Primary school students' engagement in the formative feedback process in mathematics

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Engaging students in formative feedback practices is a significant aspect of mathematics teaching, but students do not always take an active part in the process. Factors contributing to the lack of engagement could be the design of the learning context and the nature of the subject. In this study, the engagement of Grade 2 students in the formative feedback process, focusing on their mathematics reasoning, is analysed to gain knowledge about the relationship between the learning context and students' engagement in the formative feedback practice. Students' engagement was observed during a feedback event, followed by stimulated recall sessions and semi-structured interviews, and later analysed and discussed in terms of socio-mathematical norms. The study revealed a main focus on performance and producing correct answers. In addition, different views of the purpose of the formative feedback event were identified as norm conflicts, acting as barriers for the involvement of students in the formative feedback practice.

In current literature on feedback research, focus has shifted to viewing students as active, rather than passive, receivers and seekers of feedback information (e.g. Winstone et al., 2017). There are many examples of how to create effective and actionable feedback situations (e.g. Brookhart, 2007; Hattie & Timperley, 2007; Shute, 2008), but it cannot be assumed that students take an active role in formative feedback practices. Formative feedback information with a forward-looking focus on the student's learning and provided in a continuous teacher-student dialogue is referred to as a *formative feedback process* (FFP) and the assumption that students do not always take an active role is corroborated by research on students' engagement in the FFP. The research shows that students across various educational stages do not always engage with the feedback information provided in a way that supports learning and develops understanding (e.g.

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Brown & Glover, 2006; Dann, 2015; Hargreaves, 2012; MacLellan, 2001; Williams, 2010). This lack of engagement may be due to factors relating to the feedback content (e.g. Havnes et al., 2012; Jonsson, 2012; Peterson & Irving, 2008), but could also be due to the learning context (Higgins et al., 2002; Jonsson & Panadero, 2018; Lipnevich et al., 2016; Winstone et al., 2017; Yang & Carless, 2013). The influence of the learning context, in which feedback interactions take place, may even be of greater importance than content when it comes to students' engagement in the FFP (Van der Kleij et al., 2019).

As the learning context in which formative feedback practices take place is a potentially influential factor for engagement in the FFP (Winstone et al., 2017), it needs to be considered in feedback research (Van der Kleij et al., 2019). Contextual factors that may influence such engagement can for example be related to the organisation and management of feedback situations (Yang & Carless, 2013), such as promoting face-to-face dialogue and peer-feedback activities that supports learning and develops understanding of the subject matter, rather than only assessing understanding toward the end of a module. Understanding refers to a focus on the meanings of different concepts, how a task can be solved and why such a solution is considered a correct solution. Affording students' opportunities to immediately put their feedback information into practice (Jonsson, 2012; Jonsson & Panadero, 2018; Winstone et al., 2017), and giving them sufficient training in using this information (DeLuca et al., 2018; Havnes, 2012; Jonsson, 2012; Jonsson & Panadero, 2018; Winstone et al., 2017), are other examples. The perception of usefulness is significant to the formative use of feedback information (Gamlem & Smith, 2013; Harks et al., 2014; Jonsson & Panadero, 2018; Williams, 2010); although students may think differently about what useful feedback information is (Hargreaves, 2013; Jonsson & Panadero, 2018; Peterson & Earl Irving, 2008; Rakoczy et al., 2013). The norms governing the interaction between students, teachers, and the subject is a contextual factor (Voigt, 1998). This contextual factor is of particular importance, as these norms may critically influence students' engagement in the FFP. For example, in a study on students' experiences of a formative feedback situation by Green (2021), some students did not understand the purpose of formative feedback information focusing on the process and some students wanted the teacher to provide the correct solution method, suggesting a conflict between the teacher and the students regarding the social-, and socio-mathematical norms. This conflict could lead to students not engaging in the FFP.

