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Teachers' response to unexplained answers

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This paper studies students' unexplained answers and how teachers respond. The data is from observations of teaching in five different classrooms at Norwegian upper primary schools. Using frameworks and concepts usable to describe classroom discourse on a turn-by-turn basis, it is found that teachers more often attend to details of how and why when responding to unexplained answers than in general. This creates opportunities to learn for the students and opportunities for teachers to gather information usable for formative assessment. It is also observed that these teachers rarely attend to details of how and why when students answers incorrectly and by this limiting opportunities to learn.

Keywords: Communication, discourse, IRE, teachers' response.

INTRODUCTION

Several scholars have studied how teachers orchestrate classroom discourse in general. While the IRE pattern (Initiation – Response – Evaluation) (Cazden, 2001; Sinclair & Coulthard, 1975) only offers two concepts describing how teachers' intervenes, others have developed concepts such as extending, supporting and eliciting (Fraivillig, Murphy, & Fuson, 1999), advocating, reformulating and challenging (Alrø & Skovsmose, 2002), and simplification, requesting details and notice (Drageset, 2014c). Such concepts enable us with tools for describing communication in more detail, and also inspect how teachers responds to different types of student interventions.

In a recent study Drageset (2014a) has described five different types of student interventions (explanation, initiative, teacher-led responses, unexplained answers and partial answers) and described how teachers responds to these (Drageset, 2015). Unexplained answers might be one of the most interesting types of student interventions because it describes student comments where the reason for the answer is not giv-

en. The aim of this article is to go one step deeper into the data and re-visit the unexplained answers and study how teachers respond to these.

This aim resulted in the following research questions: How do teachers respond to students' unexplained answers? And what might this mean for students' opportunities to learn mathematics?

LITERATURE REVIEW

Conversation analyses developed from the hypothesis that ordinary talk is a structurally organized and ordered phenomenon (Hutchby & Wooffitt, 1998) where turns are the most fundamental feature (Sacks, Schegloff, & Jefferson, 1974). The default option is that people take turns of speaking one at a time (Sidnell, 2010). But even if the turns are sequentially organized, it is not possible to characterise a conversation as a series of individual actions, instead each turn is thoroughly dependent on previous turns and individual contributions cannot be understood in isolation from each other (Linell, 1998). This means that in a study of teacher and student turns (interventions, comments, responses, answers) it gives no meaning to study or describe turns isolated from the sequence. A description of the role of each turn is in fact a description of how it relates to prior turns and how it affects subsequent turns.

One example of such a description is the redirecting, progressing and focusing framework (Drageset, 2014c) where each single teacher turn were studied related to how teachers used student comments (turns) to work with mathematics. This developed into thirteen categories in three groups describing different ways in which teachers orchestrated the mathematical discourse in the classroom. The framework describes three types of redirecting actions (put aside, advising new strategy, and correcting questions) four types of progressing actions (demonstration, simplification, closed progress details, and open progress details)

and six types of focusing actions (enlighten details, justification, apply to similar problems, request assessment, recap, and notice).

Using the same data, Drageset (2014a) developed five main types of student interventions; explanation, initiative, teacher-led responses, unexplained answers and partial answers. The most frequent type of student turns were teacher-led responses, and this is an illustration of how dependent a turn might be of prior turns as teacher-led responses are more or less given by the teacher through the prior turn (typically a question). Both (Sidnell, 2010) and (Linell, 1998) describes that usually only one or a few responses are preferred or more relevant than others and when the preferred or relevant response is given no explanation is needed. Teacher-led responses are a strong example of this. Unexplained answers are different from this as the reason of the answer is not given during the turn or becoming obvious from prior turns. The answer might be obviously correct or incorrect to the teacher and skilled students, but no information about student thinking or how the student arrived at the answer is given. The answer seems to come out of a black box. One such example could be when a teacher asks how much $\frac{1}{4}$ added to $\frac{1}{3}$ is, and a student only answers $\frac{7}{12}$. It is obvious that students that do not immediately see that this answer is correct would benefit from an explanation about how the student was thinking to arrive at $\frac{7}{12}$, and according to Franke, Kazemi, and Battey (2007), making details explicit is one of the most powerful moves a teacher can make. This means that unexplained answers create an opportunity for the teacher to focus on how to calculate or why an answer is correct or incorrect, either by telling it, asking the student to tell or challenge other students to explain.

