conceptions of teaching and learning.

Participants were instructed to watch the video individually at their own pace and to pause the video every time they noticed something pedagogically interesting, recording the time in seconds when they paused the video. Participants interpreted these pedagogically interesting situations in written descriptions (a paper–pencil technique). The open-ended task was as follows:

> *Your task is to watch the attached video (about 12 minutes) of the classroom situation. A lecture about biodiversity is about to begin. Watch the video and pause it (space/mouse) whenever you notice something pedagogically interesting. Whenever you stop the video, answer the questions (1–3) and use pedagogical concepts (if you can) in your answers.*

The participants had to write their answers down on a form with the following questions/instructions as prompts: *1. The time you paused the video (in seconds)? 2. Why did you stop the video? 3. Briefly describe what was good/bad from a pedagogical perspective*. A pre-test/post-test design was employed, meaning the video annotation task was repeated before and after the five-credit university pedagogy course.

The video annotation task was pre-tested with a smaller sample size before the actual data collection. Pre-testing was conducted in a basic university pedagogy course (5 ECTS) held in December 2019. Seven teachers participated in the pre-testing phase. The purpose of the pre-testing was to find flaws in the video annotation measurement, in other words, whether the assignment had succeeded in measuring professional vision. The aim was to

Table 2 Incidents selected for the tailor-made video presenting pedagogically significant events in the teaching–learning situation

Incident label	Pedagogical perspectives on the incidents	Total number of incidents
Supporting students' knowledge construction by activating students' prior knowledge	Incidents noting that the teacher is supporting students' knowledge construction and/or is taking into consideration students' prior knowledge in the teacher's own teaching to support learning. The teacher is using activating teaching methods to engage students in their learning, with group discussions, for example	8
Teaching as transmission of subject knowledge and failing to support student learning	Incidents noting that the teacher is focused on their own activities and/or delivering knowledge to students. Thus, the teacher is not aware of (i.e., does not see) or does not address (but presumably should) students' questions and/or students' behavior. The teacher is keeping the lecture on track without any interruptions (e.g., ignores a student's question since it does not directly relate to the teacher's original lecture plan)	7

test whether participants noticed the incidents we predefined, or whether they paid attention to something completely irrelevant. In addition, we wanted to know how the participants interpreted these incidents. As in the actual data collection, the video annotation task was completed individually in the classroom. Participants watched the video at their own pace using their own technical equipment, and handwritten answers were then collected. Pre-testing showed that the task worked as desired, so it was not subsequently modified. The pre-testing results provided preliminary information on the reliability and validity of the task.

Questionnaire related to (mis)conceptions about teaching and learning

To identify teachers' initial conceptions and potential misconceptions related to teaching and learning, a short questionnaire was used as a background variable both before and after the training. The questionnaire included 34 items. It measured teachers' conceptions of (a) beliefs that teaching is an innate quality, (b) the role of pedagogical theories in supporting learning and developing one's own teaching, (c) teachers' perceptions of pedagogical expertise, (d) teaching as transmission of subject knowledge, and (e) the role of prior knowledge in learning, all of which were measured via 27 Likert-scale items. The Likert scales ranged from 1 (completely disagree) to 5 (completely agree). The questionnaire was designed by the authors, although certain items were adapted from Vosniadou et al. (2020) and Södervik et al. (2022). Teachers' misconceptions were explored using seven true/false items (Table 3), giving them an opportunity to provide open-ended explanations for their answers. The items concerning misconceptions were reconstructed on the basis of previous studies (Grospietsch & Mayer, 2018; Stofflett, 1994; Vosniadou et al., 2020), to meet the purpose of this study.

Data analysis

Qualitative analysis

Participants' written interpretations of the video annotation task constituted the foundation for understanding and conceptualizing a teacher's professional vision. Qualitative

Table 3 True/false items concerning teaching and learning

TRUE/FALSE ITEMS	SCORING
1) Individuals learn better when they receive information in their preferred learning styles (e.g., auditory, visual, kinesthetic)	False
2) Information that is studied over longer periods is learned better than the same information studied over shorter periods	True
3) It always eases learning if students have preconceptions about the topic to be learned	False
4) Changes in students' misconceptions are mostly dependent on the teacher's ability to explain the content clearly enough	False
5) Deep learning means that one can repeat information adopted from the course material	False
6) Misconceptions are developed through students taught wrongly	False
7) Misconceptions are changed via proof or authority	False

differences in written responses were analyzed using a theory-driven approach (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005), in which the scoring scale for the analysis was obtained from a theory based on Seidel and Stürmer's (2014) definitions of professional vision: (1) noticing and (2) reasoning about pedagogically significant incidents in the teaching–learning situation.