Havnes et al. (2012) suggest that feedback practices are subject-related, meaning that the learning context and the nature of the subject affect how feedback information is perceived and used. In the present study, mathematics is in focus and the interaction between students, teachers, and the subject is therefore thought to be regulated by socio-mathematical norms (Cobb & Yackel, 1996). In the study by Havnes et al. (2012), the feedback situation in mathematics focused mainly on correct answers. In terms of socio-mathematical norms this can be interpreted as signalling that the most important aspect of learning mathematics is to produce correct answers. Consequently, the students focused more on corrections of mistakes as compared to mathematical reasoning. According to Boistrup (2010), assessing students' answers to mathematical problems as either right or wrong seems to be a common practice in Sweden. In addition, Hargreaves (2013) suggests that looking for correct answers are common in primary classrooms. The strong emphasis on producing correct answers is unfortunate, since asking students to figure out why an answer is incorrect, or whether a problem could be solved differently, engage students in conversations about mathematical concepts (Kazemi & Stipek, 2001), making them more active in their mathematics learning.

Emphasizing correct answers could be described as an *evaluative* type of assessment, whereas a *descriptive* type relates to student's solving processes (Tunstall & Gipps, 1996b) and may therefore provide students with detailed and specific information about how to improve their solving processes. The students often prefer descriptive feedback information as it provides more detailed information about their performance, helping them in their learning process (Murtagh, 2014). Formative feedback information is a descriptive type of feedback information (Tunstall & Gipps, 1996b), which focuses on what the students know, understand, or can do (Black & Wiliam, 1998; Hattie & Timperley, 2007) and involves a process with continuous dialogue between teacher and student. This process is referred to as the FFP. Formative feedback is a key strategy within a context where the assessment focuses on students' learning (Hattie & Timperley, 2007). Students have been found to be more active in their learning process when the feedback information is provided within such a context (Remesal, 2009), which may therefore need to be developed. This requires both teachers and students to develop a feedback/assessment literacy (Havnes et al., 2012; Winstone, 2017), which includes teachers talking with students about the purpose of providing feedback information and how to engage in the FFP (Dann, 2019).

Despite the need for focusing on the learning context, research on feedback practices has predominantly focused on identifying factors that are important for feedback information to be effective, without necessarily examining how it is received or acted upon (Hattie et al., 2017; Lipnevich et al., 2016). Furthermore, since the learning context could be an influential factor for students' engagement in the FFP, additional research is needed from the student perspective to learn more about how students engage in the FFP, while simultaneously taking into account the learning context. The concept of engagement describes the individual's interactions in the FFP and include both the initiation of motivated action and its durability when facing obstacles or difficulties. Engagement consists of behavioural (e.g. persistence), emotional (e.g. uncertainty), cognitive (e.g. mastery) (Skinner et al., 2009) and agentic aspects (e.g. to communicate what they are thinking or request assistance, such as tutoring) (Reeve & Tseng, 2011). A student's engagement in the FFP could encompass one or more of these aspects simultaneously. Additionally, it might also be valuable to focus more on how students actually engage in the FFP than on how they claim to engage, or how they express their experiences or perceptions of feedback situations (Winstone et al., 2017). In addition, most studies in the research of formative feedback have involved students in higher education or upper secondary school. The number of studies at lower educational stages are limited (Van der Kleij, 2019), including in mathematics classrooms.

The aim of this study is to gain increased knowledge about students' engagement in the FFP in relation to the role of the learning context. More specifically, the study focuses on the teacher-student interactions about mathematics that is triggered by feedback events. The research question is: How do students engage in the FFP in mathematics? To answer this question, three groups of Grade 2 (7–8 years old) students were given formative feedback information, challenging them to come up with their own solution methods and explain the underlying mathematics. By understanding how students engage in the FFP in mathematics together with any potential norm conflicts seen in their engagement, it is possible to gain increased knowledge of the role of the learning context and its relation to student engagement.

Theoretical framework

The role of the learning context and its relation to the students' engagement in the FFP, can be seen through the lens of prevailing social-, and socio-mathematical norms (Cobb & Yackel, 1996). Cobb and Yackel (1996) present a model that considers how two co-existing perspectives, social/collective and individual/psychological, interrelate and this model is used as a theoretical framework for this study. The social perspective comprises observation and analysis of social-, and socio-mathematical norm development, while the individual perspective comprises observation and analysis of individual students' participation in classroom activities. The norms are delimited to, and can be described as, the interactions – initiated by formative feedback situations – between teacher and students in the mathematics classroom. The interactions define a temporarily stable system which, in turn, defines the learning context (Hiebert & Stigler, 2023). Observing the learning context involves observing the norms as these can impact student engagement in the FFP.

