Task related attention during student-teacher interaction in Swedish mathematics classrooms

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Abstract
What aspects of a mathematics task do students attend to when interacting with the teacher? In this article three different types of mathematics task-related attention are discussed. The overall purpose is to find out how students can be guided to direct their attention towards content matter in student-teacher interaction, and how this can be useful as implications for the practising and novice teachers when designing lessons. Lessons from 8th grade in a Swedish school were analysed and different variants of task-related attention during student-teacher interaction were discovered: i) Relevance of a task, ii) Solving a task and iii) Validating a task. In this article, excerpts will serve as empirical evidence of three types of task specific attention in chronological order, describing the focus of attention in student-teacher interaction during a lesson.

Keywords: Mathematics Education, Attention, Video analysis, Student-teacher interaction

1. Background
This study is a part of my thesis work on attention, interest and engagement in mathematics classrooms. One of the official aims in Swedish school is to develop interest towards mathematics. Interest as an educational concept has evolved from being a trivial, everyday term for internal/external state of affect, to empirical studies on interest towards content specific situations (Dewey, 1913; Mitchell, 1993; Krapp, 2002; Bikner-Ashbahs, 2002;). There is empirical evidence to support the importance of interest in relationship to learning mathematics. The relationship between interest and learning was established through quantitative analysis and resulted in a reciprocal relationship between interest and learning (Ma & Nand, 1997). In other words learning affects interest and vice versa. Influences by this antecedence of interest to learning, the process of interest can on a classroom level be approached through analysis of mathematics lessons. The intention of an empirical approach on interest leads us to initiating a study of task related attention. That is, attention directed towards subject matter in mathematics originates from this pedagogical dilemma. Also, it is important to stress that the concept of interest in studies of teaching and learning has certain features that are unique, not shared by motivational research. Hopefully this study will contribute with insights in how the students attend to specific features of a task in their interaction together with the teacher when certain content matter focus. Attention as an object of study “is not a thing, at least in the sense of some thing to which you can point” (Mason, 2004, p 3). He gives a view on attention as a holistic process. When looking at what
students attend to, it is, according to Mason (2004) equally important to take in consideration how they attend.

2. Empirical Study

2.1 Aim

The overall aim of this chapter is to propose a student-oriented view on how attention is directed towards tasks during classroom interaction. It will be one of the few studies to consider that interest is constructed during a process of naturalistic classroom interaction. In this study, I include the concept of task specific attention as a part of task interest construction. Students’ focus of attention and what this attention is directed towards when dealing with mathematics tasks is investigated. In other words, interest is manifested in student’s way of attending a certain task. This provides a point of departure for an approach and analysis of empirical data. The question addressed in this study concerns students dealing with tasks within a specific topic area in mathematics, namely mathematical relations. Hence, we aim to outline students’ way of attending since attention is possible to observe. The main focus of this chapter is student voice during classroom interaction. Interaction has on a group level been described as “a collective pattern in how human beings understand and behave” (Emanuelsson, 2001, p 23). Based on this conclusion we turn to a way of understanding interest as an interactive process inside the classroom. The focus of this study is the process of interaction, primarily on student’s focus of attention when dealing with a task. In my study this point of departure provides an opportunity to give students a voice without decontextualizing learning situations, without neglecting the specific turns that might be of importance in the process (Cohen et al., 2000). This study highlights the active image of the student, without neglecting the teacher. Student-teacher interaction is chosen as a focus of analysis, because this form of interaction that frequently occurs during Swedish lessons (Kilhamn, 2011).