The scores of written interpretations of the video annotation task were based on the defined scoring scale (Table 4) in adherence with the principles cited above. At first, the extent to which teachers noticed pre-defined pedagogically significant incidents (Table 2) was scored using dichotomous scoring, but it was always accompanied by a follow-up question, which was scored as continuous scoring giving the in-depth interpretation of the situation. To be awarded a point for noticing, the participant should distinguish whether something in the video is relevant to teaching and learning. However, the pedagogically significant incidents were defined in advance (a total of 15 incidents). Thus, it was not possible for the participant to obtain noticing points by constantly stopping the video. If a pedagogically significant incident was mentioned in written interpretations in the correct period, the participant received one point for noticing it (+1). If participants did not mention the pre-defined incident, they did not receive any points for noticing the incident (0). Since the video included 15 pedagogically significant incidents, the participants could receive a total score of up to 15 points. The purpose of scoring what was noticed was to find out whether the participant has any perceptions of what is relevant to teaching and learning. However, this does not mean that one can necessarily interpret the situation or give it pedagogical significance. For this reason, noticing was only a small part of the professional vision measurement.

In addition to the importance of noticing what is relevant for teaching and learning, it is also important to consider how the situation was interpreted. Because noticing is related to the interpretation of the incident, the scoring of professional vision considered the number of noticing points and the interpretation points together. Thus, the number of points noticed was not the main scoring criterion for scoring. In fact, the scoring emphasized qualitative interpretation. As Seidel and Stürmer (2014) argue, professional vision might be regarded as being one-dimensional so that the three aspects (describe, explain, predict) cannot be clearly separated; it might also be that the three aspects have to be seen as distinctive but highly interrelated. Thus, the second question (Why did you stop the video?) refers to the ability to use one's own professional knowledge to describe why the participant stopped the video at a certain time, i.e., what was a pedagogically significant incident before explaining the situations and predicting the possible consequence. The third question (Briefly describe what was good/bad from a pedagogical perspective) refers to the ability to differentiate clearly between the relevant aspects, including explaining and prediction, of a noticed incident. Thus, the task implicitly contained an explanation and a prediction in the response describing the events.

The extent to which reasoning on the pedagogically significant incidents was used was scored using continuous scoring ranging from zero to four points per incident (Table 4). In reasoning scores, statements simply describing what is seen in the video without any additional explanations scored one point. If the response deepened from the pedagogical perspective by using explanation, the participant always gained an additional point depending on the pedagogical nature of the answer. Statements representing an understanding of pedagogically significant actions was rewarded one point, and statements representing a clear understanding of pedagogical concepts and theories was rewarded with another point. In addition, speculation about an action that a

Table 4 Scoring scale for the video annotation task and its corresponding definitions

Noticing	Reasoning				
	Description		Explanation		Prediction
Pre-defined pedagogically significant incident mentioned in the correct period.	Statements lacking or providing a false interpretation or else the interpretation was not clear, for instance incorrect use of pedagogical terms and/or theories or misconceptions.	Statements simply describing what is seen or understood to be occurring in the video, presenting only a limited and descriptive explanation of the teaching-learning situation.	Statements representing some understanding of pedagogically significant actions by the teacher, such as facilitating or supporting students' learning.	Statements representing a clear understanding of pedagogical concepts and theories; using/linking them correctly with interpretations of the teaching-learning situation.	Speculation about an action that the teacher (or a student) in the video will soon take in terms of teaching and learning *or* speculation about actions that the participant her/himself would have taken in a similar situation.
0–1	0	+1	+1	+1	+1

teacher or the student would soon take was also rewarded one point. Prediction points refer to future-oriented consequences of interpreted situations, such as the actions a teacher might take after the scene was noticed (Gegenfurtner et al., 2020; Seidel & Stürmer, 2014). If the participant's response included all these pedagogical aspects, the participant received a total of four points. With a total of four points awarded for each pedagogically significant incident, participants could receive a total score of up to 60 points.

Participants responded by writing their descriptions in Finnish or in English, and the first and the fourth author scored the answers for the original descriptions. The first and fourth author planned the scoring criteria together, and any disagreements and borderline cases were discussed during the analysis phase and were resolved by expanding the coding manual and consensus discussion. Inter-rated reliability was accomplished for 20% of the pre-test data for noticing and reasoning separately, and the reliability between the two independent coders was 100% for noticing scores and 95.7% related to reasoning scores.

Quantitative analysis

The quantitative data was analyzed statistically using IBM SPSS Statistics 26. Principal component analyses (PCA) with Varimax rotation were conducted for the pre-test Likert-scale items concerning the participants' conceptions related to teaching and learning (KMO = 0.436, Bartlett χ^2 [351] = 692.921, $p < 0.001$). The PCA revealed four scale dimensions: (a) "teaching as transmission of subject knowledge," with an acceptable alpha ($\alpha = 0.740$), (b) "teaching as an innate quality," with an acceptable alpha ($\alpha = 0.750$), (c) "teaching as a way of supporting students' knowledge construction," with an acceptable alpha ($\alpha = 0.665$); the alpha with only one dimension remained too low and was therefore omitted.

Differences between and within groups with different levels of teaching experience were tested with non-parametric Mann–Whitney U -tests and Wilcoxon signed-rank tests. In addition, correlations were calculated between the participants' professional vision and (mis)conception scores.

Results

Prospective and current faculty teachers' professional vision before the pedagogical training

The participants' ($n = 70$) professional vision skills varied between prospective and current faculty teachers already identified in the pre-test (Table 5). The Mann–Whitney U -tests revealed that prospective teachers had lower professional vision scores compared to current faculty (Z = –3.079, $p = 0.002$).