Social norms refer to the classroom interactions between students and the teacher and apply to various general activities rather than specifically to mathematics learning. From the individual perspective, social norms relate to the students' views (called ”beliefs” by Cobb & Yackel, 1996) of their own roles, as well as those of others, for example who does what in the mathematics classroom. In addition to social norms, socio-mathematical norms are formed through agreements specifically involving teaching and learning in mathematics. These norms regulate the learning of, for instance, methods and concepts within mathematics or various solutions to a specific problem or in what way students tackle a task linked to its mathematical content (Cobb & Yackel, 1996; Yackel & Cobb, 1996). An example could be that a task, that includes a question, is solved when the question is answered without the need to justify the solution. Socio-mathematical norms lay the foundation for the mathematical practice in the classroom. They are created in and govern the interaction between students, the teacher, and the subject; and they are highly significant for students' learning in mathematics (Kazemi & Stipek, 2001).

The individual students make their own interpretations of what the norms mean in the current classroom situation. If there is a conflict between students and the teacher in the interpretation (e.g. that it, according to the teacher, is important to focus on the solving process rather than simply producing a correct answer) the norms may need to be re-negotiated. The norms extend beyond the individual and encompass an agreement within the entire group, regulating and constructing the participation in the classroom. Norms can be developed in different directions, creating different mathematics classroom contexts.

The social-, and socio-mathematical norms applying to the interaction between the teacher and the individual students in the mathematics classroom are sometimes described as being included in a ”didactic contract” (Brousseau, 1997). This contract serves as both a prerequisite and a condition for the mathematics teaching in a class, which means that tensions between students and the teacher may occur if there is a conflict between students' expectations and the teaching as staged by the teacher. Such a conflict could appear if the students expect the teacher to validate answers to mathematical problems as either right or wrong, rather than providing descriptive, formative feedback information without such a validation. In this situation, the didactic contract would need to be renegotiated, so that the students understand why they are not given the correct answer and what they are expected to do in the FFP. A didactic contract is usually implicit, meaning that it only becomes visible when the students or the teacher do not act as expected, thereby ”breaking the contract” (Brousseau, 1997). In this way, arising conflicts can make the current state of the norms explicit, thereby making it possible to re-negotiate and modify the existing norms. The teacher may also, by choice, initiate and guide a renegotiation and establishment of new norms together with the students (Cobb & Yackel, 1996).

In this study, students were provided with formative feedback information and an analysis was made of their engagement in the process and discussed in the light of social and socio-mathematical norms since these could have an impact on student engagement.

Method

To examine students' engagement in the FFP, 15 Grade 2 students (7–8 years old) were given individual formative feedback information. The students were from three separate classes, with three different teachers, within two schools in a medium-sized municipality in Sweden. The focus of feedback can be described at four levels (task-, process-, self-regulation, and self-level). To contribute to an understanding of the underlying mathematical processes and to help the students to develop mathematical competence, the formative feedback information in the current study was process-focused (Hattie & Timperley, 2007), with a focus on students' reasoning in mathematics. Reasoning is one of the ”abilities” Swedish students are expected to develop, according to the national curriculum (Skolverket, 2022). The teachers provided feedback information according to a feedback guide (see appendix 1), expecting the students to justify their solutions without the teachers providing a specified solution method. Data collection was conducted at two occasions per class. At Occasion #1, the students were provided with a problem-solving task [1], oral feedback information was provided by the teachers, and the students' engagement in the FFP was observed. At Occasion #2, a stimulated recall session was held with each of the students to capture their perceptions of the feedback event and how they had engaged in the FFP. Both occasions were video-recorded. Pilots of interviews and teachers providing feedback information (supported by the guide) were conducted and resulted in minor revisions.

