WHAT DO STUDENT TEACHERS ATTEND TO?

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The ability to notice key features of teaching is seen as part of student teachers' pedagogical content knowledge. The study shows what student teachers focus on when they have no experience of guided observation of lessons either in reality or on video and when they are not directed by the educator. Some preliminary findings from a wider study are presented which are in line with other existing research: namely, that the student teachers neglect the subtleties of the introduction of the mathematical content.

Keywords: pedagogical content knowledge, ability to notice, student teachers, videos

THEORETICAL FRAMEWORK

The notion of pedagogical content knowledge (or PCK) was first introduced by Shulman. The teacher needs understanding of the material he/she is teaching, but he/she also needs the "knowledge of the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations – in a word, the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1986). He/she needs to be aware of topics with which pupils might have difficulties and of their common misconceptions and misunderstandings. Bromme (2008) claims that PCK can also be seen in the ways the teacher "takes into account pupils' utterances and their previous knowledge". An (2004) stresses four aspects of the effective teacher's activity in the classroom which are part of PCK: building on students' mathematical ideas, addressing and correcting students' misconceptions, engaging students in mathematics learning and promoting and supporting students' thinking mathematically.

Thus, in my opinion, part of PCK is the *ability to notice*. In order for the teacher to take into account the pupil's utterance and build on his/her understanding, he/she has to notice the importance of this utterance in the first place, put it into the appropriate context, interpret it and only afterwards use it. According to Sherin and van Es (2005), *noticing* involves a) identifying what is important in a teaching situation, b) making connections between specific classroom interactions and the broader concepts and principles of teaching and learning that they represent, c) using what teachers know about their specific teaching context to reason about a given situation. This study is mainly concerned with the first aspect of noticing.

The (student) teachers' ability to notice is important for the development of what Mason and Spence (1999) call *knowing-to*: "Knowing-to is active knowledge which is present in the moment when it is required." They distinguish this kind of knowledge from knowing-that, knowing-how, and knowing-why. Knowing-to triggers the other types of knowing and thus its absence blocks "teachers from responding creatively in the moment" (ibid). While Mason and Spence mostly concentrate on the way knowing-to develops in pupils (e.g., while solving problems), they also touch on educating teachers to be able to know-to: "We propose that knowing-to act in the moment depends on the structure of attention in the moment, depends on what one is aware of. Educating this awareness is most effectively done by labelling experiences in which powers have been exhibited, and developing a rich network of connections and triggers so that actions 'come to mind'". (ibid)

In the same spirit, Ainley and Luntley (2006) propose the term *attention-dependent knowledge* for the knowledge that enables teachers to respond effectively to what happens during the lesson. It can only be revealed in the classroom. The analysis of videos can help us to label such events when this kind of knowledge is at play.

To sum up, the ability to notice seems to be an important component of the (student) teacher's PCK. This ability can be developed, among others, by analysing videorecordings of the teaching of others and our own (e.g., Sherin & van ES, 2005; Star & Strickland, 2008; Muñoz-Catalán, Carrillo & Climent, 2007; Hošpesová, Tichá & Macháčková, 2007). Most of the studies confirm that (student) teachers must learn what to notice. Santagata, Zannoni and Stigler (2007) found out that "more hours of observations per se [...] do not affect the quality of preservice teachers' analyses" and on the other hand, Star and Strickland (2008) claim that the ability to learn from observations of teaching "(either live or on video) is critically dependent on what is actually noticed (attended to)".

The study presented here is a part of a wider study aimed at exploring how student teachers' ability to reflect on their own teaching and the teaching of others can be developed and what the characteristics of this development are. Here, I will restrict the questions to:

What do the student teachers focus on in a pedagogical situation, on their own, that is, without any expert drawing their attention to important moments?

How deep are their observations?

How do their evaluations of the same moment differ?

METHODOLOGY

The participants of the study are student teachers, future mathematics teachers of pupils aged 11 till 19. They are in their 4th or 5th year of study. In particular, the students whose work is dealt with below were in year 4 and had one term of the Mathematics Education (or ME) course previously (partially not taught by me). From now on, "students" will be used for student teachers and "pupils" for pupils taught in the observed lesson.