When looking at professional vision skills in more detail, the participants noticed an average of 8.91 incidents from the video ($Md = 9.00$; $SD = 2.71$; $Min = 2$; $Max = 14$). Prospective teachers paid less attention to pedagogically significant incidents in the video compared to current faculty, that is to say, they received lower noticing scores (Z = – 3.255, $p = 0.001$). Prospective teachers noticed only about half of the pre-defined incidents in the

video (Table 2). Thus, the noticing scores of prospective teachers were relatively low on the pre-test ($M = 7.32$; $Md = 7.00$; $SD = 3.05$; $Min = 2$; $Max = 14$) compared to those of current faculty ($M = 9.65$; $Md = 10.00$; $SD = 2.21$; $Min = 3$; $Max = 14$).

Interpretations of the video: University teachers' reasoning skills before the pedagogical training

Prospective teachers received lower reasoning scores compared to current faculty ($Z = -2.844$, $p = 0.004$). When looking at the written responses of the participants ($n = 70$) in more detail, the scoring varied from zero to a maximum of three points (Table 5). However, most of the interpretations provided by both groups represented relatively low-level answers. Participants, who had relatively low-level answers in reasoning (max. one point) were mainly able to describe only what they had seen or understood to be happening in the noticed incident in the teaching–learning situation, without naming what was pedagogically significant about the situation or being able to predict some consequences related to teaching and learning. The following examples represent relatively low-level answers well:

> *The teacher started the lesson with a reminder about what had been discussed the previous day*. (P33, prospective teacher, incident 3, pre-test)
> *The teacher doesn't react*. (P31, prospective teacher, incident 8, pre-test)

Participants with average-level answers in reasoning (max. two points) were mostly able to describe at some level the incident noticed in the context of supporting students' learning processes or were able to predict some consequences related to teaching and learning, but without naming any pedagogical concepts or theories to explain the situation better. The following example represents an average-level answer:

> *Good in terms of activation, but the instructions were incomplete; for instance the teacher could have divided the groups (in advance/in the situation). The students were not yet familiar with Flinga either; this should have been checked.* (P46, current faculty teacher, incident 15, pre-test)

Only eight participants (three prospective teachers; five current faculty teachers) received three points on the reasoning of the pre-test, meaning they provided more sophisticated answers. Some of them were able to present a clear understanding of pedagogically significant interactions using correct concepts for the noticed incident in the teaching–learning situation in the context of supporting students' learning processes. Others were also able to predict certain actions by the teacher or students, including assumptions about possible learning consequences. The following examples represent more sophisticated answers well:

> *Flipped learning came up, and an activating group task to discuss it. Learning with peers is possible through group discussion*. (P9, current faculty teacher, incident 5, pre-test)
> *Ignoring the student's question doesn't encourage further activity. The teacher could show that they had even noticed the question with a certain gesture*. (P18, prospective teacher, incident 8, pre-test)

Table 5 Comparison of the professional vision and (mis)conception scores before the course between prospective ($n=22$) and current faculty teachers ($n=48$)

	Prospective teachers ($n=22$)					Current faculty teachers ($n=48$)					Total ($n=70$)				
	M	*Md*	*SD*	*Min*	*Max*	*M*	*Md*	*SD*	*Min*	*Max*	*M*	*Md*	*SD*	*Min*	*Max*
Professional vision (max. score 75)	17.64	18.00**	6.63	5	29	23.31	24.00**	6.42	8	37	21.53	21.50	6.96	5	37
Noticing (max. score 15)	7.32	7.00***	3.05	2	14	9.65	10.00***	2.21	3	14	8.91	9.00	2.71	2	14
Reasoning (max. score 60)	10.32	11.00**	3.99	3	17	13.67	14.00**	4.62	1	23	12.61	13.00	4.67	1	23
Teaching as transmission of subject knowledge (max. score 5)	3.40	3.30	0.83	2	5	3.07	3.20	0.72	2	4	3.18	3.20	0.77	2	5
Teaching as an innate quality (max. score 5)	2.55	2.57	0.63	1	4	2.32	2.29	0.48	1	4	2.40	2.43	0.54	1	4
Teaching as supporting students' knowledge construction (max. score 5)	4.58	4.67	0.48	4	5	4.64	4.67	0.41	3	5	4.62	4.67	0.43	3	5
Misconceptions (max. score 7)	3.77	3.50*	1.15	2	6	3.09	3.00*	1.57	0	6	3.30	3.00	1.48	0	6

*$p<.05$, **$p<.01$, ***$p<.001$

Prospective and current faculty teachers' (mis)conceptions before the pedagogical training

The participants' ($n=70$) conceptions about teaching and learning varied between the prospective and current faculty teachers in the pre-test (Table 5). When examining the scores for the items concerning misconceptions, the participants averaged 3.30 misconceptions related to educational psychology phenomena (Table 5). Prospective teachers had more misconceptions compared to current faculty ($Z=-2.048$, $p=0.041$). Thus, the misconception scores of the prospective teachers ($M=3.77$; $Md=3.50$; $SD=1.15$; $Min=2$; $Max=6$) were relatively high in the pre-test.