Another example of a framework describing teacher and student comments on a turn-by-turn basis is the eight communicative features suggested by Alrø and Skovsmose (2002); getting in contact, locating, identifying, advocating, thinking aloud, reformulating, challenging, and evaluating. This framework does not differ between student and teacher turns. Advocating relates to justification and student explanations, challenging relates to redirecting actions, thinking aloud relates to enlighten details and student explanations, and evaluation relates to notice, recap and put aside. By relating it does not mean that they are identical,

but that these concepts seem to describe related phenomenon.

While Alrø and Skovsmose (2002) and Drageset (2014b, 2014c) both describe frameworks intended to cover all different types of teacher and student turns in the observed classrooms, others describe teacher actions related to specific purposes. One such example is the Advancing Children's Thinking framework (ACT) (Fraivillig et al., 1999). The ACT frameworks were developed by intensive studies of one skilled teacher, describing three different teacher actions; elicit children's solution methods, supporting children's conceptual understanding, and extending children's mathematical thinking. While the eliciting and supporting components focus on the assessment and facilitation of mathematics with which the students are familiar, the extending component is focusing on further development of the students' thinking.

Another phenomenon is the tendency teachers have to reduce the complexity of tasks and rules. One way of reducing the complexity is by adding information, hinting or even changing the task in order to help the student find a (the) correct answer. Brousseau and Balacheff (1997) describes this as the Topaze effect, and the category of simplification (Drageset, 2014c) essentially describes the same. Another way to reduce the complexity is described by Lithner (2008) as guided algorithmic reasoning where the teacher takes care of the process while the students answer basic questions. Closed progress details (Drageset, 2014c) is quite similar to guided algorithmic reasoning, describing how the teacher splits up a task into smaller steps, decides the method to be used and asks students basic question (typically calculations) with just one correct answer. Such reduction of complexity is seen as a hinder for students learn and understand mathematics (Lithner, 2008), probably because it reduces their opportunities to work and struggle with important mathematical ideas. And according to Kilpatrick, Swafford, and Findell (2001), opportunities to learn is considered the single most important predictor of student achievement. It might be obvious that when students are exposed to a topic they have a better chance to learn it than students that are not. But opportunities to learn is also about how students are exposed to topics, and teaching plays a major role in creating learning opportunities through emphasis on different goals, expectation for learning, time allocated, kinds of tasks, kinds of questions, kinds of

responses accepted, and the nature of the discussions (Hiebert & Grouws, 2007).

The above frameworks relate to how learning can be fostered or hindered, and Wiliam (2007) offers five key strategies related to assessment for learning. One is to clarify and share learning intentions and criteria for success, a second is to engineer effective classroom discussions that elicit evidence or learning, a third is to provide feedback that moves the learners forward, a fourth is to activate students as instructive resources for one another, and a fifth is to activate students as owners of their own learning. The frameworks offered by Alrø and Skovsmose (2002), Drageset (2014b, 2014c) and Fraivillig and colleagues (1999) provides us with tools to describe mathematical discourse in the classroom in detail on a turn-by-turn basis. But there is still an open question if and how this can help us understand more about how teachers can engineer discussions in such a way that it elicits evidence for learning, how the feedback can move learners forward, and how to activate students as owners of their own learning. It is also an open question how such framework can help us describe how the opportunities to learn vary in quality between different situations and classrooms. The devil might lie in the details, and in a recent study Drageset (2014b) studied how students explained and teachers responded. This resulted in a description of three different types of student explanations; explaining how, explaining why and explaining concept. But even if the three types of student explanations were quite distinct, no major differences were found in how teachers responded to these. Looking for further detail, this article will look deeper into how teachers respond to students' unexplained answers and what this might mean for their opportunities to learn mathematics.