Participants

The teachers, with between 11 and 16 years of teaching experience, were suggested by the school principals, but participated voluntarily. The students were selected by each teacher, ensuring a distribution in level of achievement and ambition among the students. Furthermore, as the students were only seven to eight years old, the selection was made to increase the chances of involving students with the ability to express themselves verbally in the stimulated recall sessions. All the selected students agreed to participate, and written consent was provided by their legal guardians.

Student occasion #1

Important characteristics of the problem-solving task was a rich mathematical content, no specified solution method, and the task being possible to solve using different strategies and at different levels of difficulty. A feedback guide (see Sidenvall, 2019) was adapted to be used by the teachers in their assessment of the solution process, guiding them in providing process-focused feedback information and ensuring that the teachers' responses were based on students' task performance. The teachers were trained in how to use the guide during a workshop and in a lesson without any data collection. As students' understanding of the mathematical content of the task was central, they were challenged to justify their solutions based on a set of questions (e.g. "Can you verify your solution in any way?"), aiming to direct their attention to the underlying mathematics. The feedback information was process-focused as it focused on how to solve the task (i.e. the process), and not only the final answer (or end-product). The students were asked to describe the mathematical processes performed (e.g. dividing natural numbers, using tables and diagrams, and strategies for mathematical problem-solving). They were also asked to justify why these processes were considered correct, or why they had reached a certain conclusion, as well as the meaning of the concepts used (e.g. proportional relationships; double/half) and relationships between them.

The feedback process entailed the following loop, which repeated itself during the lesson: The teacher elicited information from the student through the questions and provided formative feedback information; the teacher listened to and assessed the student's response, and then used this information to help the student move forward with the problem-solving process.

The observations of the students' engagement were recorded on digital video with the dual purpose of using the recordings for the stimulated recall sessions and for the analysis of the engagement. The recordings were limited to capturing the students' voices and hands, or the material (e.g. money, blocks, crayons) used. The final solutions to the problem were also recorded, but not used in the current analysis.

Student occasion #2

The students' engagement in the FFP at Occasion #1 were followed up a day later, with the purpose of capturing the students' perspective on their engagement. The students were informed about the research project and their participation. They were assured that the information they provided would be treated with confidentiality and they were told that they could withdraw from the study at any point. The researcher held semi-structured interviews with the students lasting 23 to 50 minutes (mean 33 min.). Stimulated recall sessions with the video sequences from Occasion #1 were used to remind them of the feedback information they had received.

The students had the opportunity to interrupt with questions at any time, or request that the video playback should be stopped, and the researcher could do the same. To capture the students' perspectives, they were asked questions, specified in an interview guide, about their engagement (e.g. what they thought of what the teacher had said and if there was anything they wished the teacher had told them in the feedback situation). The language was sensitive to the students' vocabulary (Punch, 1998); for example, the term ”feedback” was not used (”what X said” was used instead), and the questions were asked in a curious rather than judging manner with an active listening approach.

Data analysis

Data collected during the student occasions was analysed to identify students' engagement. The engagement was mainly verbal, sometimes supported by non-verbal engagement, such as raising hands or turning a paper over. The following cues were used to identify engagement: the students' emotional reactions and attention to what was requested in the feedback situation, their focus when working with mathematics (i.e., if there was an interest in reasoning about mathematics that extended beyond the task), and how they regulated their problem solving. The data was analysed using these cues and data with similar meaning were grouped together. An analysis of these groups revealed new patterns of engagement and the groups were further condensed into the final categories based on similar meanings (Brinkmann & Kvale, 2015).

To better understand the role of the learning context and its relation to students' engagement in the FFP, the students' views were derived from their engagement to establish if the introduction of formative feedback information caused a norm conflict between the teacher and the students regarding the purpose of the feedback (i.e., if the didactic contract was broken in the feedback situation). The students' views of mathematics, mathematics teaching, and mathematics learning influence their activities (engagement) and refers to the individual perspective (Yackel & Cobb, 1996). Furthermore, as there is a reflexive interrelation between the individual and the social perspective, social-, and socio-mathematical norms can be identified. Engagement concerning the students' views of their own role and the roles of others, as well as how general activities should play out (e.g. who is expected to do what), constitute social norms. Engagement concerning the views (e.g. what is perceived as the proper way to do things) of mathematics, mathematics teaching, and mathematics learning were identified as socio-mathematical norms.

