Pre-service teachers' noticing: On the way to expert target

Naďa Vondrová[1], Magdalena Novotná[1], Lenka Pavlasová[1], Jarmila Robová[2], Jana Stará[1], Klára Uličná[1]

[1] Faculty of Education, Charles University, M. Rettigové 4, 116 39 Praha 1, Czech Republic; nada.vondrova@pedf.cuni.cz
[2] Faculty of Mathematics and Physics, Charles university, Sokolovská 83, 186 75 Praha 8, Czech Republic

Unlike prevailing research focusing on what pre-service teachers attend to in a lesson and how they interpret it, the study investigates the content of their comments, knowledge-based reasoning and whether it agrees with experts' views. Study 1 determined the dimensions of quality teaching pertinent to lessons in which a new subject matter is introduced and made a noticing target. In Study 2, pre-service teachers ($N = 174$) at the end of their university study made a written reflection of a video lesson, which was compared against the target. Most could not discern situations important for deep work with the content in the lesson. They failed to apply their theoretical knowledge in interpreting the ones they mentioned. Only half of their comments included knowledge-based reasoning, and their views were mostly partially consistent or inconsistent with the experts' ones. This highlights the need to focus on content-related important situations in a lesson and their interpretation in teacher preparation and on developing the ability to discern the dimensions of instructional quality in concrete lessons.

Key words: teacher noticing, knowledge-based reasoning, pre-service teachers.

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1 Introduction

The concept of professional vision capturing noticing and reasoning skills is a mediator between teachers' dispositions and classroom practice (Blömeke et al., 2015). The skills to notice effective teaching manifestations have been shown to correlate with implementing them in one's teaching, even for pre-service teachers (Sun & van Es, 2015; Wiens et al., 2021). This makes noticing an important target for teacher preparation, yet, pre-service teachers' (PST) noticing is lacking. PSTs tend to focus on management, pay little attention to content, and notice the teacher's rather than the pupils' actions. They tend to make general comments, evaluate rather than interpret and use naïve assumptions rather than theory for explanations even though they meet theory in their university courses (e.g., McDonald, 2016; Schäfer & Seidel, 2015; Simpson et al., 2018; Sonmez & Hakverdi-Can, 2012).

Studies on noticing use a normative frame of reference of what participants should notice to demonstrate noticing mostly implicitly. Only some studies present an explicit frame and investigate whether PSTs notice teaching-learning situations deemed important by experts and whether what they say is compatible with experts' views. We maintain that both aspects are relevant for PSTs' learning as future teachers. Thus, our research falls within the studies in which the instrument's validity is "grounded in the collective expertise of a community of experts" (Roose et al., 2018, p. 73). Taking expert noticing and knowledge-based reasoning as a long-term target, the paper aims to show how PSTs' noticing and knowledge-based reasoning at the end of their university study compares to that of experts.

2 Theoretical framework and literature review

The term 'professional vision' was coined as the expert ability to perceive and identify phenomena in a scene compared to the ability of lay persons (novices) (Goodwin, 1994). In education, it often overlaps teacher noticing, defined as "*professional vision* in which teachers selectively attend to events that take place and then draw on existing knowledge to interpret these noticed events" (Sherin et al., 2011, pp. 80–81).

While studies vary in their conception of professional vision, they agree on its two subprocesses (Blomberg et al., 2011; Sherin & van Es, 2009; Sherin et al., 2011): attending to events in an instructional setting (selective attention) and making sense of them (knowledge-based reasoning). The latter involves "processes of making sense of what has been noticed by linking observed situations to knowledge" (Schäfer & Seidel, 2015, p. 38) about teaching and learning. Later, this conception was expanded by acknowledging that to identify noteworthy features, one must disregard some features, too, and that to use one's knowledge to make sense of situations, one adopts a stance of inquiry (van Es & Sherin, 2021).

Analytical frameworks used to describe participants' reasoning differentiate whether the observer describes and/or evaluates the event or whether they also explain it (e.g., Sherin & van Es, 2009). We build on Stockero (2008), who distinguished describing, explaining, theorising, confronting (considering alternative explanations and others' points of view), and restructuring (re-examining one's beliefs and assumptions). The alteration, modifying a teaching-learning situation to reach its goal in a new/more effective way, is sometimes included in the frameworks capturing professional vision (Santagata, 2011). "Suggesting alterations within the [teaching-learning] situations is a way of professional learning" (Janík et al., 2019, p. 188) and is considered a sign of expertise (Stürmer et al., 2013).

Analytical frameworks do not usually differentiate between comments regarding the plausibility of the interpretation presented in these comments. For example, two comments may be coded 'theorise', as both include theory elements, but one may not be considered plausible by experts. Schäfer and Seidel (2015, p. 36) note:

> a teacher might notice an event and reason that student thinking was encouraged in the video [...] but an expert in the field of teaching and learning viewing the same video would reason that student thinking actually was not being encouraged.

This study addresses the lack of research focus on the plausibility of PSTs' comments when reflecting on a lesson.

2.1 PSTs' noticing

Research brings converging results in that PSTs tend to focus on management and behaviour issues, pay little attention to content, attend to the teacher's rather than the pupils' actions and tend to make general comments, evaluate rather than interpret, and use naïve assumptions rather than theory (e.g., McDonald, 2016; Schäfer & Seidel, 2015; Simpson et al., 2018; Sonmez & Hakverdi-Can, 2012). While acknowledging that PSTs cannot be expected to possess advanced professional vision, researchers implicitly use a normative frame of reference of what PSTs should notice to demonstrate skills, which then serves as a long-term goal to achieve. There seems to be an agreement that teachers should be able to attend to pupils' and not only to the teacher's actions, to pay attention to the content in relation to the pupils and use theory to explain the observed. A few studies make target noticing (Stockero & Rupnow, 2017) explicit and indicate what teachers are supposed to notice to demonstrate good noticing. They create expert norms which determine situations in the lesson pertinent to its success. For example, in Wiens et al.'s (2021) study, a specific framework was developed by researchers to measure how the PSTs noticed the nature of pupil-teacher interactions.