In order to answer the research questions, we need to put students in a situation in which they will be confronted with a mathematics lesson but in which an educator's influence is minimal. The first, obvious, type of data are received from *individual students* who are asked to write unstructured reflections about a video recording of the whole mathematics lesson. They watch it at home. However, a discussion between students can perhaps lead to a richer analysis. Thus, the second type of data is gathered from *pairs of students* who are asked to analyse a lesson on video. They do it at school, in an empty office, without the educator's presence, and they are being video recorded. In order to find out their immediate reactions, they are asked to stop the video whenever they feel that something deserves commenting on and to say the comment aloud to each other.

The collected data are organised in two ways: a) According to the lesson observed: the same videos of teaching have been used repeatedly so that reactions from different students are received. b) According to the type of origin, i.e., individuals' reflections, pairs' discussions, my teaching (videorecordings of the ME course in which video analyses are sometimes used), teaching practice (students' descriptions of didactical moments which they consider to be important when they observe lessons; their very choice and evaluation of these moments can be of importance).

The data collection still proceeds. In this article, I will restrict myself to the data connected to one particular lesson (see below) which was analysed by 3 pairs of students and 4 individual students. Their list follows (pseudonyms are used). In parentheses, the students' study results are given, received as a weighted average of their marks from mathematical courses during their first 3 years of study at the Faculty (1 is the best mark): A – 1, B – (1, 2), C – higher than 2.

Pairs (video recordings, transcripts, written reflections): John (B) and James (C), Molly (A) and Mark (B), Lota (A) and Meg (A)

Individuals (written reflections): Zina (B), Jack (B), Lance (C), Paul (B).

The students were told that they would be given a recording of an Australian mathematics lesson from Grade 8 from TIMSS Video Study 1999 and that the topic was the division of a quantity in a given ratio. The lesson in question was used on purpose – I believed that there was a lot to be noticed and, on the other hand, to be missed. Moreover, I supposed that the students would feel more interested in a foreign lesson.

The students were also given the teacher's preparation and self-reflection (written by her after viewing the video recording of her own lesson) and pupils' worksheets. They watched the video in English with the Czech subtitles. Pairs of students could write a reflection if they wanted (to complement their discussion while viewing the video), while the individuals were obliged to write a reflection. It was an unstructured reflection. They were told that they could write whatever they wanted or felt important.

In the data analysis, I had in mind six key moments which, in my opinion, were important from the point of view of the mathematical content and its presentation in the lesson. Their short description together with my perception from the lesson in question follows.

1. Manipulation. The division of a quantity in a given ratio is introduced using the model of cubes and boxes. This should help pupils to build an image of the whole process.

Comment: The pupils first work with cubes and create ratios such as 1 : 2, 5 : 8, etc. Then they work with empty boxes. When solving problems, they are asked to first model the situation and only then to calculate.

2. Block versus box. While blocks are counted as separate individuals, the empty boxes stand for a certain unknown number (or amount). Each must contain the same number (or amount). The letters *a, b* in the ratio *a* : *b* stand not only for a certain number of things but also for groups of (or boxes full of) things.

Comment: The pupils are asked to imagine that there is a certain number of things (or a certain amount of money) in each box and to solve problems such as divide 210 dollars in the ratio of 2 : 5. The teacher often refers to the boxes and asks, e.g., how many things are in one box (when looking for a unit quantity). The pupils are asked to actually move boxes on their desk to the left or right according to the ratio.

3. Relationship between the ratio and quantity. In order for the division of a quantity in a given ratio to have integer answers, the whole quantity must be divisible by a unit quantity.

Comment: The teacher wants the pupils to think of their own story problems with ratios but she realises that there might be a problem if they do not see the relationship in question. She probably thinks that a non-integer answer would add to the cognitive burden and unnecessarily lead the pupils away from the idea of ratios. She, therefore, asks them whether they see this relationship. The pupils seem not to know what to do so the teacher points to the already solved ratios and to the numbers which she deliberately chose. When one girl says that the quantity must be “easily divisible”, the teacher picks her idea up and explains the relationship. The question remains whether this important idea could have been found by the pupils themselves when trying to think up (and solve) their own story problems.