Results

The analysis of the teacher-student interactions about mathematics (triggered by the formative feedback event), resulted in five distinct categories of how the students engaged in the FFP. The categories are mutually exclusive and consist of various engagements rather than individual students. However, an individual student's engagement can span multiple categories as it was possible for a student to engage differently in each subtask. The categories include different aspects of engagement (spanning across the behavioural, emotional, cognitive and agentic aspects) which, to varying degrees, are in line with the socio-mathematical norms that the FFP introduced to teacher and students in the mathematics classroom. Students' views of mathematics, mathematics teaching, and mathematics learning that are not in line with the purpose of the feedback information indicate a norm conflict. The students are denoted by numbers in parentheses. If multiple students are represented, the expression has no number. Contrary to students' engagement, the teachers' responses to the students are not category specific, and the same response can therefore appear in relation to more than one category.

A. The feedback situation uncovered a task focus

The primary focus of most of the students was to solve the task at task level (i.e., they focused on the answer itself instead of the solution process), and they expressed that it was important to quickly "finish" the task. Finishing the task did not involve verifying or justifying their solutions. Several students focused on the answer itself, which they were in a hurry to get to. This can be interpreted as not seeing the feedback process as having anything to do with learning, and that these students had a view of performance in mathematics as being either right or wrong, rather than something with different qualities that can be developed. Some students turned the paper over, talked to the student next to them, or leaned back in their chair, showing that they were finished (even if they had not solved all the subtasks). The students mainly produced solutions without explaining how they had reasoned, even when the teacher specifically asked them how they had reasoned or why they thought the answer was correct. Their descriptions of what they had done focused on the final answer and how they solved the task, rather than on why they thought it was the correct answer, which was one of the things the feedback information challenged. Focusing on the answer, instead of the solution process or one's own learning, indicates that they had a different view of mathematics and mathematics learning than what was conveyed through the feedback situation.

There was a desire among the students to get confirmation at the task level, for instance whether they had solved the task correctly or not (e.g. ”Is it equal to 25?” [15]). If the answer was wrong, some students specifically expressed that they wanted the teacher to provide a solution method. This view among the students constitutes a social norm conflict. Moreover, some students wanted the teacher to be clearer about how to proceed to solve the task. They also sought confirmation from the teacher regarding what to do, for example by asking ”Should I try writing?” [9]. Instead of relying on their own capability for finding a solution, some students copied the solution of neighbouring students, which could sometimes be wrong. In general, they were quick to ask for help if they got stuck, indicating that there was a focus on finding (correct) solutions quickly and a view that this is what mathematics and learning in mathematics are about. A strong focus on finding correct solutions indicates that performance or results are more important than the process itself. This focus can be seen as a conflict with the socio-mathematical norm introduced by the FFP, the purpose of which was to support understanding through a focus on the underlying mathematics (the process) instead of only finding correct solutions.

Some students sighed when asked to explain how they had reasoned and on some occasions the students were in a hurry to get to the next subtask even though they knew that they had made a mistake in their solution. They were made aware of their mistakes through the feedback with questions like ”Can you find something that's wrong?”. For example, one student had calculated that one fish would cost 3 Swedish crowns and that another (similar) fish would cost 2 crowns (Subtask c), and had thus made a mistake in her/his solution. The teacher asked if it could be true that the price of the other fish could be different, but the student was in a hurry to continue to the next subtask; the important thing seemed to be to get to an answer quickly and to move on. Altogether, the primary focus for most students was on performance or result and varied between solving the problem and getting confirmation at task level, being somewhat passive and moving on quickly.