Professionals creating the expert norm vary. They may be experienced teachers (McDonald, 2016; Star et al., 2011) or researchers who follow and conduct research, write and review papers, teach at the university, etc., and thus, are presumed to have "acquired integrated knowledge structures" (Schäfer & Seidel, 2015, p. 54). In the field of professional vision, experts may be researchers and teacher educators who specialise in instructional design and educational research (Blomberg et al., 2011; Shäfer & Seidel, 2015) or in subject education (Mitchell & Marin, 2015; Steffensky et al., 2015; Stockero & Rupnow, 2017; Vondrová & Žalská, 2015).

The above opens up an issue of differences between the researcher professional vision and the practitioner professional vision (Lefstein & Snell, 2011), which may adversely impact setting an expert benchmark. To bridge this divide, Roose et al. (2018) suggest involving a range of experts such as academics, teachers, teacher educators, etc. In our study, the expert norm is a product of plural expert professional visions (Lefstein & Snell, 2011) of teacher educators of different fields.

2.2 Instructional quality

In line with Litke, et al. (2021), we understand the quality of teaching as "the extent to which classroom instruction consists of structures and practices believed by researchers and practitioners in the field to provide rich learning experiences for students" (p. 1). In their meta-analysis, Seidel and Shavelson (2007) identified effective teaching variables in goal setting, orientation (mobilising pupils' prior knowledge and investigating possible routes towards the goal), execution of learning activities, evaluation of learning processes, and teacher guidance and support. Killen's (2006) quality teaching model includes intellectual quality, relevance (connectedness), a socially supportive learning environment, and recognition of difference. Even within the subject, there is no widely shared agreement on what quality teaching means. For example, Litke et al. (2021) synthesised three frameworks for quality teaching in mathematics into one model of general elements of teaching quality. They pointed to the merits and pitfalls of looking for one model to capture all dimensions of teaching quality.

Another aspect to consider is the type of lesson under consideration. The characteristics of a successful revision lesson will differ from the ones of the lesson in which a new subject matter is introduced. In our study, we restrict ourselves to the latter. Thus, two dimensions of Litke et al.'s (2021) synthesised model are particularly relevant: *Selecting and addressing the content and subject-specific methods* (motivating the content, addressing the content in structured, accurate, and disciplinary correct ways) and *cognitive activation* (practices creating opportunities for pupils' learning, teacher facilitation of pupils' cognitive activities and of metacognitive learning from cognitively activating tasks). This model is supported by subject-specific studies on instructional quality. For example, Steffensky et al. (2015) highlighted the dimension of learning support with cognitive activation and structuring, and Kaiser et al. (2015, p. 374) emphasised "demanding orchestration of teaching the mathematical subject matter, potential for cognitive activation of the learners, individual learning support and classroom management" as prerequisites of quality teaching. Cognitive activation includes metacognitive activities and pupils' self-regulation and independence, applicable across subjects (Perry et al., 2018).

In our research, we mainly build on the conceptions of Schlesinger et al. (2018) and Janík et al. (2019).

Schlesinger et al.'s (2018) framework comes from mathematics education. It includes two subject-specific dimensions of instructional quality. The dimension of subject-related quality comprises dealing with mathematical errors of students, a teacher's mathematical correctness, a teacher's mathematical explanations, mathematical depth of the lesson and support of mathematical competencies. The dimension of teaching-related quality comprises using multiple representations, deliberate practice, appropriate mathematical examples and relevance of mathematics pupils.

Janík et al. (2019), whose model is based on the analysis of lessons across subjects, connect the quality of instruction to its integrity, namely, to "the quality of functional relationships between (1) teaching and learning content, (2) teaching and learning objectives and (3) the activities of a teacher and students" (p. 189). Situations with high integrity are examples of *didactic excellence*, while situations with lower integrity (or even disconnection between the three levels) are examples of *didactic formalism*. They often result from over-focusing on the form (or organization) of teaching at the expense of the content. Janík et al. (2019) present two types of didactic formalism: stolen cognition and concealed cognition.

If the teacher over-reduces the space available for pupils' cognitive work with the content, we are witnesses of *stolen cognition*. Pupils are passive as the content is "remote from their cognitive and motivational states, and the learning environment cannot give them sufficient insight into the content" (Janík et al., 2019, p. 192). Stolen cognition is the result of problems in the selection of content (e.g., it is too distant and demanding), in didactic structuring of content, which leads to a lack of clarity of content representation or in assessment, and work with mistakes which is less formative and does not "support autonomy in learning and cognitive activities well" (ibid. 2019, p. 192).

Situations of *concealed cognition* are "instances of purposeless cognitive activation of students due to their being disconnected from the content" (Janík et al., 2019, p. 185). Pupils are seemingly active and work on the task, but the teaching-learning situation does not enable them to develop a deep understanding of the content. Pupils "miss important elements of content and crucial relationships between them; they 'lose themselves' in content — distort it, make it too easy or notice only its unimportant aspects" (ibid. 2019, p. 197). Janík et al. (2019) posit that concealed cognition might be less obvious than stolen cognition because pupils are usually keen to work on the task, and thus, a teacher does not get warning feedback, and that is the reason why examining the manifestation of didactic formalism in teaching and learning is important.