3. Method

The LPS data provides a rare opportunity to analyse development through students’ actions in detail, as well as to follow this interactive process in naturalistic settings (LPS, 2011). This data is a unique high quality data set where ethical aspects are taken in consideration at all the stages of data gathering. In this secondary data analysis attempt we spent time reducing extensive amounts of recordings and transcripts to a manageable number of sequences. In this study a secondary data analysis of video sequences involved from 10 different lessons from the LPS data in one Swedish school (SW1). The aim was to investigate what aspects of tasks students attend to. Episodes from one particular lesson (SW1L10) were selected for further analyses. The lesson that was chosen for further analysis was especially rich in student-teacher interaction with content matter in focus. Categories that were generated from this material can be recognised as a result of a qualitative approach in order to “penetrate the situations in ways that are not always susceptible to numerical analysis” (Cohen et al., 2000, p 253). Visual data makes it possible to go back and forth in the data,
scrutinising it in collaboration with different research groups of various insights and perspectives. Therefore I chose to take specific precautions when handling and analysing recorded material. For one, the avoidance of material downloads to unprotected computer sources and the risk of spreading confidential material. Analysing recordings from the original source, in this case a server, highly protected by individual codes, was a suitable solution to this ethical issue. Also, as a part of validation, sequences were presented for working groups, courses and conference participants. In such cases of scrutiny the permission from students who participated in those sequences needs to be thoroughly controlled; there was permission to use the material. In some cases, permission was given for research but not for conference presentations and discussions. Those students were eliminated from the analysis.

Only students who agreed to be full participants are included, and everybody is referred to anonymously in the transcripts. The final precaution made had to do with the teacher’s role. When analysing a teacher’s actions it is important to keep a sensitive, honouring way of expressing oneself in the analysis. It is important not to become normative in a sense that values the teacher’s performance, but instead interpret what actions mean. These considerations correspond well with the legal requirements of confidentiality and utility according to Swedish recommendation, that individuals are protected from identification and not exploited for non-scientific purposes. Since this study is of an explorative character, not all ethical aspects are expected to be obvious from the beginning. By following general guidelines research participants’, teachers’ and students’, personal integrity is not neglected.

4. Results
In the following section we present three categories of what student’s attend to discovered during student-teacher interaction: i) Relevance of a task, ii) Solving a task and iii) Validation of a task. Hereby the results are presented with support from a set of episodes, where students’ attention is visible in student-teacher interaction. In order to interpret the presented data, we have revised lesson transcripts and impose the following key symbols:

, or . paus;
... unfinished sentence;
(...) speech impossible to detect;
[...] events or behaviour outside speech;
// simultaneous speech

Another common feature of the interaction in all the episodes is that the student is initiating the interaction by approaching the teacher with a question or a comment.
4.1 Relevance of the task: What do you need this for?
In the first episode, the student who is instructed to work individually tries to understand the relevance of the tasks on mathematical relationships.

Excerpt L10:1

04:54:16  Student  Where’s everything? [Leafs through the maths book]
04:54:26  Teacher  What’s it called?
04:57:24  Teacher  Yes yes. What do you mean?
04:58:19  Student  (...) 
05:00:07  Teacher  Yes //yes, you draw a line, yes you do. [Nods]
05:00:20  Student  //Yes but... It’s so... It’s like no one... It... I don’t know how to explain... Well... It’s so... It’s like... Yes, am I going to have any use for being able to draw lines ... I mean I
05:19:25  Student  I understand... well I sort of understand stuff like this... I(…)But why should I? And I can show where this point is (...) compared to that one.
05:20:07  Teacher  Yes well yes//But that’s really good...But that’s good, yes but that’s really good then
05:29:24  Student  //But I don’t want to, to keep on doing this for like 20 pages and stuff and carry on there and then there’s even... more (here)
05:34:11  Teacher  Yes but can you, can you, like, do it?
05:36:17  Student  Yes I think so?
05:37:19  Teacher  Yes well I think that you should do move on and stuff because in the red section...
05:40:28  Student  Yes. [Nods]
05:42:18  Teacher  (...) then there’ll definitely be things you can’t do. It’ll...
05:43:38  Teacher  It’ll be a bit more there (…) so it’ll be a bit different.

The student in Excerpt L10:1 is upset and involves the teacher in a conversation about the tasks suggested by the teacher. The student starts by approaching the teacher, who is standing next to her, and questions the relevance of the tasks. In this episode the teacher listens actively, responding by nodding and confirming the student’s concern (04:59:09, 05:40:28). He tries to direct student’s attention to the purpose of dealing with the tasks, by bringing up hierarchical structure of mathematics as a subject, where prior knowledge is important in order to deal with coming tasks. The student requires the long-term relevance of the topic and at the same time seeks for how mathematics can be justified as an important school subject.