4. Simplifying ratios. We know from the teacher’s reflection that the pupils should know about simplifying ratios from the previous lesson.

Comment: In the classwork, the need to simplify ratios does not arise. When the pupils work on posing problems, the teacher moves around and check them. A pupil has a ratio of 4 : 6 and the teacher says that “it would be better as 2 : 3, because we like simple ratios”. After a minute, she can see another pupil with a ratio of 6 : 3 and this time, she does not mention this possibility. There is no comment on simplifying ratios later during the classwork.

5. Two methods. The unitary method is based on finding the unit and then multiplying it by the numbers in the ratio. The fraction method enables us to calculate each share by multiplying the quantity by a fraction, i.e., given *a* : *b*, quantity *q*, then the first share is *a* / (*a* + *b*) times *q*, etc.

Comment: The teacher demonstrates the fraction method on 3 examples written on the board and previously solved by the unitary method. In my opinion, it is rather quick and the pupils do not have any opportunity to actually try it. No wonder that, when asked to vote which method they prefer, they vote for the unitary method (which they used throughout the lesson).

6. Pupils' problem posing (or PP). When asked to pose their own problems, pupils are encouraged to think about the matter more deeply and the teacher can assess to what extent they understand it and where the problems lie. It is usually motivating for them. In my opinion, it is advisable to ask pupils to solve the problems, too, as it makes them focus on the mathematical part as well as the context.

Comment: The teacher asks the pupils to think of their own question with a ratio and then talks about making a "story". This might have contributed to most pupils producing a story without a question.

The problem posing activity enabled the pupils to grasp the difference between the two types of task: to look for a ratio, and to divide a quantity in a given ratio. The pupils apparently mixed the two types together and the teacher became aware of this fact only on the basis of this activity (based on her reflection).

The above six key moments were the springboard from which I started the data analysis. All the data were uploaded to the software *Atlas.ti* as separate documents. The documents were coded first using the six items (their names were used as the code names) and then open coded in the sense of Strauss and Corbin (1998), analysing a whole sentence or a paragraph rather than line-by-line because, especially in the pair experiment, one idea was spread in students' several utterances.

During the coding process, five more codes emerged as important for some students. Thus, I tracked them in all the reflections.

7. Involvement of pupils. It shows to what extent the pupils are actively involved in the construction of new knowledge (as far as we can say that from the video recording only!) and other mathematical work in the lesson. It involves two free codes: Pupils' activity and Pupils' understanding.

Comment: It is difficult to generalize, but at many stages of the lesson I have the impression that the pupils are not given enough time to think the questions over and find the solutions themselves, but rather that they are given the solutions by the teacher immediately. They are almost never encouraged to explain their thinking or strategies, but rather the teacher offers the explanation and corrects their mistakes.

8. Elaboration – consequences. It involves the elaboration of the observed teaching practice in terms of its possible consequence for the pupils' understanding or for the flow of the lesson. (See below for examples.)

9. Elaboration – their teaching. It concerns the elaboration of the observed teaching practice in terms of its possible connections with the students' future teaching practice.

10. Alternatives. It means suggesting an alternative action to what actually happened.

11. General perception. It means a general perception of the lesson based on the codes Chaotic versus calm, Teacher's personality, Teaching method, Appraisal / Criticism of the teaching practice, Classroom environment, Empathy for the teacher.

PRELIMINARY RESULTS

The results will be first presented in the form of two tables and then discussed.

<u>Explanation:</u> "+" – the student mentioned the item (it will sometimes be briefly given in what way), "x" – it did not appear. T stands for the teacher, Ps for pupils. In item 7, | means a reference to pupils' potential understanding. In item 10, | means a reference to the mathematics of the lesson, * to the organisation of the lesson.