2.3 Research aim

To sum up, only a few studies focus on the compatibility of the views of experts and PSTs or practising teachers when analysing a (video)-lesson (e.g., Blomberg et al., 2011; Mitchell & Marin, 2015; Schäfer & Seidel, 2015; Stockero & Rupnow, 2017; Stürmer et al., 2013). Yet, the alignment between PSTs' views and what experts consider appropriate is important (Schäfer & Seidel, 2015) as it informs teacher educators of where PSTs are on their way to a long-term target (expert-like noticing and knowledge-based reasoning).

As our research concerns the analysis of teaching in different fields, a shared view of quality teaching across these fields was needed. We grounded it in the characteristics of the teaching quality, which we found applicable across our respective fields. We selected the dimensions of content representation, content selection, didactic structuring of content, and assessing and dealing with mistakes (Janík et al., 2019), and a teacher's correctness, content depth of the lesson, multiple representations, and content relevance (Schlessinger et al., 2018).

This paper consists of two related studies. The first aims to develop an expert target, a framework for identifying content-related situations in the lesson deemed important by experts for its instructional quality. The second study aims to determine whether PSTs notice phenomena deemed important by experts and whether their comments are compatible with the experts' ones. The second study compares PSTs' noticing and knowledge-based reasoning against the target developed in the first study.

3 Study 1: Identification of expert phenomena

In Study 1, we developed a framework for determining important situations in the lesson in which a new subject matter is introduced. Its bases were the characteristics and indicators for the teaching quality of Janík et al. (2019) and Schlessinger et al. (2018), as given above. This framework was applied to videos of lessons, and phenomena pertinent to their instructional quality (*expert phenomena*) were determined.

3.1 Participants

The noticing target was made by six teacher educators (authors) from different educational fields (art, biology, mathematics, English as a second language, and general education) with similar research and work experience. Each educated PSTs at the same university, taught subject and subject education courses and supervised PSTs during school placements. All conducted research in their respective fields and had experience with cross-subject research on noticing. They had 7 to 36 years of experience at the university, and five had experience teaching at primary and/or secondary schools.

3.2 Video selection

First, we decided to use videos of whole lessons rather than clips as they provide a broader context of the teaching-learning situations. Second, we agreed to use lessons comprising the introduction of a new subject matter. Lessons focusing on revision tend to be repetitive. In contrast, lessons with a new subject matter introduction include more diverse teaching-learning situations that merit attention and cannot be envisaged fully. The course of such lessons is dependent on pupils' reactions.

Each researcher selected videos of three lessons with which they had experience from their courses, and the whole team evaluated their suitability. The lessons were to be self-contained (with no need for additional context) authentic lessons from Czech schools, with new content (familiar to PSTs) being introduced. It is considered a sign of teacher noticing if a breach of a norm (Dreher et al., 2021) regarding an aspect of instructional quality is noted. Teaching-learning situations bearing signs of didactic formalism (Janík et al., 2019) can be seen as a breach of the norm of quality teaching. Thus, the selected lessons also included examples of stolen and concealed cognition.[1] Our assumption, supported by our experience with using videos of lessons with PSTs in subject education courses, was that such situations might be easier to recognise for PSTs with little teaching experience and will motivate them to comment on such situations and suggest alterations. Finally, it was considered whether the PSTs had had an opportunity to gain sufficient pedagogical content knowledge (Shulman, 1986) during their subject education courses (taught by the authors) to spot and interpret such situations.

One lesson on elementary art education (EAE), elementary social studies (ESS), biology (BI), the English language as a second language (EL), and mathematics (MA) was assigned for pilot reflection to PSTs studying the subject in question. They were given the task: "You will see a video which captures a lesson on [subject]. You can watch the video as many times as you want. Write a reflection; the length is not specified. Write down what you find interesting; what is, in your opinion, important." Their written responses were analysed to see whether they felt motivated to comment on situations connected to the introduction of new knowledge and situations of didactic formalism and whether the lessons made sense to them.

3.3 Designing an analytical framework

For each of the five lessons, we proceeded as follows. We watched the lesson individually, and using Janík et al.'s (2019) and Schlessinger et al.'s (2018) frameworks, we distinguished teaching-learning situations in which work with content could be seen and described them. Next, we compared the lists of such situations and created a master list of the ones mentioned by at least half of the team. We met, watched the lesson together, stopped it at moments from the master list, and discussed their importance for the lesson's success and possible interpretations. The discussion was led by the team member within whose expertise the lesson fell (e.g., the mathematics educator led the discussion for the mathematics lessons). It was audiotaped and summarised by the discussion leader. The team provided their written feedback on this summary, considering whether the suggested situations were related to the quality of teaching, whether they agreed on their interpretation, and if PSTs, in their opinion, had enough knowledge to reach such an interpretation. The most frequent argument for excluding the situation was that we agreed it might only be visible to the experts in the respective field and not to a PST with hardly any teaching experience.

[1]Note that it does not mean that the lessons were examples of "bad" teaching; they included situations which can be classified as examples of didactic excellence (Janík et al., 2019) as will be seen in examples below.

Six to eight teaching-learning situations originated for each lesson, and we negotiated them until an agreement on six was reached (to compare responses for different lessons). The description of the lesson's specific situations and the agreed-on interpretation (causes, implications, explanations supported with theoretical notions, alternative actions) is called *an expert phenomenon* here. Next, a categorisation of the expert phenomena was sought, and after multiple discussions, six categories emerged.

In the second validation stage, we checked whether the expert phenomena could be used to analyse PSTs' responses regarding the compatibility of views. Two PSTs' responses from the pilot stage were selected for each lesson and scrutinised for any mention of the expert phenomena. Then, we considered the compatibility of the views depicted in the expert framework and those of the PSTs. Similarly to Stockero and Rupnow (2017), this was not always straightforward. We sometimes agreed with the PST's comment only partially, as the PST stated something plausible about the situation but failed to comment on an aspect which we deemed important. Moreover, we realised that some phenomena were more complex than others and/or spanned more time and included several aspects that the PSTs could mention. We revisited the lists of expert phenomena and distinguished two to four characteristics for each phenomenon. A detailed manual of the expert target originated.