Excerpt L10:2
The teacher hesitates when it comes to explaining the practical implications of the task (05:51:15). The student expresses that she will attend to the tasks if she finds out the relevance of them. The teacher now tries to provide a meaningful explanation. He does so by suggesting procedural purpose of mathematics (05:58:29). His first explanation of these tasks’ relevance to the student is to be able to interpret graphs in different situations and to become skilful when dealing with future tasks.

Excerpt L10:3

05:49:28 Student What do you need this for?
05:51:15 Teacher What you need this for? Yes, well the thing, the thing, the thing is... that it is good for... It’s that you will be able to read graphs and understand what they mean...
05:58:06 Student Hmm
05:58:29 Teacher ... and it’s not always so very simple. If you can do it and read and understand the difference between the pear and apple tree right here, or pears and apples, that’s good

The teacher argues with the teacher, she thinks that she is already able to work with the graphs (06:25:10). The teacher instructs her to do provide an area of application from everyday life that student can relate to (06:09.25). Also, at this point of the interaction the teacher signals that the conversation is over, by making an attempt to leave. The student resists this action and continues to express her frustration about plotting graphs.

Excerpt L10:4

06:09:12 Student Hmm
06:09:25 Teacher But it’s a really... It’s a really simple diagram (this one)... But I... I... It’s... it’s good if you’re practicing this because it’s... It’s I think important for everyone to be able to do. If you’ve got a graph in a newspaper you need be able to understand what the graph is. And later we’re going to talk a bit about
06:25:10 Student Hmm but that’s what I’m doing. It’s about (...)

The student argues with the teacher, she thinks that she is already able to work with the graphs (06:25:10). The teacher instructs her to do provide an area of application from everyday life that student can relate to (06:09.25). Also, at this point of the interaction the teacher signals that the conversation is over, by making an attempt to leave. The student resists this action and continues to express her frustration about plotting graphs.
This student is expressing unwillingness to carry out the tasks on mathematical relationships and does not seem to be satisfied with the given answer - she carries on arguing. She does not let the teacher leave and move on to the next student (06:29:17). She is still attending to finding out the relevance of similar tasks. She wants to avoid repetition of the tasks she already claims to master, as shown in the excerpt L10:4.

Excerpt L10:4 ends on a positive note, in other words on a positive note. In order to focus her attention on mathematical relationships, this student seeks for meaningful tasks. She shows her understanding of the topic as she interprets it, about drawing lines and comparing points plotted in a graph (05:00:20). It is the procedure and not the concepts she is determined to avoid (05:29:24). She opens up for an opportunity to continue the construction of interest as he justifies this topic (06:09:25). The student returns to that issue later in the interview, meaning that she can proceed with any task as long as she knows the purpose. What do we need this knowledge for? When is it applicable? Interaction involving the clarification of the relevance structure, both practical but also considering abstract sides of mathematics, can be a part of the process.

To sum up excerpts that form this episode (L10:1-L10:4), during this lesson sequence the student brings up a question on the relevance of tasks that involve plotting graphs. This insight indicates that interest can be approached as a co-construction with the aspect of relevance in focus. The teacher tries to convince her with examples of practical implication in everyday life, such as “to read and understand curves in newspapers”. In the beginning the student was upset, questioning the relevance of dealing with this content matter. The student revealed her way of understanding mathematical relations while reflecting on her own knowledge. When she claims to already be capable of understand representations in diagrams and graphs, it becomes visible that she is doubting her own ability to do so. She does not want to attend to a procedure on a topic she claims to master.
At the same time, in her interaction with the teacher, she shows insecurity indicating there might be gaps of knowledge (05:36). Arguments that the teacher suggests for letting the student continuing doing something she already claims to know is that it is necessary; that basic knowledge is constituted by solving simpler tasks and is a condition for to solve more complex tasks. There will be, according to the teacher, new challenges later in the chapter, the red section. The student in those excerpts is interested to pursue repetition only if she can see a relevance of the tasks. In other words, the student pays attention to the relevance of content matter, and she does so in a passionate way. By questioning the relevance she begins to construct interest in the interaction with the teacher.

4.2 Solving the task: The bigger the x-value, the steeper the graph
Next scenario aims to capture a type of attention unit where the student communicates a wish to clarify mathematics strategies within a specific task. The student is focused on solving the task and concentrates the communication around that aim: The task itself is marked with a star, which means it is on a higher level than ordinary tasks (Figure 2).