The most common misconception regarding educational psychology phenomena was related to the belief that individuals learn better when they receive information in their preferred learning styles (e.g., auditory, visual, kinesthetic). The following examples illustrate several teachers' initial misconceptions that individuals learn better with their preferred learning styles:

> *Different learning styles have been identified in research.* (P46, current faculty teacher, item 1, pre-test)
> *Individual differences in learning are real, based on my understanding*. (P78, current faculty teacher, item 1, pre-test)

Prospective and current faculty teachers' professional vision after the pedagogical training

The professional vision scores of both prospective and current faculty teachers increased during the pedagogical training (Table 6). The Wilcoxon signed-rank test revealed that the scores of both prospective ($Z=-2.162$, $p=0.031$) and current faculty teachers ($Z=-4.177$, $p<0.001$) increased statistically significantly in professional vision during the course, based on their scores from the video annotation task. However, the pre-test and post-test results showed no statistically significant improvement in noticing skills in either of the groups.

The Mann–Whitney U-tests revealed no statistical differences in professional vision or reasoning scores between the groups in the post-test. However, prospective teachers still received lower noticing scores compared to current faculty after the course ($Z=-1.985$, $p=0.047$). Thus, prospective teachers had caught up with current faculty in their reasoning capability during the course, but not in the noticing skills.

When looking at the pre-test and post-test written responses of the participants ($n=64$) in more detail, the results of the Wilcoxon signed-rank test showed that reasoning skills increased statistically significantly during the course both among prospective teachers ($Z=-2.444$, $p=0.015$) and among current faculty teachers ($Z=-4.409$, $p<0.001$). After the course, the interpretations varied from zero to a maximum of four points, in other words, from relatively low-level answers to sophisticated answers. Responses earning only a single point had decreased in both groups compared to the pre-test, while two-point responses had increased among prospective teachers but slightly decreased among current faculty teachers. On the other hand, responses earning three points increased in both groups, but current faculty teachers had four times more three-point answers compared to prospective teachers. In addition, only current faculty teachers ($n=6$) earned four points in their reasoning scores.

Table 6 Comparison of the professional vision and (mis)conception scores after the course between prospective ($n=18$) and current faculty teachers ($n=46$)

		Prospective teachers ($n=22$; $n=18$)					Current faculty teachers ($n=48$; $n=46$)					Total ($n=70$; $n=64$)				
		M	*Md*	*SD*	*Min*	*Max*	*M*	*Md*	*SD*	*Min*	*Max*	*M*	*Md*	*SD*	*Min*	*Max*
Professional vision (max. score 75)	Pre	17.64	18.00**	6.63	5	29	23.31	24.00**	6.42	8	37	21.53	21.50	6.96	5	37
	Post	23.72	25.50	9.50	6	40	28.80	28.50	10.27	7	54	27.38	26.50	10.25	6	54
Noticing (max. score 15)	Pre	7.32	7.00***	3.05	2	14	9.65	10.00***	2.21	3	14	8.91	9.00	2.71	2	14
	Post	8.50	9.00*	3.11	2	14	10.22	10.50*	2.93	2	15	9.73	10.00	3.06	2	15
Reasoning (max. score 60)	Pre	10.32	11.00**	3.99	3	17	13.67	14.00**	4.62	1	23	12.61	13.00	4.67	1	23
	Post	15.22	16.00	6.67	4	28	18.59	17.50	8.05	4	40	17.64	17.00	7.79	4	40
Teaching as transmission of subject knowledge (max. score 5)	Pre	3.40	3.30	0.83	2	5	3.07	3.20	0.72	2	4	3.18	3.20	0.77	2	5
	Post	3.03	3.00*	0.86	1	5	2.51	2.60*	0.58	2	3	2.66	2.70	0.70	1	5
Teaching as an innate quality (max. score 5)	Pre	2.55	2.57	0.63	1	4	2.32	2.29	0.48	1	4	2.40	2.43	0.54	1	4
	Post	2.05	1.93	0.64	1	4	2.07	2.00	0.49	1	3	2.06	2.00	0.53	1	4
Teaching as supporting students' knowledge construction (max. score 5)	Pre	4.58	4.67	0.48	4	5	4.64	4.67	0.41	3	5	4.62	4.67	0.43	3	5
	Post	4.78	5.00	0.30	4	5	4.76	5.00	0.35	4	5	4.77	5.00	0.33	4	5
Misconceptions (max. score 7)	Pre	3.77	3.50*	1.15	2	6	3.09	3.00*	1.57	0	6	3.30	3.00	1.48	0	6
	Post	3.28	3.50**	1.84	0	6	1.70	1.00**	1.44	0	5	2.14	2.00	1.71	0	6

*$p<.05$, **$p<.01$, ***$p<.001$

5.3.1. Interpretations of the video: Change in university teachers' reasoning skills as a result of the pedagogical training