3.4 Results: Expert phenomena

The identified expert phenomena fall within six categories. 'Pupils' cognitive activation' captures whether pupils are engaged in gaining knowledge. 'Depth (work with concepts)' depicts whether the concepts are dealt with sufficiently deep and wide. 'Terminology and precision' relates to the correctness and appropriateness of terms related to the content, of the language used, or of definitions of concepts, taking into account the age of pupils in the lesson. 'Mobilising prior knowledge' points to situations where pupils' prior knowledge necessary for the new subject matter is evoked. 'Relevance' concerns situations in which the subject matter is introduced as relevant to pupils' learning or life, pupils are motivated to learn the content, and connections are made to other subjects. 'Representations' describes the situations in which representations of the new content are presented (or not). Situations falling within these categories can be envisaged as examples of didactic excellence or didactic formalism if the norm of quality teaching is breached.

As there are five lessons, each described by six expert phenomena and each such phenomenon is accompanied by 2 to 4 characteristics, it is above the scope of this paper to present all. One expert phenomenon for each lesson is illustrated. They are denoted by the subject acronym, numbers 1 to 6 and a letter implying a specific characteristic. As the identified dimensions of quality teaching overlap and "cannot be completely separated" (Schlesinger et al., 2018, p. 478), our expert phenomena are not uniquely categorised either.

In the situations described in the expert phenomenon EL5 (categorised 'Depth [work with concepts]' and 'Mobilising prior knowledge'), an inductive approach was used for pupils to infer rules for relative pronouns from the text, using their prior knowledge (EL5a). Implementing this approach in grammar teaching has multiple benefits (EL5b) and is considered a sign of quality teaching (e.g., Jean & Simard, 2013). Thus, this lesson includes situations demonstrating the principle of 'selecting appropriate content and subject-specific methods' (Litke et al., 2021). However, using the inductive method is uncommon in Czech foreign language teaching, and PSTs might see it as a breach of the norm. This might lead them to suggest that only the deductive method is appropriate when introducing rules for relative pronouns.

In the situations captured in the expert phenomenon MA6 (categorised as 'Pupils' cognitive activation' and 'Depth [work with concepts]'), the teacher assigned the pupils two potentially cognitively challenging tasks which could be used for the assessment of pupils' understanding of the newly introduced Thales's theorem (MA6a). However, their implementation was not adequate. One task could be answered without much thought, and the other was too difficult for the pupils at this stage of learning to solve within the short time provided by the teacher (MA6b). This situation bears signs of a breach of the principles of 'selecting appropriate content' and 'teacher facilitation of pupils' cognitive activity' (Litke et al., 2021).

During the situations described in the expert phenomenon BI4 (categorised as 'Pupils' cognitive activation' and 'Representations'), multiple representations of products of nature (e.g., shells) were used with a potential for pupils' cognitive activation (BI4a). Teaching with the support of products of nature has been shown beneficial to pupils' understanding of content (e.g., Sugni et al., 2011). However, the pupils in the video could not touch objects, and only some could see them properly (BI4b). While the content and representations were well selected, the subject-specific method was not, and the teacher did not create good opportunities for pupils' learning.

In the situations described in the expert phenomenon EAE5 (categorised as 'Relevance' and 'Mobilizing prior knowledge'), the pupils were asked to reflect in groups on themselves in relation to the others to prepare for the subsequent artistic creation of a portrait. Their ability to think conceptually about human identity was targeted (EAE5a). The teacher did not emphasize the difference between internal and external identity (EAE5b), which remained blurred (Mason & Buschkuehle, 2013). The examples provided by the teacher were too simplistic and instructive (EAE5c). The situation might be seen as an example of stolen cognition. The chosen topic demands pupils to express themselves on sensitive and discrete issues (EAE5d) while sensitively maintaining the possibility of silence.

In the situations described in the expert phenomenon ESS4 (categorised as 'Pupils' cognitive activation' and 'Relevance'), the teacher suggested that pupils organise a campaign against food waste which could potentially lead to their commitment to the content (ESS4a). However, the teacher did not include the pupils in the campaign planning or motivate them (ESS4b). The pupils could have been led to realise that they could assist in food waste prevention (ESS4c), which could serve as a proxy for authentic learning situations that benefit pupils' learning (e.g., Cheng et al., 2019).

The identified expert phenomena make an expert target against which PSTs' noticing and reasoning in Study 2 are compared.

4 Study 2: Pre-service teachers' noticing and knowledge-based reasoning

The research questions of Study 2 were the following:
RQ1: What expert phenomena identified in Study 1 do PSTs at the end of their university study notice in the lessons?
RQ2: How does PSTs' knowledge-based reasoning compare to that of experts?

4.1 Participants and the task

The study is situated at a faculty educating teachers in the Czech Republic. Future secondary teachers complete a 3-year bachelor's degree and a 2-year master's degree. The study for elementary teachers consists of a 5-year undivided master's degree. PSTs take subject and subject education courses, pedagogical and psychological courses and undergo school practice placements. After the defence of a master's thesis and the final state examination, they become qualified teachers. There is no induction period.

The PSTs did not attend any courses aimed at the development of noticing. However, they dealt with the concept of quality teaching in their general education and subject education courses, in which they were also encouraged to justify their ideas about teaching and learning. Videos of lessons were sometimes used in their courses to accompany the content.

The PSTs were in their 4^{th} or 5^{th} year (Tab. 1) (age $M = 24$, $SD = 5.2$, 89% female). 20% PSTs had teaching experience ($M = 3$ years, $SD = 2.1$ years). All PSTs in the year group studying the programme participated. An exception is EAE, where 34 PSTs out of 36 invited participated.