Imagine the following relationships to the drawn in a diagram.

of the following
a) are parallel lines
b) start in origin.

Figure 2: Representation of the task the student is working on

Excerpt L10:5

47:55:05 Student ... are parallel [reads the task]
47:55:26 Teacher Yes

48:17:15 Student Yes ... They can’t be parallel because they

48:20:24 Teacher Why is... Why can’t they be parallel?
48:22:17 Student Well because it’s... It changes... yeah
48:22:23 Student (...) A lot higher up #2

48:26:15 Teacher Good, you’ve come a long way. What is this?
What sort is this? Who... What determines how much it is changed or how, how much it slopes?

48:33:13 Student That!
#2
Teacher Yes, exactly, the one next to x there.

Student Yes.

Teacher The bigger x you have, what happens then with a graph?

Student //Mhm

Teacher It goes up more quickly, doesn’t it... Hmm... How quickly does that one go up?

Student Quite quickly?

Teacher Yes because for one step on the X-axis it rises...six steps on the Y-axis ... and on that one then... so for one step on the X-axis it also rises... six... steps on the Y-axis

Student (maybe) [says it in English]

Teacher Yes but look here.

Student #2 (maybe) [says it in in English]

The student in excerpt L10:5 approach the teacher and a teacher-student interaction takes place. The student initiates the conversation by raising her hand and wishes to determine which lines are parallel and pair those together. At the same time as a peer student becomes involved by joining the conversation and task solving. In order to solve the tasks, the students focus their attention on teacher’s questions. This student has a hard time keeping her attention on the procedure in the task through the episode. The conversation becomes teacher-driven. Attention in this case is directed towards answering teacher’s questions. The teacher explains how the shape of the line changes depending on the x, and the student seems to be insecure and guessing in the beginning (48:47:26), how the student can find a satisfactory solution to the task. There is doubt in the students’ comments, and that indicates that the students have not understood. Due to lack of understanding they are still trying to guess the answer or say what is expected of them in the conversation (48:47:26; 49:06:15; 49:07:14).

Excerpt L10:6

49:08:12 Student But what are you doing now, do I have to look?

49:24:17 Teacher One two three... Eeer, here... That’s zero... It goes from the origin

49:31:11 Student Hmm

49:31:17 Student #2 Hmm

49:32:05 Teacher Does this one go from the origin?

49:32:27 Student Yeah

#2
In excerpt L10:6 we observed the rapid flow of teacher’s questions followed by students’ answering more and more simultaneously. Directly after every explanation, the students’ attention is caught again. Attention becomes visible in the data when the two students start to form a unity in answering question (48:41:07; 49:35:21). Second student (S2) turns towards the teacher and the first student when the teacher is suggesting a way to solve the task, when he starts explain the development from the origin (49:24:17). The co-construction of interest in form of overlapping speech becomes frequent, in fact every time the teacher receives an answer.

Excerpt L10:7

49:33:14 Student   Mmm (nodding)
49:33:22 Teacher   Does this one go from the origin?
49:34:06 Student   No
   #2
49:34:15 Student   Nah
49:34:26 Teacher   Does this one go from the origin?
49:35:17 Student   //no
   #2
49:35:21 Student   //no

49:35:27 Teacher   No. That’s good. Now we’ll get an incline on this one and how much it inclines, it’s, if I know that this is x six, then I know that for one step it inclines six
49:45:00 Student   //hmm
49:45:05 Student   //hmm
   #2
49:45:09 Teacher   Two steps then, it’s going to rise, 12.
49:47:29 Student   //hmm
49:48:04 Student   //hmm
   #2
49:51:09 Teacher   This one on the other hand... It actually starts on 20... And for each x it’s only going to rise two
50:02:21 Student   [Approaches T by patting him on the back, tries to get his attention]
   #3
50:04:05 Student   Yes but that one also starts on 20
50:05:23 Teacher   That also starts on 20
50:06:13 Student   You’ve drawn that
50:07:23 Teacher   But was it that... aha
50:09:26 Student   But was it that... aha
50:12:06 Teacher   So that starts there as well but it’s going to have.... the same... So those two are going to be parallel... Because they have the same “incline coefficient” - is what it’s called
In particular, in L10:7 the teacher is active; he tries to shift students’ attention to the main question. The structure of the conversation is presenting the procedure to the student in chronological order emphasises the important knowledge. In contrast to the first example, here the focus of attention is not on finding relevance; he does not define or try to specify the meaning of parallel lines and what it can mean in practise. However he wants to communicate the key message: the larger the x-value, the steeper the graph. Also, in the beginning the student gets acknowledgement for her pre-knowledge and at the end support for her understanding of the concept. Up to this stage both students confirm that they understand what the teacher was trying to say (50:26:05; 50:26:11). It seems as if the student has understood how to determine if two lines really are parallel (50:38:26).

