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The power of natural frameworks: Technology and the question of agency in CSCL settings

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Abstract Students frame activities in school in specific ways which are fundamental for their learning and problem solving. The introduction of digital technology and multimedia applications leads to additional aspects to consider, creating a need for research on interaction and activities in relation to new tools. The aim of this study is to analyze how students frame computer-supported collaborative learning situations. The analytic agenda is based on sociocultural assumptions of learning. Data have been collected through video documentation of secondary school students' interactions with educational software in mathematics. The results show that when the students work with task solving in educational software and "get stuck", they negotiate how to understand the activity; sometimes they search for the answer in their own actions, and sometimes they consider the answer to be within the technology. Goffman's concept of frameworks can be applied to understand this alternative as a continuous shift between employing *social frameworks* where the students themselves are playing an active role in the understanding of the task, and employing *natural frameworks,* where their difficulties are understood to be, in Goffman's words, due to natural determinants, that is, to the design of the technology. The main conclusion is that, in interactional activities using digital technology, there is a possibility that the participants' activities are framed in such a way that they do not consider themselves as being accountable for the lack of understanding of the educational content.

Keywords Meaning making · Word problems · Problem solving · Digital tools · Multimedia tool · Framing · Frameworks · Agency Q1

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Introduction

Computer tools are used all over the world and have now entered schools as tools for communicating, computing, and so forth. The use of multimedia and educational software in school often provides an alternative to traditional textbooks. Digital technologies imply new types of learning, and in this specific study, the focus has been on students' mathematical reasoning in a computer-supported collaborative learning (CSCL) environment.

Learning is seen here as a development that is always connected to the situation and the setting. This implies that every context has its own implications for learning. The institutionalisation of schooling has resulted in certain communicative patterns dominating; being a student implies taking on specific roles, using a prior understanding of how to act in a school context, and knowing how to make sense of a task situation (Lave and Wenger 1991; Mercer 1992; Limberg et al. 2008). Analytically, this can be understood as students *framing* (Goffman 1974/1986; Tannen 1993) the school situation in specific ways by following certain explicit or unspoken rules; their success depends on their accumulation and application of this educational experience. Thus, learning is *framed* within the practice of the school institution. However, when new tools are brought into an activity, the activity changes. Therefore, there is a need to analyse what happens to learning activities in school when digital technology and multimedia applications are introduced and to understand how students frame situations when interacting with new tools.

Digital tools have recently been implemented in a number of subjects and may play a particularly significant role in mathematics. Even if the general point here is not restricted to the specific subject of mathematics, I will use a case study where students work with educational software on mathematical problems as a means of illustrating interactive patterns in connection with the use of a digital tool. Because the students in the present case study work with word problems, I will start with a brief comment on school tasks in general and mathematical reasoning in particular.

Meaning-making practices, word problems and the introduction of technology in school settings

Within sociocultural perspectives, learning is not understood simply as an individual process, but as a process mediated by the use of cultural tools such as writing, spoken language, and various physical artefacts (Säljö 2000, 2005; Vygotsky 1978; Wertsch 1998), as people participate in routine activities in communities of practice, such as classrooms (Lave and Wenger 1991). When a task is framed in institutionalized learning environments, students implicitly try to understand what is demanded, and they often assume that there is *one* right way of solving the task.

When it comes to mathematics in educational settings, Wyndhamn and Säljö (1988, 1997) show that students often focus on the mathematical calculations instead of focusing on the meaning of what is described in the task. This finding is confirmed by a substantial body of research (e.g., Verschaffel et al. 2000; Lave 1988, 1992) showing that the institutionalized context implies that students seem to disregard what they know about the world when solving mathematical word problems in school. Irrespective of what kind of problem is presented, students frame it as a disguised mathematic task and tend to engage in calculations without attending to how the tasks should be modelled. Verschaffel et al. (2000) refer to this phenomenon as *suspension of sense making*, implying that the educational context leads the students to make assumptions about the nature of the problem without using their everyday experience. One might also think of this as a *variation of sense making* because there is sense making at all times, although the sense made by the students may not be that intended by the instructor. When students enter a mathematical classroom, they simply *frame* (Goffman 1974/1986) the tasks in such a manner that they neglect their everyday experiences of what makes sense and seems reasonable. Various studies of everyday cognition (e.g., Scribner 1984; Lave 1988; Carraher et al. 1985) show that people are much more successful in solving mathematical problems in an everyday setting than in a school setting. These studies show that the framing of the practical activity, for example, doing calculations in a grocery store in order to compare prices, leads to a reasoning that differs considerably from the formal, standardized, and procedure-like framing of the activity in school. It is, hence, a question of a different framing of the activity in school mathematics and mathematics in an everyday setting. An important conclusion of the research done by Verschaffel et al. (2000) is that students do not behave irrationally, but act in accordance with their previous knowledge of the rules that guide the institutional setting of the school as a specific context and their socialization in this school practice. Lave (1992, p. 89) makes this issue even more explicit by emphasizing that the meaning of a word problem in mathematics is not primarily based on the mathematical parts of the task, but on the task's role as a school activity. "Thus, the meaning of word problems does not lie in their mathematical properties but in the role in the activity system of schooling, or dieting, or becoming a merchant in Venice in the 1500s."

Even though this issue is well researched, educational systems change over time. This involves new situated practices where sense making with mathematical word problems takes on different forms. The development of information technology has transformed educational practices; for instance, now mathematical word problems are not necessarily presented in the medium of the traditional textbook.