Tab. 1: Participants

PSTs	Group	Acronym	N	Total
Elementary	Elementary English Language	EEL	23	80
	Elementary Social Studies	ESS	23	
	Elementary Art Education	EAE	34	
Secondary	English Language	EL	25	94
	Biology	BI	43	
	Mathematics	MA	26	

The PSTs were assigned the task in their subject education course: "You will see a video which captures a lesson on [subject]. You can watch the video as many times as you want. Write a reflection; the length is not specified. Write down what you find interesting; what is, in your opinion, important. Do not feel afraid to write your views; there are no correct answers. You will not be assessed according to your reflection." The task was rather open, not to focus PSTs' attention on anything. It was assigned as homework to give them enough time to watch the lesson repeatedly and provide multiple opportunities to notice important situations. Each student watched one lesson.

4.2 Data analysis

The data consists of the PSTs' written responses to one lesson. They were scrutinised for any mention of expert phenomena particular to the lesson, and all such mentions made one unit of analysis; each unit concerns one expert phenomenon. One researcher split responses into units (Tab. 2), and the second checked its validity. Any inconsistencies were negotiated. The units ranged from one sentence to several paragraphs.

Tab. 2: Number of units

Group	EEL	ESS	EAE	EL	BI	MA	**TOTAL**
N	50	75	89	59	141	90	**504**

The units were coded using the coding framework in Tab. 3. The levels of description and evaluation do not attest to any knowledge-based reasoning. The level of theorising is considered more expert-like than the level of explanation. As the lessons included breaches of a norm which naturally leads to suggesting alternatives, we also coded the units for their presence (Alteration).

Tab. 3: Coding framework

Description	Recounting
Evaluation	Subjective judgment without explaining
Explanation	Layman (naïve) explanation or explanation based on one's experience as a pupil or a teacher
Theorising	Generalisation with theory

We coded the same four reflections independently, then met, negotiated our agreement, and modified the coding manual accordingly. Next, the reflections of each group were coded by two researchers, one of them being a specialist in the particular field (but her role was not prioritised over the role of the non-specialist). The researchers worked independently (inter-rater reliability found as per cent agreement was from 80.2% to 91.0%) and negotiated any differences until an agreement was reached.

Next, each unit coded Evaluation, Explanation or Theorising was assigned a value of 0/1 for each expert phenomenon's characteristics, depending on whether the PST's comment was consistent with the experts' one. The same pairs of researchers as in the first stage coded the units (inter-rater reliability ranged from 85.1% to 89.1%) and negotiated any differences until an agreement was reached. The decision about each unit was *Match* (the unit received all 1s), *Limited match* (the unit received more or the same number of 1s than 0s), or *No match* (in other cases). Thus, the unit was assigned *No match* if the PST did not comment on more than half of the characteristics of the expert phenomenon and/or their interpretation of the phenomenon was inconsistent with the experts' view.

Finally, units coded Alteration were assigned *Match/No match* with the experts' view. At this stage, the role of the specialist in the field was important, and the final decision was hers.

Examples of PSTs' comments and their coding are in Section 4.3.

4.3 Results

On average, the PSTs commented on half of the expert phenomena (Tab. 4, Fig. 1).

Tab. 4: Number of mentioned expert phenomena per PST

	EEL	ESS	EAE	EL	BI	MA	**TOTAL**
Mean	2.2	3.3	2.6	2.4	3.3	3.5	**2.9**
Median	2.0	3.0	3.0	2.0	3.0	3.5	**3.0**

Nearly half of the units show no knowledge-based reasoning (Description 18.5%, Evaluation 27.4%). In the rest, explanation without theory prevails (Explanation 34.5%, Theorising 19.6%); see Tab. 5.

Tab. 5: Units according to knowledge-based reasoning per group (%)

	Description	Evaluation	Explanation	Theorising
EEL	26.0	10.0	28.0	36.0
ESS	22.7	24.0	28.0	25.3
EAE	15.7	30.3	44.9	9.0
EL	13.6	6.8	33.9	45.8
BI	22.7	34.8	29.8	12.8
MA	10.0	38.9	41.1	10.0
Total	**18.5**	**27.4**	**34.5**	**19.6**