Excerpt LT10:8

50:40:14 Teacher Do you understand?
50:41:05 Student Yep.
50:42:25 Teacher So those two are parallel.
50:44:01 Student Okay.
50:44:21 Student Okay.
    #2
50:46:01 Teacher Are those two parallel?
50:48:29 Student Can never be.
50:50:28 Teacher Exactly, they can never be, right, this one here only increases by two for every step that one slopes a hundred.
50:54:08 Student Then it should be two.
50:54:15 Teacher [Nods]

The teacher is trying to test if the student can apply what they have learned about the parallel lines (50:40:14). During this conversation, both students confirm that they have learned what the teacher was trying to explain about parallel lines (50:41.05-50:44:21). However it is possible that students confirm or give a positive reply because it is expected of them as a part of interaction. Next step the teacher choses is to let the students show that they can apply their knowledge in a new example on the same theme. The teacher poses a
question whether the students can determine if two other lines are parallel (50:46:01). When the student gives a correct answer and also provides details on the new task the teacher accepts the answers (50:54:08, 50.50.28) and it can be concluded that learning has been taking place. Rephrasing the answer and adding to the earlier explanation is a strategy this teacher uses to find out if the students learned (50:50:28).

The two students are engaged in the same task. Student number one is interacting with the teacher, while the other student is initially passive in the conversation, but instead engaged as an active listener, which is indicated in the data by her way of concentrating and taking notes. The teacher is looking at her as well, including her in the conversation. Gradually, the dialog develops into a group interaction and both students are simultaneously engaged in the conversation. That aspect becomes visible in his gestures initially directed to one student, but later turning to the other student, having eye contact and in that sense making a verbal and physical attempt to include the second student in the interaction (50:44:10, 50:44,11).

4.3 Validation of the task: Can you work it out using this unit anyway?

The student sits at the back of the classroom and solves a task and validates the solution by comparing it to the suggested one at the back of the book. The task is about a journey. A graph of the journey is plotted, illustrating time on the x-axis and distance in kilometres on the y-axis (Figure 3).

![Figure 3: Graph of the journey in the task](image)

The question reads: Which speed does the traveller have if she a) bikes to the beach, b) bikes home and c) walks home. Next to the task there is a framed formula in red, describing the relationship between speed and distance.

Excerpt L10:9

15:35:1 Student That's not right at all? [laughter]
15:36:1 Teacher All right what is it that is not right?
15:37:0 Student It's wrong in the answers [in the book].
Is it wrong in the answers [in the book]?

Yes [laughter]

(...) have cycled... to the beach. What is... it is? It, that one [points on the task]

(...) yes

Or there?

Hmm, ten kilometres.

Yes they cycled ten kilometres in distance in the time.

30 minutes.

30 minutes.

And then, then it says that it should be 20.

Yes it says that yes, that’s what I think as well.

(...)... yes but what is it that’s wrong then?

What have you worked out then?

Yeah, kind of that.

Yes, what? What sort of unit is it then?

[sniggers]

The answers do not match, she discovers it and displays doubts and consequently approaches the teacher. This student asks the teacher to resolve the matter. Here the student wants to point out what she believes is a mistake in the answer at the back of the book. The student notices that the teacher initially supports the answer in the book (16:00:08). When the reason for the mistake is pointed out to the student a reaction is provoked (16:07:14).

Excerpt L10:10

What... What is this?

Kilometres.

Right. And that?

Minutes.

You’ve calculated a speed for how... This many kilometres per minute.

Yees... Then it has to be...

...how many hours is that?

A half.

What’s... Ten?

Oh, right.