<table>
<tr><th>Pairs</th><th>John + James</th><th>Molly + Mark</th><th>Lota + Meg</th></tr>
<tr><td>1. Manipul.</td><td>+ no elaboration</td><td>+ "good idea"</td><td>+ good for Ps, they "see it"</td></tr>
<tr><td>2. Block/box</td><td>+ consider them the same</td><td>x</td><td>+ see the difference</td></tr>
<tr><td>3. Ratio vs. quantity</td><td>x</td><td>x</td><td>+ T should simply say it as a rule</td></tr>
<tr><td>4. Simplify</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>5. Two methods</td><td>x</td><td>+ very quick, voting nonsense</td><td>+ not 2 methods but a different notation, T should've stressed the common properties; voting nonsense</td></tr>
<tr><td>6. Pupils'PP</td><td>+ consider it nonsense</td><td>+ good, story vs. task</td><td>+ good</td></tr>
<tr><td>7. Involv. of pupils
Ps' unders.</td><td>+ T shows the methods, explains where there is a mistake |</td><td>+ pupils are only passively involved
|</td><td>x
|||||</td></tr>
<tr><td>8. Conseq.</td><td>x</td><td>+ PP – T can see how Ps understand</td><td>x</td></tr>
<tr><td>9. Teaching</td><td>x</td><td>+ "I tried to imagine myself in T's shoes."</td><td>+ "What to do with quick pupils?"</td></tr>
<tr><td>10. Altern.</td><td>****</td><td>**|*|*</td><td>|||||****|*|||</td></tr>
<tr><td>11. General perception</td><td>chaotic, no system, T lacks organis. skills, no bird's view eye, doesn't care what Ps do, doesn't understand what Ps say</td><td>T is calm, does not get angry, no emotions, Ps comfortable with the work</td><td>T changes activities</td></tr>
</table>

Individuals	Zina	Jack	Lance	Paul
1. Manipul.	x	+ good for Ps, but not enough time	+ good for	x

		for solution	understanding	
2. Block versus box	x	x	+ can see the difference	x
3. Ratio vs. quantity	+ it is the key question	+ thinks that Ps found it	+ Ps should have found it in PP	x
4. Simplify	x	x	x	x
5. Two m.	x	x	x	+ good
6. Pupils' PP	+ good	+ good	+ good	+ good, but above Ps' abilities
7. Involv. of pupils **Ps' under.**	+ Ps discover the knowledge for themselves	+ not enough time for own discovery of knowledge	+ Ps not involved enough	
8. Conseq.	+ PP – good for cooperation, application of math. in reality, motivating	+ PP – good for Ps' understanding	x	+ PP – breaks stereotype of problem solving
9. Teaching	x	x	x	+ "I have tried PP with pupils."
10. Altern.	*	x	***	x
11. General perception	T leads Ps from concrete to abstract knowledge, towards relationships, waits till Ps find knowledge themselves	a calm lesson, probably too calm	too noisy, more discipline is needed	x

If the item is missing from the students' reflections, we can presume that they did not notice it <u>or</u> did not attribute any importance to it.

DISCUSSION OF RESULTS

Discussion of individual items

Manipulation was seen as important for the mathematical content of the lesson 4 times out of 7, however, only Lance and one pair could see the difference represented by blocks and boxes. Despite the teacher's frequent reference to it, John and James consider them the same and from their discussion we can infer that they are lost in the mathematical part of the activity. This aspect, which I see as important for the development of pupils' knowledge of ratio, was not mentioned at all 4 times out of 7.

The question about the relationship between the quantity and ratio was noticed 4 times out of 7 but another mathematical item about simplifying ratios was not addressed at all. The "two method" item was only mentioned 3 times and in 2 of them, the vote was rejected as nonsense on the grounds that the pupils did not have time to actually try it.

Pupils' problem posing was commented on by all students and mostly judged positively. John and James have another view but they do not give any reason for it.

The students made interpretative comments, too. In most cases they commented upon the problem posing activity and its advantages. The reason why they actually thought about this type of activity deeper might be that it was novel for them. In Czech schools, problem posing by pupils is quite rare. Only 3 times, the students elaborated a little on what they saw from the point of view of their (future) role as teachers.