B. The feedback information led to uncertainty in the feedback situation

There were students who did not seem to understand the purpose of the feedback information and who showed uncertainty in the feedback situation, as they did not understand what the teacher was asking for, for instance what it meant to check their solutions. These students expressed that it was strange that the teacher wanted to know how they had reasoned, whether the solution could be correct, whether they could tell in their own words what had been requested, or whether they could present their solution. It was not habitual to them to present their reasoning or justify their solutions. This can be seen as a conflict with the socio-mathematical norm introduced by the FFP where you were expected to check your solution. The uncertainty could be expressed in the interviews as a direct feeling of having done something wrong through comments like ”I think it will be correct” [8] or ”It feels like something's wrong” [6]. When the teacher asked questions such as ”Can you verify your solution in any way?” or ”Why is the answer 25?”, the students expressed, for example, ”I just counted” or ”I just thought” [8], instead of describing or justifying their reasoning. This indicates that these students had a focus on how they had arrived at their answer instead of why their solutions were correct. One of the students specifically expressed that it was a new situation for the class; that they were used to only having to explain their solutions when the teacher asked for answers during classroom group discussions.

C. The feedback situation led to justification of the solutions

The majority of the students showed attempts and a willingness to justify their solution when they were challenged with the feedback information through questions like ”Can you verify your solution in any way?”. The teacher's questions seemed to help the students focus on the process, and in this way the feedback situation also contributed to most of the students justifying their solutions. Thus, the key was not only to arrive at a solution, but also to explain the underlying mathematics. The result in this category shows an engagement that was in accord with the socio-mathematical norm in the FFP focusing on the mathematical processes and continuous learning.

There were students who presented their solutions without having to be particularly challenged with feedback information, but this only happened on a few occasions. The feedback information was thus important in challenging the students to justify their solution or explain their reasoning. This can be exemplified by some students who found it difficult to justify their solutions because it was ”difficult to write” [11], or as one student put it, ”because sometimes I just can’t draw it in a good way” [15]. However, even if some students were initially silent or said ”I don’t really know”, several students still argued for the underlying mathematics in response to the feedback information.

The students often expressed themselves in the form of ”because” when they reasoned, which thus constituted justification for the solution. There were also students who wanted to show alternative methods for how the task could be solved without the teacher, at that time, asking whether the task could be solved in another way, through other strategies or methods: ”I can write multiplication too” [11]. The students’ justification of a solution to a task in which a focus on the underlying mathematics is described (when the students are asked to justify their solution; for example whether they can talk about why the way they solved the task works) could be expressed as ”because 4 cost 10 crowns and 5 + 5 are 10 and then it’s 4 and 2 + 2 are 4, so then I thought that then she only gets 2 fish for 5 crowns” [12].

Attempts and a willingness to justify appeared even if the students had made a mistake in their solution. For instance, some of them tried to use the cost of one fish and reasoned based on their knowledge of natural numbers. One student was quick to say ”I thought like this” [9] as soon as the teacher came to her, even if the solution was wrong. The teacher’s repetition of the question ”Can you tell how you came up with your solution?” contributed to the student being quick to explain.

D. The feedback situation led to control over one’s own learning

The fact that the teacher made the students aware of what was sensible in their reasoning and led them to what needed to be developed (without specifying a solution method) seemed to have helped most of them to finally arrive at correct solutions and to explain the underlying mathematics. Through the feedback situation, they were thus able to describe their own solution process, even if on several occasions they became stuck in both strategy and method.

An example of such help was the teachers' questions that opened for students' verifications, such as "Can you show that you got a correct solution?". On several occasions they could find their possible mistakes themselves. While it was difficult to answer the teacher's questions, they helped them discover when they were disoriented in the solution process. Discovering that a solution was correct was important to them, and with the help of questions that challenged them to justify their choice of concepts and processes, they were able to guide their own learning. They reflected on their solution process, and could themselves take the next step in the problem-solving: "Yes, how many, should we try to divide 25, or how?" [9]. Some students reasoned loudly with themselves, and in this way their own learning was guided forward.

The feedback situation initiated a process of finding answers and alternative ways of thinking. In this way, the task could be solved at the process level (i.e. they focused on the solution process) with the help of the feedback information. This gave the students the opportunity to create their own solution methods, instead of guessing and trying, as they were challenged in both their thinking and to put their thoughts into words. Most difficult for the students was to choose an appropriate strategy or method, and receiving suggestions for this was usually what they said that they needed when they got stuck in their solution process. In one interview it was expressed that "it was difficult to figure out how to do it, but otherwise it was quite simple" [4].