METHOD

This study is based on the same data that were used to develop the redirecting, progressing and focusing framework (Drageset, 2014c) and the five types of student comments (Drageset, 2014a). Based on a

survey of 356 teachers, five teachers from upper primary (year five to seven, students aged 11 to 14) were selected for further study. These five teachers had a variation related to the survey constructs of mathematical knowledge for teaching and beliefs about teaching and learning. They all had several years experience as mathematics teachers and were educated as general teachers, which is the typical education for Norwegian teachers. All mathematics teaching for one week was filmed in each classroom (typically four lessons of 45 minutes). The camera followed the teacher, and a microphone attached to the teacher recorded all conversations in which the teacher was involved.

During the development of the frameworks describing teacher and student comments every turn were studied, describing its role in the conversation, grouping similar turns and developing categories gradually using a grounded theory approach. In the study reported in this article, the students' unexplained answers were re-visited, inspecting how the teachers responded to different types of unexplained answers in different ways. Unexplained answers are the ones where no information is given about how the student reasoned. This means that important details are hidden for the teacher and fellow students. An overview over different types of teacher responses to unexplained answers give a deeper insight into how these teachers use, or not use, the opportunities to make the hidden details explicit.

FINDINGS

By simply counting different types of teacher responses to unexplained answers and overall responses in the five classrooms, some interesting differences occur. As Table 1 illustrates, the five teachers tend to use progressing actions less frequently when responding to unexplained answer, and instead uses redirecting and focusing actions more often. A first impression is that the teachers uses the opportunity to focus on the answer more often when it is unexplained, but also more often tries to change the students approach by redirecting.

	Redirecting actions	Progressing actions	Focusing actions
Responding to unexplained answers	22%	36%	42%
Overall response to student comments	11%	55%	34%

Table 1: Responses to unexplained answers versus overall responses

	Redirecting actions	Progressing actions	Focusing actions
Responses to unexplained and <i>correct</i> answer	2%	17%	36%
Responses to unexplained and <i>incorrect</i> answer	20%	11%	3%
Responses to students <i>unable</i> to answer	0%	8%	3%

Table 2: Responses to unexplained answers separated for correct, incorrect and unable to answer

In order to understand what this means it is necessary to go one step deeper. The unexplained answers could be divided into three distinct groups or sub-categorise. One group is the correct answers that come without any explanations what was done, how the student was thinking or why this is thought to be correct. Another group is the incorrect answers, which vary from those close to correct to those where the student simply chooses a strategy than cannot work, and also these have in common that no information about the solution process or thinking is given. The third group of answers is those where the student is unable to answer or come up with a suggestion and where there is no information about why the student struggles. As Table 2 illustrates, these sub-categories gives us new information.

One striking difference is how redirecting and focusing actions follows different types of unexplained answers, which illustrates how a turn is thoroughly dependent of previous turns (Linell, 1998). It might not be surprising that redirecting actions mainly follows incorrect answers or strategies, as there is less need to redirect correct answers. Then it might be more interesting that focusing actions almost exclusively follows correct answers and rarely follows incorrect answers.

In general, teachers use redirecting actions to guide students towards other strategies, progressing actions to help students progress towards an answer, and focusing actions to make students work with, or to point out, mathematical ideas. So far we have observed that redirecting, progressing and focusing actions are used more or less often based on how the prior turn looks like. But which types of redirecting, progressing and focusing actions were used, and which types of such actions are used more or less frequently?

Just over half of the unexplained answers were correct. The main response to these was the focusing ac-

tions, and especially requesting students to enlighten details or requesting justification. When a teacher requests students to enlighten details the teacher typically asks how or what ('how did you find that answer?', 'what did you think when you solved this task?'). This is about making details explicit, which according to Franke and colleagues (2007) is one of the most powerful moves a teacher can make. In addition to this, such information is the basis on which a teacher can make formative assessment. A justification is typically requested by asking 'why is this correct'. This is different from requesting students to enlighten details as a relevant answer to why something is correct involves mathematical argumentation and not just a description of what is done to reach the answer. Also justifications are important for other students to understand or discuss. Together, both requesting students to enlighten details and to justify their answers are about making details explicit, which again might create opportunities to learn how to solve, think and reason. Requesting justifications are also vital for the teacher to get insight into a student's thinking and sense making which again is necessary for the teacher to be able to carry out formative assessment. It is particularly interesting to see that these five teachers' responds with requests for justification three times as often following a correct unexplained than they do following student comments in general.