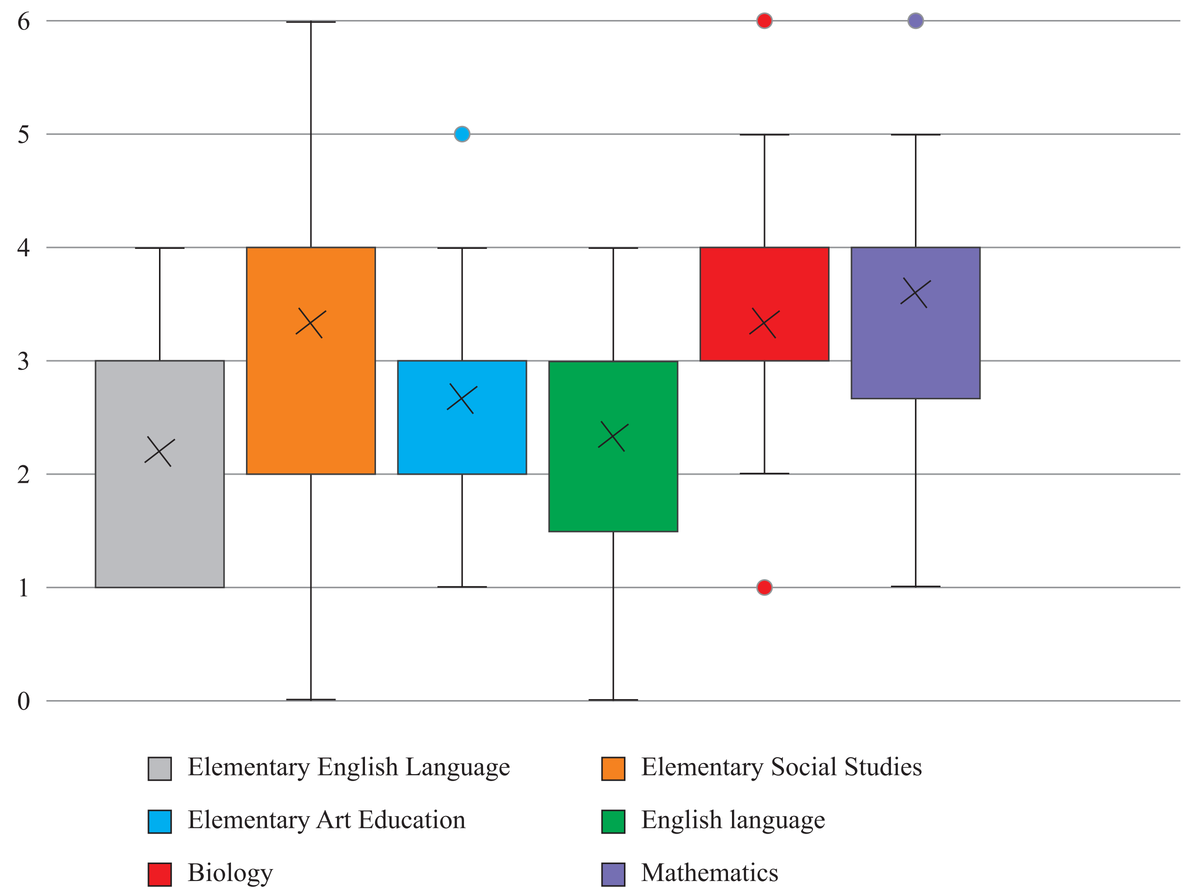

Fig. 1: Number of mentioned expert phenomena per PST (× depicts the mean, the horizontal segment is the median, and the plots depict the maximum, minimum, and upper and lower quartiles)

Our focus was on the content of the comments coded Evaluation and above regarding the compatibility of views of the PSTs and the experts. For example, a comment categorised as MA6 (see Section 3.4) "The teacher asked questions related to Thales's theorem which made the pupils think." was assigned 0 for both MA6a and MA6b. The decision was *No match* as the PST did not mention any didactic potential of the tasks, and the experts doubted that the pupils were cognitively activated. The comment "The pupils got two yes-no questions from the teacher which they should answer. In this way, she found out that the pupils understood the subject matter." received 1 for MA6a and 0 for MA6b as the missed learning opportunity was not recognised (*Limited match*).

The comment coded EL5 (see Section 3.4) "The grammar (relative pronouns) was taught inductively. From specific instances, they [the pupils] arrived at the general principle. It is important that the pupils came to a conclusion themselves." was assigned 1 for both EL5a and EL5b and the final decision was *Match*. The comment "The grammar was taught inductively, at first, the pupils worked with the relative pronouns [...] and then formulated the rule for single relative pronouns." was assigned 1 for recognising an inductive approach (EL5a) and 0 as no benefit was mentioned (EL5b). The final decision was *Limited match*.

For the whole sample, comments in 29.6% of the units agreed with the experts' views, 35.4% agreed partially, and 35.0% were in disagreement (Tab. 6).

Tab. 6: Compatibility of the PSTs' and experts' views (%)

	Match	*Limited match*	*No match*
EEL	70.3	27.0	2.7
ESS	22.4	34.5	43.1
EAE	21.3	50.7	28.0
EL	78.4	21.6	0.0
BI	9.4	37.4	53.3
MA	19.8	32.1	48.2
TOTAL	**29.6**	**35.4**	**35.0**

Note: 100% is the number of units categorised as Evaluation and above.

Next, we related the compatibility of PSTs' and experts' views and the levels of knowledge-based reasoning. Tab. 7 shows that most *No match* units were on the evaluation level, and the biggest share of *Match* was on the theorising level. Comments coded *No match/Evaluation* ($N = 70$) are the most inadequate as PSTs do not provide any explanation, and their subjective judgment does not concern the selected characteristics of the expert phenomenon or is contrary to the experts' view. On the other hand, the most advanced comments (*Match/Theorising*, $N = 45$) are signs of developed professional vision. Most of the PSTs' comments were between the two poles.

Tab. 7: Compatibility according to the level of knowledge-based reasoning (%)

	Match	*Limited match*	*No match*
Evaluation	14.5	34.8	50.7
Explanation	32.6	39.0	28.5
Theorising	45.5	30.3	24.2
TOTAL	**29.6**	**35.4**	**35.0**

The PSTs' responses included 112 alterations to the teaching in the lessons (Fig. 2).