Kilometres per hour... and you’ve calculated
Attention in excerpt L10:10 is directed towards the correctness of the answer produced by the student and the one printed at the back of the answers section in the book. Those do not correspond, and surprisingly the answer the student truly believes is correct is her own (16:38:07). This is a case of validation and reflection, arguing not only about the validity of the answer but also questioning the correctness of the suggested answer in the book. The student directs her attention towards the numerical answer. This indicates student’s strong confidence in herself and her own mathematics ability (15.37.00; 15.38.13; 15.39.11). In other words, the student is confident enough to think the suggested answer at the back of the book is wrong.

The teacher interacts with the student having the answer in focus, but at the same time clarifying why the answer in the book differs from the answer of the student. He tries to help her in evaluation of the units in her answer (16:35:13). That is, the teacher helps her to shift attention towards the units. Despite the student’s strong conviction of the correctness of her answer, she takes an accepting role throughout the conversation, but opposes at the end of the interaction sequence (16:38:07). She expresses a wish to make the teacher accept the correct part of her answer instead of adjusting it to the given answer at the back of the book (16:44:22). This student constructs interest through evaluation, validating the correctness of her answer in relation to mathematical correctness rather than expectations or the importance of having suitable units (16:45:29).

4. Discussion and conclusion
The results show three types of task-related attention that emerge in student-teacher interaction. In the first one, attention can be seen in the process students’ questioning the relevance of the tasks given to her by the teacher. She questions the purpose of plotting a graph or points on a graph when she already feels she can understand the concept of mathematical relations. Interest constructed during a discussion on the relevance of the task is a possible entrance for a student to both solving the task and seeing the meaning of it, not necessarily a practical or instrumental, everyday reason. As Clarke (2006) points out,
it is a part of Swedish classroom discourse for the student to question the relevance of the task and the teacher to engage in the matter. The second type discovered shows the stage where the student accepted the relevance of the task and is already dealing with it. This type of attention highlights the importance of the relevance structure of a task (Booth et al., 1999). In the case of the task on parallel lines the teacher pays attention to students’ own reasoning. The teacher has a clear idea of what he wants to convey about the parallel lines. The teacher has a possibility to co-construct interest by taking the initiative and leading the conversation, while the students join in simultaneously, supporting each other’s answers to the questions that follow the teacher’s reasoning. The third type of task specific interest is illustrated by an episode where the student is validating her answer. This episode shows how it is possible for the student in Swedish settings to express interest by reflecting over the answer by for instance questioning the correctness of the answer printed in the book. In that sense the student evaluates the answer in relation to the content of the task. Instead of neglecting the answer, the student looks at the problem as a whole and through interaction with the teacher determines the value of the answer and the reason for it being incorrect. This category, in contrast to the first one, emphasises the student’s acknowledgement of the teacher as an authority, superior to both herself and the book.

The results of this video analysis suggest the possibility to evolve theoretical framework of motivational processes such as interest, beyond the psychological state of an individual, with support from empirical data in different forms of naturalistic classroom interaction. In all three categories the students, and the role of the interaction with the teacher express the attention on details in content matter stand out. This study could signify the focus of attention of the students during a mathematics lesson and evolve into a study where interest construction is a condition for learning. In future research it would be fruitful to make comparative studies on students’ interest construction in relation to different types of classrooms interaction, that is keeping the subject specific areas in mathematics constant and varying the type of interaction observed.

In conclusion, what can one learn from this study? Questioning the relevance of a specific task or the topic of mathematical relationships is important to consider when teaching mathematics. Also, to see a student confident enough to rely on the teacher’s answer rather than the one suggested in the book raises question of importance of the teacher’s role. This study showed that this interactive co-construction of engagement demands both student and teacher participation. In that sense engagement in content matter can be approached in coming research as a condition for learning. It can therefore be argued that interest construction will become visible through student participation. Most importantly gains from this study are different aspects of task specific attention during classroom interaction that is crucial to the teachers. By giving examples of student voice during common Swedish classroom interaction we acknowledge students’ perspective, but at the same time capture the importance of the teacher’s actions. According to the results of this study, interest can
further be approached at a classroom level in a longitudinal study, starting with determining
the focus of attention constructed in the gaps of knowledge between what is known to the
student and the knowledge desired. Hopefully this classroom-oriented approach on interest
can be set in relation to students’ knowledge and have potential in inquiry and instructional
practise.

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