About one third of the unexplained answers were incorrect, and as Table 2 illustrates the teacher responses changes strongly. The most typical response was to redirect students towards another strategy, and the main way this was done was by asking correcting questions. Typically, these were questions that involve a correction such as 'yes, but what if...'. It is hardly a surprise that teachers tries to guide students when they answers incorrectly. However, it is interesting to see that they are rarely exploring student thinking or reasoning when answers are incorrect. By only exploring thinking and reasoning when answers are correct some opportunities to learn are lost, for

example since it is difficult to involve students in real discussions if only the correct are presented. Also, the teachers loose access to vital information about what students think and why they are not reaching a correct answer. This seems to tell us that these five teachers do not think such information is of any use to themselves or to other students.

The least frequent of the unexplained student answers were when the students were unable to give an answer. The teachers typically responded using the progressing actions of simplification and closed progress details and the focusing action of notice. Simplification is about making the task easier so that the student might be able to progress. This typically involves extra information and hints that reduces the complexity, and sometimes the teacher changes the entire task to create what Brousseau and Balacheff (1997) labels a Topaze effect. Closed progress details are rather equal to guided algorithmic reasoning (Lithner, 2008) and describe a situation where the teacher takes the responsibility of the process while the student contributes with answering basic tasks. Simplification and closed progress details describes two different ways to reduce complexity. It is not surprising that teachers try to help students that are unable to answer by reducing the complexity, and this might even be a good idea. The danger is when teachers consistently reduce complexity of tasks because then the students loose opportunities to learn the important mathematical ideas at their grade or level. The focusing action of notice is different, as it describes actions where teachers point out important information during task solving. This seems to be done in order to help students remember what we already know and can use, or help them to get back on track. It is also typical that notice is used to point out important arguments or things to remember.

In addition to the above, Table 2 also illustrates that a relatively large part of teacher responses to correct and incorrect answers are progressing actions. But looking into the different types of progressing actions does not give much information, it only reveals that it is used less responding to unexplained answers than in general.

CONCLUSION

The aim of this study was to look closer into students' unexplained answers and how teachers respond to them. Unexplained answers are defined to be those where information about the solution strategy or

student thinking is not observable, neither during the student turn nor during prior turns. Using the redirecting, progressing and focusing framework (Drageset, 2014c) it was possible to see that teachers tended to more often use redirecting and focusing actions and less often use progressing actions than in general. By dividing the unexplained answers into three distinct sub-categories (correct, incorrect and unable) it became possible to observe that most redirecting actions came as a response to the unexplained answers that were incorrect and most focusing actions came as a response to the correct ones. By looking into the different types of redirecting, progressing and focusing actions it was found that as a response to correct answers teachers typically requested students to explain how and what (enlighten details) and why (justification). Also, it was found that responding to incorrect answers teachers typically guided the students by asking correcting questions, and when responding to students unable to answer the teachers typically reduced the complexity of the task (simplification and closed progress details) or pointed out important elements or earlier findings (notice).

Kilpatrick and colleagues (2001) states that opportunities to learn are the single most important predictor for student achievement. If so, one should look at which opportunities are given during discussion and not. By requesting details (enlighten details and justification) the teachers make these explicit for other students to reflect upon, discuss or ask, and for the teacher to understand the students thinking, reasoning and understanding. Making details explicit is important for student learning in general (Franke et al., 2007), and this is about creating opportunities to learn the important mathematics by attending to thinking, strategies and reasoning. But it is worth to emphasise that these teachers often requested such details when responding to an unexplained answer that was correct, and rarely did it when the answer was incorrect. This means that opportunities were lost, both for students to explore the reasons for the error, and for the teacher to gather information about students incorrect or incomplete thinking as a basis for formative assessment. Also since students need to struggle with mathematical ideas to learn (Hiebert & Grouws, 2007), something important might be lost if the students are only struggling with understanding what somebody else already understands and rarely have to struggle with something incorrect or incomplete and how to develop from there.

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