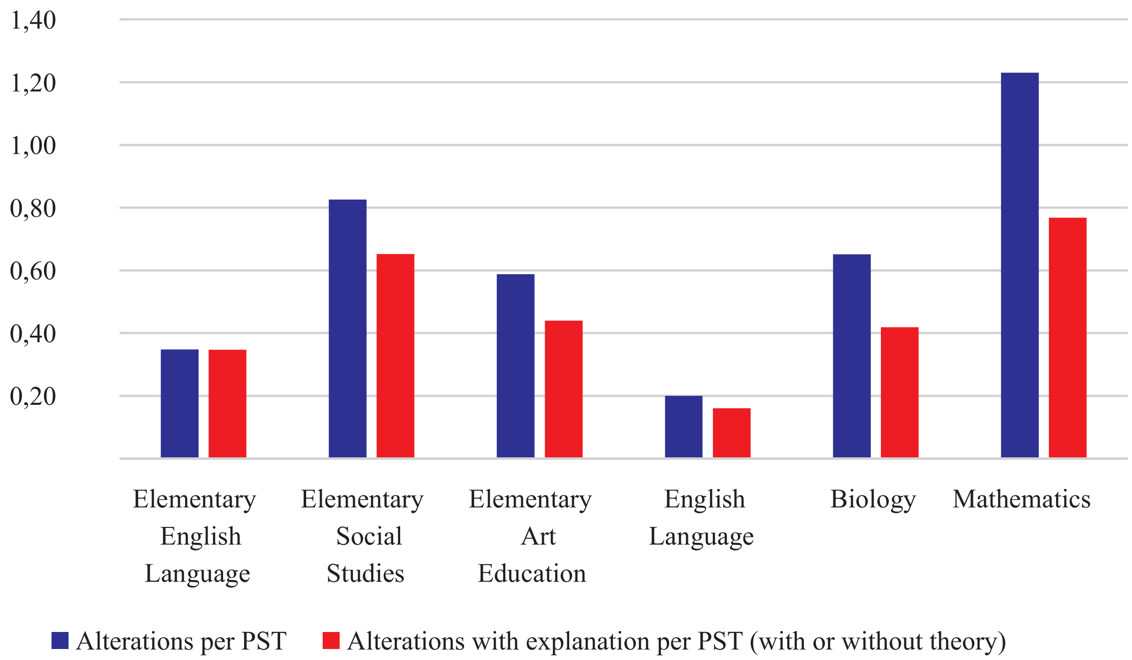

Fig. 2: Average number of alterations per PST

The lowest level alterations were accompanied by subjective judgment only (28.6%). Most suggested alterations (49.1%) were explanative. For example, a PST suggested for the ESS lesson: "I find the example of the amount of food wasted by people in Asia and Europe and North America valuable. However, judging by some pupils' statements, I am not sure they understood that the amount of food wasted by European people also concerns themselves, so if I were the teacher, I would make them aware of this fact."

About 22.3% of the alterations were supported by theory. For example, for the EL lesson, a PST wrote: "The teacher sometimes switched to the mother tongue. Very often, it wasn't necessary to use Czech because it wasn't anything the children wouldn't understand. When she said 'To jsem zvědavá! Výborně! Buďte opatrní.',[2] she could have said it in English (or both – English and Czech) to let the pupils acquire the second language. This subconscious process would result in permanent knowledge according to Krashen's Theory of Second Language Acquisition."

Table 8 shows that the PSTs mostly suggested alterations coded as *Match* (82.1%), but it does not necessarily mean that the experts suggested the same. For example, the pupils were asked to formulate Thales's theorem towards the end of the MA lesson. A PST appreciated this task but suggested that the theorem could have been written in "a more mathematical" way by the teacher. This comment was coded *Match*, as the experts would welcome it if the theorem were correctly written mathematically. However,

[2] 'I want to see this! Very well! Be careful!'

Tab. 8: Alignment of PSTs' alterations with experts (%)

	Match	*No match*
EEL	87.5	12.5
ESS	79.0	21.1
EAE	80.0	20.0
EL	60.0	40.0
BI	89.3	10.7
MA	81.3	18.8
TOTAL	**82.1**	**17.9**

they saw a more pressing alteration in this part of the lesson; the task was above the pupils' ability at this stage of learning, and more time should be devoted to letting pupils formulate the theorem in their own words.

According to the experts, *No match* (17.9%) alterations would not enhance teaching. An example is a comment on the BI lesson: "I do not think this way of teaching should be used to introduce a new subject matter. A table is an excellent tool which enables sorting out information. Still, I would use such type of lesson only for the revision of the subject matter." According to the experts, sorting out data through a table can be successfully used for the inductive introduction of subject matter. Another example is a PST's suggestion "to concentrate on only one activity leading to Thales's theorem, not two". From the PST's analysis, it was clear that he does not understand that the two activities are not the same but differ in the direction. It does not agree with the experts' view as the two "activities" in the lesson represent two directions of implication which make Thales's theorem.[3]

5 Discussion and implications

It is documented in the literature what PSTs pay attention to and what they neglect in a video lesson. It is less clear how their noticing and reasoning relate to that of experts. Based on the frameworks of instructional quality (Janík et al., 2019; Kaiser et al., 2015; Litke et al., 2021; Schlesinger et al., 2018; Seidel & Shavelson, 2007), we determined six dimensions which we found applicable in selected lessons across subjects. In Study 1, the experts distinguished and interpreted the situations deemed important for pupils' learning of new content to develop a target against which the PSTs' responses were compared in Study 2. Our literature search confirmed that studies using such targets are rare (McDonald, 2016; Mitchel & Marin, 2015; Steffensky et al., 2015; Stockero & Rupnow, 2017; Vondrová & Žalská, 2015).

We showed that PSTs at the end of their university study found it difficult to notice content-related situations deemed important by the experts, as they mentioned half of the expert phenomena. The same conclusion was reached for PSTs' ability to notice generic aspects pertinent to instructional quality (Schäfer & Seidel, 2015). Subject-focused research on expert-like noticing seems to exist for mathematics only. In Stockero and Rupnow's (2017) study, PSTs noticed one-third of the events determined by experts as examples of Mathematically Significant Pedagogical Opportunity to Build on Student Thinking. PSTs' mean score in Star et al.'s (2011) study for what they call important moments was 53% (ours was 48%). Little attention to the subject-related expert phenomena was found in a study with mathematics PSTs at the end of university with the same educational experience as our MA group (Vondrová & Žalská, 2015); the median was 2, while the expert value was 7. The results in the present study are better, which can be attributed to the way the expert target originated. Mathematics educators made it in Vondrová and Žalská's study, while experts from five fields were involved in the present study and the phenomena deemed important by the experts in mathematics education but not visible to the experts outside the field were excluded.