The reasoning skills of both prospective and current faculty teachers clearly developed during the course, as evidenced by higher reasoning scores, that is, broader interpretations. After the course, a much larger number of participants showed a more diverse understanding of pedagogically significant incidents. In addition, their use of pedagogical concepts clearly increased, indicating a better understanding of pedagogical theories. Participants who provided more sophisticated answers in the reasoning section (max. three points) were able to present a clear understanding of pedagogically significant interactions using correct concepts for the noticed incidents in the teaching–learning situation in the context of supporting students' learning processes. Some of them were also able to predict certain actions by the teacher or students, including assumptions about possible learning consequences. The following examples represent well the development toward more sophisticated answers during the course:

P75, current faculty teacher, incident 3:
It is important to repeat what has already been gone through and what lies ahead. (pre-test)
Good: A recap of what has been previously learned also helps to activate prior knowledge to serve conceptual change. (post-test).
P4, prospective teacher, incident 4:
Gets everyone to work. (pre-test)
Prepare students for lecture topics and to reflect on their own thoughts about the topics. By comparing them to the things presented in the lecture, they could correct their misconceptions and learn something new. (post-test)
P20, current faculty teacher, incident 13:
It is good that the teacher is aware of the students; she tried to wake up the students. It is good. (pre-test)
Students get bored with a teacher-centered approach; they need to be more active. It is normal that they are sleeping. Teacher should use more student-centered approaches, ask questions, allow students to discuss in groups. But instead the teacher used a higher volume of speaking to wake them up. This is bad. (post-test)

Only current faculty teachers provided the most sophisticated answers in the reasoning (max. four points). They were able to present both a clear understanding of pedagogically significant incidents by using correct pedagogical concepts related to the situation and were also able to predict certain consequences related to teaching and learning based on the interactions they had noticed in the classroom. The examples below represent the more sophisticated answers, which speculate on the consequences for learning based on a teacher's actions in the classroom:

The student is uncertain about something but the teacher does not do anything to clarify the subject. This may hinder students' learning. There might be a misconception that the teacher should try to fix. (P54, current faculty teacher, incident 8, post-test).
Content-focused teaching. The teacher is talking about rather abstract concepts and is starting to lose the students' concentration. However, one active student has a question that breaks the monologue. The teacher also waits until providing an explanation of the concept without immediately interrupting (this could have affected the

learning of some students negatively). Addressing the question increases interaction and reactivates students—well done. (P79, current faculty teacher, incident 8, post-test)

Prospective and current faculty teachers' (mis)conceptions after the pedagogical training

The (mis)conception scores of both prospective and current faculty teachers developed during the pedagogical training (Table 6). The Mann–Whitney U -tests revealed that prospective teachers had higher scores related to their conceptions of teaching as the transmission of subject knowledge compared to current faculty ($Z = -2.228$, $p = 0.026$) after the course.

The pre-test and post-test results of the Wilcoxon signed-rank test revealed that prospective and current faculty teachers changed in their conceptions that teaching is merely the transmission of subject knowledge after participating in the course (prospective teachers: $Z = -2.994$, $p = 0.003$; current faculty: $Z = -4.311$, $p < 0.001$). In addition, conceptions related to teaching as an innate quality statistically improved among both prospective ($Z = -2.896$, $p = 0.004$) and current faculty ($Z = -3.641$, $p < 0.001$) teachers. Likewise, conceptions related to teaching as supporting students' knowledge construction statistically improved among prospective teachers ($Z = -2.101$, $p = 0.036$), but not among current faculty teachers.

In addition, when examining the scores for the items concerning misconceptions, prospective teachers still had more misconceptions compared to current faculty ($Z = -3.108$, $p = 0.002$). The Wilcoxon signed-rank test revealed that the number of misconceptions decreased among current faculty teachers ($Z = -4.447$, $p < 0.001$), while the prospective teachers showed no statistically significant improvement in their misconceptions during the course, and their misconceptions were still relatively high after the pedagogical training ($M = 3.28$; $Md = 3.50$; $SD = 1.84$; $Min = 0$; $Max = 6$). Thus, the pedagogical training course supported especially teachers with prior teaching experience in changing their misconceptions about pedagogical phenomena. In the pre-test, for the first true/false item concerning teaching and learning (Table 3), many participants had answered that the claim was true, that is to say, they thought that individuals learn better in their preferred learning styles. However, in the post-test measurement, they had answered that the claim was false, which shows development in the understanding of learning theories. In addition, the participants gave written descriptions in open-ended explanations, which supported this assumption regarding conceptual development. The following examples represent this change in teachers' conceptions:

P57, current faculty teacher, item 1:

Some people don't learn well from just lecture slides. (pre-test).
The preferred style of learning does not affect learning (according to research) but different ways of presenting information can still be used in teaching. (post-test)
P72, current faculty teacher, item 1:
I presume that the information is effectively better acquired when learnt in our preferred style. (pre-test)
I learned that this kind of preferred learning has no scientific basis. It is more important to accommodate conceptual change. (post-test)

Table 7 Correlation table of post-test scores ($n=64$)