Sometimes it was necessary for the students to think about whether they could in some way continue with what they had done so far, which was something the teacher asked for in the feedback situation. Sometimes it was obvious for the student to bring information, thoughts, and mathematical ideas from the previous subtask(s) into the next. This was the most common strategy. For example, one student expressed: "I didn't understand it at first, but then when I solved it, I understood the other ones a little more" [15].

E. The feedback situation triggered persistence in the learning process

In having to explain the underlying mathematics or to answer the teacher's diagnostic questions, such as "How have you reasoned so far?", the students were challenged in their mathematical reasoning. Indicatively, this contributed to the students becoming more involved in solving, justifying, and verifying their solutions. With the initial help in better understanding the task through questions like "What are you going to find or show?", some students seemed to be persistent in trying on their own and expressing "I will try" [15] was not far away. Thus, these students did not give up, and questions like "Can it be true?" and "Is your answer reasonable?" helped them move forward; that is, to initiate a process towards correct solutions and to help them explain the underlying mathematics without a provided solution method. After they struggled to answer the teacher's questions, and the teacher left, they tried on their own, and could then joyfully exclaim "I've got it!" [9].

There were also students who especially showed that understanding and not giving up were important, even if both the situation and the task were perceived as complicated. For example, a student expressed "I think about how I can do this", "I think", and "I don't understand anything" [3], but still managed to both solve the task and justify the solution. The same student did not give up and wanted to continue, even when, after a longer period of thinking and trying, the teacher said that now we must give up. Here, the questions motivated the student, as they included the student in the solution process. Some students also showed persistence in trying to understand what was wrong when suspicions of error arose, which may have contributed to them not letting go of the problem.

There were students who from the beginning had decided that the task was too difficult and had given up before they even had tried to solve the respective subtask, but who still tried when challenged to do so through the teacher's questions. The FFP provided the students with suggestions to try for example new strategies and, for the students not immediately showing persistence in the learning process, these suggestions pushed them towards an engagement that was in line with the expected socio-mathematical norm.

Discussion

The learning context includes norms (Voigt, 1998) and previous research has showed that the learning context is a potentially influential factor for students' engagement (e.g. Jonsson & Panadero, 2018; Lipnevich et al., 2016; Winstone et al., 2017). By examining students' engagement in the FFP in mathematics, combined with using norm conflicts to understand students' possible lack of engagement, the present study contributes to an increased knowledge about students' engagement in the FFP in relation to the role of the learning context. This approach could be argued to be novel and therefore constitute a unique contribution to research on formative feedback.

As can be seen from the results describing how the students engaged in the FFP, some students held different views regarding their own role and that of the teacher, in relation to the new feedback situation. The novel situation thus initiated a change of the social roles, whereby the students' role was to create their own solution methods instead of being provided with them, and to justify their solutions. Furthermore, among the students there was a focus on performance and on producing a correct answer, which means that the students and the teacher had different views of the purpose of the formative feedback practice. This can be described as a conflict between the teacher and the students regarding their conception of the socio-mathematical norms. The new feedback situation thus called for a change of the norms into a norm where mathematics learning is about understanding the underlying mathematics, even if both the task and the teacher's questions could be perceived as difficult. The teachers asking challenging questions and paying attention to students' solving processes and potential improvements, without specifying a solution method, were critical for encouraging the students to focus on the process and to justify their solutions.

The conflict observed in relation to the students' engagement in the FFP, suggests that the didactic contract had been broken. The findings that there was a task focus and uncertainty in the feedback situation (categories A and B), with some students focusing on quick responses to move forward and some not seeming to understand the purpose of the feedback situation, reveal different views of the purpose of formative feedback information in mathematics and mathematics learning in the new situation. Such a conflict can act as a barrier to getting students involved in the FFP. Not understanding the purpose of formative feedback information could mean not understanding its relevance and therefore not seeing its usefulness. Experience of usefulness is a significant factor in students' using the feedback information formatively (Gamlem & Smith, 2013; Harks et al., 2014; Jonsson & Panadero, 2018; Williams, 2010).