In many cases, the students suggested alternative actions for both the organisational and mathematical aspects of the lesson, often after a critical remark about what actually happened in the lesson.

Comparison of reflections

Two pairs stand out in the quality of reflection. At the one end of the spectrum, John and James made a lot of critical remarks but only suggested alternatives to the organisational aspects of the lesson. They probably did not give much thought to the mathematical part (except for frequent comments at the beginning of the lesson that "it makes no sense what the teacher does") and did not think about the types of tasks the teacher used. Their dialogue is mainly descriptive without any elaboration of what the event might mean. They are extremely critical about the lesson and, of the 10 students are the only ones to make critical comments on the personality of the teacher and her skills.

At the other end, Meg and Lota also did not understand at first where the teacher was heading with modelling but after much effort and discussion, they grasped it. They comment on nearly all mathematical items. They make the most references to pupils' possible understanding and suggest the most alternatives, most of which are for the mathematics of the lesson. Their level of reflection is deeper than the boys' one. I believe that, among others, their content knowledge might have influenced this difference. While Meg and Lota have A's, John has B and James has C. Their insufficient knowledge of mathematics and thus inability to see where the teacher was leading the pupils might have influenced their appraisal of the lesson.

Finally, quite surprisingly for me, there are opposing views concerning the same items. While Jack believes that the pupils discovered the relationship between the ratio and quantity themselves, Lance suggests otherwise as he points out that the pupils should be allowed to discover it when posing problems.

The involvement of pupils in the development of knowledge is also differently judged. While Molly and Mark, and Lance (and indirectly also John and James) think that the pupils were rather passive and the teacher did the explanation, Zina believes that the pupils were actively involved and Lance suggests that the teacher wants them to be more involved but that allows them little time.

The general impression from the lesson differs widely. John and James, quite understandably considering the above, see the lesson as chaotic, with no system, and have little empathy for the teacher. Molly and Mark as well as Jack consider the lesson calm and the pupils comfortable with the work. For Lance, there is little discipline and too much noise in the lesson.

It might have been illuminating to let the students discuss their opposing views to see on what grounds they put their claims. As it is, we have little information as to the reasons for the discrepancies.

Star and Strickland (2008) also studied preservice teachers' uninfluenced responses to a lesson on video, thus it seems appropriate to compare their results with mine. They let the students watch the video and take notes and then asked them questions concerning 5 aspects of the lesson which they should answer based on their memory and notes. (They did not look, however, into how the students interpreted the events.) The five aspects were: Classroom environment, Classroom management, Communication, Tasks (refer to the activities pupils do in the class; it includes my code Pupils' problem posing), Mathematical content (it includes my codes Manipulation, Block versus box, Relationship between the ratio and quantity, Simplifying ratios, Two methods). The first three dimensions are not among my codes as the students did not mention them. My remaining codes concern interpretation and, as such, cannot be put into the five categories.

Star and Strickland (ibid) found that without any training, the investigated student teachers were good observers of Classroom management, quite attentive to the category of Tasks and did least well on Classroom environment (in my study, the students hardly mentioned it, too) and Mathematical content. The authors say that "preservice teachers largely did not notice subtleties in the ways that the teacher helped students think about content" and "the mathematics of the lesson and the students' understandings of that mathematics were not noticed [...], either in the initial or in the second viewing of the video" (p. 118). This is echoed in the preliminary findings of my study where the mathematics of the lesson was rarely attended to.

FUTURE WORK

In order to answer my research questions, more analysis is needed. While doing the open coding, the elements of the following stage of analysis, that is axial coding, gradually emerged and some categories began to be assembled. Clearly, some codes are connected with the mathematics in the presented lesson only (e.g., Two methods) while others are more general (e.g., Alternatives). Some codes are closely tied (e.g., Alternatives and Elaboration – their teaching). In my further work, the various types of data for different lessons will be coded. It is assumed that during this process some categories will emerge which would help me to concentrate on some of them not in one type of data or in the data tied to one particular lesson, but more generally. It may also be valuable to compare reflections received from individuals and those from pairs. Does a discussion between students influence the depth of their considerations? This will also be the focus of my future work.

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