	Noticing	Reasoning	Teaching as transmission of subject knowledge	Teaching as an innate quality	Teaching as supporting students' knowledge construction	Misconceptions
Professional vision	.858**	.979**	− .290*	− .285*	.248*	− .215
Noticing		.736**	− .096	− .221	.187	− .096
Reasoning			− .344**	− .289*	.254*	− .246
Teaching as transmission of subject knowledge				.146	− .111	.181
Teaching as an innate quality					− .222	.174
Teaching as supporting students' knowledge construction						.318

*$p<.05$, **$p<.01$, ***$p<.001$

5.5. The relationship between university teachers' professional vision and (mis) conceptions concerning teaching and learning

When investigating the relationship between participants' professional vision and (mis) conceptions concerning teaching and learning in the pre-test, no significant correlation was identified. However, when investigating the relationship after the pedagogical training, teachers who had better professional vision and reasoning skills changed in their scores concerning conceptions about (a) teaching as the transmission of subject knowledge ($r=-0.290$, $p=0.020$; $r=-0.344$, $p=0.005$; Table 7), concerning conceptions about (b) teaching as an innate quality ($r=-0.285$, $p=0.022$; $r=-0.289$, $p=0.021$), and concerning conceptions about (c) teaching as a means of supporting students' knowledge construction ($r=0.248$, $p=0.48$; $r=0.254$, $p=0.043$). In addition, teachers with better reasoning skills had fewer misconceptions related to teaching and learning ($r=-0.246$, $p=0.050$).

Discussion

The aim of this study was to investigate prospective and current faculty teachers' professional vision and their related (mis)conceptions about teaching and learning and whether the short pedagogical training had any effect on them. This research adds to the limited research on university teachers' professional vision, especially those studies using a qualitative approach. Additionally, there is a lack of understanding about the effectiveness of pedagogical training in a higher education context. In this study, we analyzed how the participants noticed and interpreted significant incidents in a teaching–learning situation based on their teaching experience to advance their understanding of professional vision as a dimension of teachers' pedagogical expertise in the context of higher education. To obtain deeper insights into teachers' understanding, we explored how teachers' (mis)conceptions concerning teaching and learning were associated with their professional vision.

Initial differences between prospective and current faculty teachers before the pedagogical training

The results of our study demonstrated that before the pedagogical training, prior teaching experience seemed to play a role in university teachers' professional vision capability. In line with previous expert-novice research from the field of teacher education (e.g., Berliner, 2001), the current faculty teachers in our study were better able to notice and interpret significant incidents in a teaching–learning situation than prospective teachers.

Based on previous studies (Wolff et al., 2017) we know that novice teachers' processing of classroom events differ from more experienced teachers' processing in many ways. The major findings of our study demonstrate that prospective teachers missed as much as half of the significant incidents in the video that were important in terms of supporting student learning. This finding aligns with previous research on the problems faced by novice teachers in directing their attention toward relevant events in classrooms (Seidel & Prenzel, 2007) or even missing some relevant information compared to more experienced teachers (Chi, 2006; Wolff et al., 2016). Even though more incidents in our study were noticed by current faculty teachers than prospective teachers, the current faculty teachers also missed a substantial number of pedagogically relevant incidents. This may lead to problems in supporting student learning in real-life teaching–learning situations if a university teacher's ability to notice important events is rather weak. Prior work by Copur-Gencturk and Rodrigues (2021) on what teachers notice in a classroom has contended that a teacher's ability to identify critical incidents in a classroom is likely to contribute efficiently to the quality of teaching and student learning. Research from previous studies has shown that teaching experience directly influences how teachers process information in teaching–learning situations (Behets, 1996; Carter et al., 1988; Hattie, 2003, 2012; Livingston & Borko, 1989; Sabers et al., 1991), and the evidence from our study's pre-test supports these findings. Evidence of professional vision in the higher education context is still rare, so the findings presented in this study offer novel evidence that university teachers' professional vision is associated with teaching experience.

Moreover, in our study current faculty teachers provided significantly broader written responses regarding the video-based teaching–learning situation than prospective teachers. Prospective teachers' reasoning skills were quite limited and descriptive at the beginning of the pedagogical training, and they were mainly able to write only about what they had seen in the video. These outcomes are in line with previous findings (e.g., Berliner, 2001; Wolff et al., 2016, 2017), indicating that interpreting classroom situations is more challenging for novices than for more experienced teachers (Stahnke et al., 2016).

Contrary to what was assumed based on previous findings (Meyer, 2004; Postareff & Lindblom-Ylänne, 2008), the results of our study show no statistical differences between prospective and current faculty teachers in their initial conceptions concerning teaching and learning, although prospective teachers received lower scores than current faculty teachers. However, both prospective and current faculty teachers received relatively high scores relating to initial misconceptions concerning teaching and learning, though we still identified significant differences between prospective and current faculty teachers. These results align with previous studies reporting that a lack of pedagogical training may have certain harmful consequences for teachers' conceptions, such as them having rather naïve views about teaching and learning or even forming misconceptions

about both teaching and learning (Dekker et al., 2012; Grospietsch & Mayer, 2018; Postareff & Lindblom-Ylänne, 2008; Södervik et al., 2022; Vosniadou et al., 2020). Many misconceptions concerning teaching and learning might indicate that life sciences teachers are not aware of how they can support students' learning processes properly. Better understanding of differences in professional vision and conceptions between prospective teachers and current faculty teachers in this study allow us to develop university pedagogy based on scientific evidence.