To handle the conflict, the norms may need to be challenged and changed for students to benefit from the formative feedback situation, as norms seem to be relevant for students' engagement in the FFP. The results from this study therefore suggest that the introduction of process-focused formative feedback situations can aid the process of breaking and re-negotiating an existing didactic contract. Breaking the didactic contract can thus be a first step to change the current socio-mathematical norms and reach a common understanding, where mathematics and mathematics learning are about understanding concepts and processes and where a formative feedback practice is thought to support this view. The second step may involve the teacher starting a process of establishing a new didactic contract (Brousseau, 1997) through introducing norms where students are expected to create their own solution methods, instead of being provided with them, as well as presenting their reasoning and justifying their solutions.

It is important to note, however, that although there seemed to be a conflict in the social-, and socio-mathematical norms, this conflict did not stand in the way of involving the students in trying to come up with correct solutions and justifying them (category C), as has been reported in previous research (Sidenvall, 2019). The feedback situation supported the students, like the students in the studies by Remesal (2009) and Kazemi and Stipek (2001), to become more active in their learning. Furthermore, engagement was created through students being challenged by the feedback information, described in the categories D and E as having control over one's own learning and triggering persistence. Being challenged by being asked to explain the underlying mathematics, can thus create a greater engagement among students. In addition, the students appreciated the type of feedback information provided, as they received guidance regarding the correct solution. More precisely, the feedback situation led them to guide their own learning with the help of the relevant and specific questions in the feedback guide.

The students in this study were not in a clearly process-oriented learning context. This seems to be common according to previous research (Hargreaves, 2013) and perhaps even more common in mathematics classrooms, with a strong focus on right and wrong answers (Boistrup, 2010). If the students are in a classroom where the socio-mathematical norm is that mathematics is something that is right or wrong, there will likely be a focus on quick answers to move forward or on correct answers and how to get them (Havnes et al., 2012).

Similarly, if students are in a learning context with norms where it is not normal to justify their solutions, as in this study, it can be difficult to get them more engaged in the FFP. Since the learning context with its norms regulating the interaction between teacher, student and the subject may be critical for engagement, teachers active work on changing the norms is a key task in getting students more engaged in the FFP. The goal should be to create a context in which students learn why they receive formative feedback information and how they can leverage it in their learning. However, to be able to create this new learning context, teachers may need to unveil and break the current learning context and its norms.

Limitations and further research

Evaluative and descriptive assessment span a continuum (Tunstall & Gipps; 1996a) and depending on where on this continuum the ordinary feedback practice is located, what is critical for getting students involved in a formative feedback practice can be expressed in different ways. If the evaluative type is strongly represented regarding how the teacher helps the students developing their work, there is a risk that barriers to getting students involved in the FFP will become more visible, which could have been the case in this study. The same applies if the students, instead of working individually with the task, had been allowed to collaborate. This might have resulted in them presenting their reasoning more habitually, and the feedback situation not being equally essential in getting them to present their solution. Another possible limitation of the study could be that the task was more difficult than the students were used to. This may have affected their engagement, as they were demanding more from themselves than usual. That this would be the case, however, was not apparent in their solutions. When interpreting and generalizing the results, it is also relevant to point out that a further limitation could be that children at this age may have difficulties recalling, verbally expressing (Doverborg & Pramling, 1993), and reflecting upon the meaning of feedback information. However, the interview data does not stand alone as it was complemented with observations of the feedback situations.

In this study, students became more involved in solving, justifying, and verifying their solutions when they were challenged to explain the underlying mathematics. The question is, what happens if students continue to be challenged with this type of feedback situations? Will the teacher's questions be equally critical in getting them to explain their reasoning so that the focus ends up on the process instead of applying procedures? To understand this even better there is a need for more research in this area, for instance by involving the students in process-focused feedback situations over an extended period and observing whether there are any changes in their engagement.

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Note

1 The fish problem

Kim is about to buy fish for his aquarium. At the pet store, 4 fish cost SEK 10.
a) How many fish can Kim get for SEK 20?
b) How many fish can Kim get for SEK 15?
c) How much do 10 fish cost?
d) At the same pet store, Kim has previously paid SEK 12 for 16 fish. How much did 28 fish cost at that time?

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