About half of the comments of our sample bore no sign of knowledge-based reasoning. The PSTs described the events and/or made personal judgments about them. In the other half, an explanation based on their experience as pupils or naïve assumptions prevailed. Concepts from learning and teaching theories introduced during their university studies were only present in 20% of comments. The PSTs in Schäfer and Seidel's (2015) study also struggled when reasoning about important events. For goal clarity, nearly 73% of their comments were naïve assumptions with judgmental character, and only 27% included the use of professional knowledge. For learning climate, it was 89% against 11%.

Another focus of our study was on the agreement between the PSTs and experts. The PSTs' comments fully aligned with those of the experts in less than a third of the cases and partially in another third.

[3]In Czech textbooks, Thales' theorem is formulated as an equivalence.

The PSTs who provided the rest of the comments could not apply their knowledge outside the university course. This supports the literature showing that PSTs struggle to apply theoretical notions in practice (e.g., Hammerness et al., 2002).

Two of the few studies comparing the PSTs' and experts' views available to us reached similar results. In Schäfer and Seidel's (2015) study, the PSTs' reasoning matched the experts' in about a third of their statements for goal clarity and a quarter for learning climate. Blomberg et al. (2011) found for PSTs of different subjects that the average agreement with the experts' views was 31%.

Determining what is important in a lesson is not trivial for PSTs. Moreover, we must remember that PSTs' "acquired professional knowledge is not yet very elaborated and still is determined by naïve judgments and subjective theories" (Schäfer & Seidel, 2015, p. 36). Our study supports the body of research calling for developing PSTs' professional vision in both its aspects (noticing and knowledge-based reasoning), e.g., in video interventions supported by scaffolding frameworks (e.g., Santagata, 2011; Stockero & Rupnow, 2017). As the PSTs struggled with noticing situations deemed important by the experts, we suggest that university courses target the content dimensions of instructional quality and how they manifest themselves in lessons. The PSTs would also benefit from tasks on reasoning about the consequences of events and suggesting alterations. They should be given multiple opportunities to apply theoretical knowledge to concrete lessons.

6 Limitations and conclusions

Our conclusions should be considered in light of a limited sample. It did not allow us to draw any conclusions regarding similarities and differences between subject groups which the tables presenting results seem to suggest. In some cases, the number of units is low, and no conclusions are possible about differences (see, e.g., the number of alterations suggested by all the PSTs or the number of comments coded Evaluating, Theorising, etc.). Some differences, though, seem to be present. For example, concerning the two English language groups (EEL and EL), they used theorising most often (Tab. 5), and the vast majority of their comments were in agreement with the experts' views (Tab. 6). This observation may be a result of the selected lesson. The EEL lesson might provide more opportunities (and more recognisable) than the other lessons used in our study for PSTs to apply a theory they learned. In such a case, they could be assigned another lesson for reflection (with a different topic, different teaching-learning situations, etc.). Then the analysis of the two lessons could be compared. However, such a task would be enormous (if not impossible), given the number of characteristics present in a single lesson which could be varied. Another reason for the diverging results of the EEL/EL groups might be that they learned more theory (or in a more appropriate way, enabling them to grasp it better) than the other PSTs in our study in their subject education courses. Yet another reason might lie in the sample itself – this group of PSTs might have more developed knowledge-based reasoning than the other groups within our sample. Indeed, Simpson and Vondrová (2019) found differences in noticing skills between two samples of mathematics PSTs with the same background and in the same stage of their university education.

Thus, at this stage of analysis, no conclusions can be made about the differences between subject groups. However, in a future study, the analysis could delve deeper into the content of the PSTs' comments to see the characteristics of those expert phenomena in which the PSTs were (or were not) able to apply theory and agreed (or did not agree) with the experts' views. This goes beyond this paper and would merit a separate paper for each subject group.

Another limitation of our study is the type of task we used – it was formulated openly. A future study could use a more specific task to focus PSTs' attention and, moreover, ask for justifications and alterations, which we did not do. Assigning the task as homework might have enabled the PSTs not to make their best effort. However, the diversity and length of their responses suggest that it was not the case.

Another limitation concerns the noticing target. It originated through a comparative judgment whose validity is based on the collective expertise of a community of experts from different fields. Still, it remains subjective and might be skewed towards the researcher professional vision. In a future study, experienced teachers could participate in the expert analysis (Lefstein & Snell, 2011; Roose et al., 2018). No experts outside the research team validated the noticing target, which is another limitation (although not uncommon, e.g., in Mitchel and Marin's (2015) study, both researchers were master raters). Dreher et al. (2021) point out that any norm for teacher noticing is necessarily culture-specific; thus, our conclusions must be read in Western culture.

The question of visibility of situations comes to the fore as our sample did not see the same lesson. Similarly to Blomberg et al. (2011), we tried to account for this by balancing the input from an expert in the field, able to spot hidden features of the lesson, with the inputs from researchers from different fields. By an elaborate way of selecting the phenomena for each lesson, we strove to ensure that they were similarly observable. Moreover, all the selected phenomena allowed for higher levels of reasoning and, thus, presented comparable conditions for PSTs to manifest their knowledge-based reasoning.

To sum up, our study brought new insights into the understudied area. Unlike prevailing research focusing on what PSTs attend to and how they interpret it, we also investigated the content of PSTs' comments and whether it aligns with what experts accept. Most PSTs in our sample about to start teaching could not discern situations important for deep work with content in the lesson and apply their theoretical knowledge for interpreting them. The ability to do so is necessary for their future careers as teachers, and thus, we need to know how their noticing and reasoning relate to those of experts. More studies are needed to validate our results with PSTs of various subjects and different lessons (or clips).

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