Changes among and between prospective and current faculty teachers as a result of pedagogical training

The results of our study show that the pedagogical training was successful in supporting all participants' professional vision development, which aligns with previous studies indicating that professional vision is a capability that can be learned and developed (Berliner et al. 1988; Carter et al., 1988; Jacobs et al., 2010; Stürmer et al., 2013b).

Our study shows no statistical improvement among prospective and current faculty teachers' noticing skills, even though both groups improved their noticing scores. Prior research on teacher education shows that teachers acquire their noticing skills not only through teaching experience, but also through well-designed pedagogical courses or interventions, especially among pre-service teachers (Lee, 2021). As noted in the study by Lee (2021), before teachers' beliefs and habits become solidified, it is important to provide opportunities and specific interventions for novice teachers to support the development of noticing skills. However, our study still found statistical differences between prospective and current faculty teachers' noticing skills after the training. Prospective teachers struggled to notice relevant incidents in the video, possibly indicating a difficulty in not being aware of the typical learning challenges faced by their students. This is worrying in terms of effectively supporting student learning. In our study, current faculty teachers might have benefitted from their practical experience in teaching, and thus, from greater prior knowledge in how to connect the lessons learned from the course to actual teaching situations (see also Wolff et al., 2017). In contrast, prospective teachers might have developed weaker noticing skills because of a lack of such practical teaching skills (Jacobs et al., 2010). In addition, a recent literature review by Amador et al. (2021) highlights that many researchers have achieved mixed or neutral outcomes in developing prospective teacher noticing skills in a teacher education context.

Our study also further improved understanding of professional vision by using a qualitative approach, especially with respect to university teachers' reasoning skills. Qualitative responses to the video annotation task showed that a short pedagogical training program can successfully provide all participants with more in-depth reasoning skills. Although prospective teachers' written interpretations were not so limited and descriptive after the training as at the beginning of the course, current faculty teachers' written interpretations were still more elaborate, including more statements predicting upcoming events in teaching–learning situations. We assume that current faculty teachers interpreted events from the teaching–learning situation differently from prospective teachers because they were able to assimilate new information in relation to their prior knowledge of similar events that they have gained through teaching experience. Through such an awareness, current faculty teachers may have developed the ability to phrase interpretations of their observations as predictions about what may arise in the classroom. In our study, prospective teachers rarely made predictive interpretations, probably because they did not have enough prior

teaching experience, and therefore had less prior knowledge about pedagogically significant interactions.

Previous studies indicate that disciplinary differences might be related to teachers' beliefs and conceptions on teaching and learning (Lindblom-Ylänne et al., 2006; Lueddeke, 2003; Trigwell, 2002), and university life science teachers tend to hold transmissive beliefs about teaching (Lindblom-Ylänne et al., 2006). Despite the slight improvement in prospective teachers' conception scores, they still had significantly more transmissive conceptions about teaching and learning compared to current faculty teachers after the training. Previous studies also indicate that transmissive beliefs may hinder teachers' professional vision (Meschede et al., 2017), which may be one of the reasons why current faculty teachers developed somewhat better in their professional vision skills compared to prospective teachers.

The number of misconceptions decreased significantly among current faculty teachers, but not among prospective teachers, who still had many misconceptions after the training. The results were quite opposite from the findings by Postareff and Nevgi (2015) and (Vilppu et al., 2019), where the results indicate that novice teachers would be more willing to change their conceptions concerning teaching and learning than more experienced teachers. Thus, the contents of the university pedagogical course discussed in this study might have contrasted more with prospective teachers' initial beliefs and conceptions. This might explain the greater improvement among current faculty teachers, since preconceptions deviating from the scientific explanation are generally more difficult to modify (Vilppu et al., 2019). In addition, current faculty teachers' prior knowledge might have been more consistent with recent scientific models, which may well have supported the learning of something new. These results suggest that pedagogical training should ideally be offered especially to novice teachers who have not yet assumed any teaching duties in order to help them avoid forming naïve and even false conceptions concerning teaching and learning.

These results suggest that all the participants professional vision and (mis)conceptions concerning teaching and learning might have changed because of the short pedagogical training, although previous research has suggested that longer periods of pedagogical training are usually needed (e.g., Gibbs & Coffey, 2004; Postareff et al., 2007; Prebble et al., 2004). In the present study, but also in an earlier study by Vilppu et al. (2019), the change occurred much more quickly, and the findings indicate that even shorter pedagogical training can support university teachers in adopting a learning-facilitation way of teaching. The results of this study show that it is possible to support university teachers' pedagogical expertise with relatively light interventions. University teachers may need more accurately targeted pedagogical training that helps them learn to focus more on student-centered learning.

In this study, a change was noted in the post-test measurement conducted immediately after the pedagogical training. Without a control group, it is not possible to judge the extent to which this change was precisely the effect of the intervention. To ensure the permanence of such changes, a delayed post-test should be used in future studies. This kind of intervention can be expected to have an effect, as noticing pedagogically relevant situations requires pedagogical understanding, and this cannot be achieved without systematic study and teaching. The use of pedagogical concepts in the interpretation of situations increased remarkably and this would presumably not have taken place without specific pedagogical training.

Finally, we examined how university teachers' professional vision was related to their (mis)conceptions concerning teaching and learning. The results of the post-test

support the assumption that teachers' conceptions concerning teaching and learning are related to how teachers interpret significant incidents in teaching–learning situations. This is because research has identified a connection between teachers' conceptions and their professional vision, especially with respect to their reasoning skills (see Blömeke et al., 2015; Ericsson & Pool, 2016; Meschede et al., 2017). Meschede et al. (2017) have also found that transmissive beliefs hinder teachers' professional vision. Thus, the change in teachers' conceptions toward a more constructivist view of teaching promoted their reasoning skills. The assumption that conceptions guide the development of teachers' professional vision is also supported by other studies (see, e.g., Blomberg et al., 2011; Meschede et al., 2017; Stürmer et al., 2013a; Wolff et al., 2016).

Limitations of the study

There are some limitations concerning our study that need to be considered. First, our sample might be biased due to the voluntary nature of participation in the pedagogical training. This might indicate participants' motivation to develop their pedagogical expertise in the first place. In further studies, a control group of teachers who did not take part in the pedagogical training should be considered to see whether the development is related to participating in pedagogical training or to other factors. Additionally, sample sizes between prospective teachers and current faculty teachers varied because a smaller number of doctoral students attended the pedagogical training compared to the number of current faculty teachers.

Second, the post-test of the study was conducted at the end of the pedagogical training, so the pre-test/post-test design addressed only the immediate changes in the participants' professional vision. To test whether the changes in teachers' professional vision are truly maintained, a delayed post-test could have been administered to show the stability of the change. Third, this study focused on professional vision in an activating lecture context. However, in the case of life sciences subjects like those in this study, practical laboratory courses are also a common teaching method. Therefore, investigating professional vision in these varying teaching environments, in which teachers assist students in their practical work, is needed in future studies.

Fourth, this study only investigated teachers' professional vision capability and their (mis)conceptions concerning teaching and learning, but it would also be important in the future to examine how teachers act in teaching–learning situations based on these dimensions of a teacher's pedagogical expertise. A disadvantage of using a video annotation task to measure professional vision is that it does not acknowledge the situated nature of teachers' knowledge, such as offering contextual clues on how to know your students and the learning environment, which are important elements of decision-making processes (Chan et al., 2020). In future studies, it would be interesting to examine the relationship between a teacher's integrated pedagogical knowledge and practical professional vision skills in authentic teaching–learning situations. Eye-tracking or mobile eye-tracking may serve as promising methods for investigating the quality of integrated teacher knowledge in relation to professional vision skills (see e.g., Pouta et al., 2020; Wyss et al., 2020) in authentic teaching situations, which is a novel approach to investigating the development of pedagogical expertise among university teachers.

Finally, the present study compared prospective and current faculty teachers, all of whom were novices in terms of their pedagogical expertise. It would be interesting in further studies to compare the professional vision of novice teachers with expert teachers who possess more teaching experience over longer periods of time. Comparisons between teachers with no previous pedagogical training and teachers with extensive pedagogical training and/or formal education should be considered. Furthermore, this study focused only on life science teachers, so it would be worthwhile to compare teachers from other disciplines to understand any disciplinary differences better.

Conclusions

Our findings revealed differences in professional vision capability among and between prospective and current faculty teachers. In addition, this study showed that even a short pedagogical training can potentially affect teachers' professional vision and (mis)conceptions concerning teaching and learning. This is especially true when the participants have previous practical experience in teaching, and thus, greater prior knowledge concerning teaching and learning in practice. Nevertheless, the weak initial level of professional vision and the large number of misconceptions among both groups is worrying, since such teachers are teaching at the university and, in other words, are helping develop their students' expertise.

This study has provided more insights on the development of teachers' pedagogical expertise, and the results can be used to advance teacher education in a higher education context. The study acknowledges the importance of how teachers' beliefs and (mis)conceptions regarding pedagogical theories may promote or hinder their professional vision capability. Thus, it is important to provide opportunities for university teachers to undertake pedagogical training that supports and improves the development of their pedagogical expertise.

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Data availability The data presented in this study are available on request from the corresponding authors.

Code availability Not applicable.

Declarations

Conflicts of interest The authors declare no conflict of interest.

Ethics approval Voluntary participation, informed consent, and anonymity of the participants were ensured in the research process. The study did not involve intervention in the physical integrity of the participants, deviation from informed consent, studying children under the age of 15 without parental consent, exposure to exceptionally strong stimuli, causing long-term mental harm beyond the risks of daily life, or risking par-

ticipants' security (cf. Finnish Advisory Board on Research Integrity 2019). Consequently, this study did not require a Finnish ethics review.

Informed consent Informed consent was obtained from all subjects involved in the study.

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