The logic of the field of educational software has partly been accomplished with applications that the researchers have developed and implemented themselves. This means that the settings of the studies are not necessarily part of a natural context, which gives the knowledge a hypothetical and rhetorical nature (e.g., Schrum et al. 2005; Arnseth 2004). To reduce the circular reasoning in those studies, more independent research on the usage of technology in practices where it is applied, has been called for (e.g., McCormick and Scrimshaw 2001; Tolmie 2001; Lagrange et al. 2001; Iding et al. 2002; Egenfeldt-Nielsen 2006; Luppinici 2007). In the present study, the aim is to scrutinize the activity as a routine in an ongoing practice where students work with one of the most widespread educational softwares in Sweden. The aim is neither to evaluate nor to improve the tool used, but to study the interaction in relation to existing software in environments where the software has already been implemented.

Frameworks

The analysis is conducted with the idea that all social encounters are guided by frameworks. In Goffman's (1974/1986) terminology, we make sense of situations by explicitly or implicitly asking ourselves *what is going on*. The answer to this question then forms the definition of the situation, which is shared with the other participants. The meaning of an utterance, an action, or an incident is dependent on the framing of the situation. Thus, framing is seen as a natural way for people to understand what is going on in situations and to be helped in how to respond and act. So framing is a dynamic and interactional activity as well as something that is embedded in the situation. The understanding of a situation is often implicit and something that takes place more or less without reflection. A multitude of frameworks may be involved in an activity, and different frameworks have different qualities and, hence, consequences for how the activity is interpreted and how it continues.[1]

In an earlier study of students' meaning making and learning related to mathematical word problems in the context of digital tools (Lantz-Andersson et al. 2008), we found that when students arrived at a solution that they believed was correct but was obviously not, there was a breakdown in the situation. That is, there was a halt in the activity and the interaction, and they displayed uncertainty about how to continue. How they framed the situation then played a significant role. The students often had, analytically speaking, difficulties in how to frame the situation; Had they themselves performed an incorrect modelling or did the difficulties lie in the digital design? The difficulty of defining the situation indicated that the students end up being uncertain about how to continue and how to act in the situation; there was, according to Goffman (1974/1986), a conflict of what framing was relevant. In the present study, which is part of the research described above where the students have been studied in a natural environment, the analysis is deepened in relation to the previous results and is focused on the qualities and the consequences of the frameworks employed in breakdown situations. The research is guided by questions of what rationalities are productive for the students' framing of computer-supported collaborative learning situations, and what this implies for their continuous problem solving and learning.

Method

Interaction analysis

A case study has been chosen to illustrate how students engage in the activity of problem solving and mathematical reasoning. The study of activities and communication are means for developing an understanding of what kind of situated practices are developed in this specific context. The analytic agenda implies that people, contexts, tools, and cultural constructions of tools are constitutive and inseparable elements of an activity (Wertsch 1991). In this study, it is about the activity performed by the students in negotiating how to understand the nature of breakdown situations when they work with educational software. The analysis then aims at understanding the human action and the cultural, institutional context (Wertsch 1998; Säljö 2005). The focus is more on the social than the individual, which is a characteristic of the dialogical approach in the CSCL tradition (this is further developed in e.g., Arnseth and Ludvigsen 2006; Wegerif 2006).

The empirical material consists of video films of students in pairs or groups of three, which have been analysed using interaction analysis (Jordan and Henderson 1995). The video films make it possible to focus on the temporal organization of communication and on the interaction between the students and between the students and the software. By focusing on how students engage in doing mathematics, the goal has been to analyse the interactional roles they have in conversation and to scrutinize how they frame the situation by analysing their interaction.

[1] Goffman (1974/1986) makes a distinction between *primary* framework and *key* or *keyings*. *Key* or *keyings* are constituted by frameworks that are dependent on an original, e.g. unfurling an umbrella on a stage is something we would not be able to interpret if we did not know of the original situation that is referred to, i.e. an umbrella is unfurled when it starts to rain. The *primary* frameworks adopted for the analysis in this study are, on the other hand, described as being taken for granted and do not depend on any prior interpretation.

The setting and participants

The educational software used by the participants is an interactive Web-based multimedia program in mathematics, the *VETA*[2] *Learning Game*. The software has been produced for upper secondary school level (ages 16 to 18), and consists of problem-based assignments in a story-based game context. While working on the assignments, students have no answer book[3] available where the correct answer can be seen. The only feedback they receive is whether their response is correct or not. When the response is incorrect, there is no additional information about what is wrong. This feature of the software is, as will be shown, significant for the students' communication, interaction, and for how they continue when they encounter difficulties.

In the software, the tasks are presented both in text and through spoken language, and there are different options for the students to get further help via theory sections and various kinds of help buttons. The tool also includes a variety of sounds, stills or animated graphics, and film segments. Thus, the educational software covers a lot of help functions, although this is not to say that the students use these facilities regularly. All the educational software produced by this company follows the guidelines, the curricula, the syllabi, and the grading criteria set up by the Swedish Board of Education.

The setting for the research is an upper secondary school. A characteristic of the specific study programme attended by the students is that they all have access to a portable computer in a building where there is wireless connection to the Web. The video sessions filmed took place in a room adjacent to the classroom, where the students worked with VETA's educational software during their regular classes. Thus, the students in this study worked with the software they used in their normal lessons, and the teachers regularly entered the room and interacted with the students.

The empirical material presented here consists of three sequences from one study[4] in the research project. This material includes 16 films, each lasting about 60 min. Sixteen girls and 18 boys, that is, 34 students in all, participated. The students worked in pairs, except for two sessions when there were three in each group. During most sessions, there were three cameras in use. One captured the screen, a second one captured the students from the back in order to document their non-verbal activities (pointing to the screen, etc.), and a third captured the activities from the front in order to see the students' expressions and to follow the conversation. The films have been synchronized into one film, where the different camera angles are visible at the same time, as is shown in the following screenshot (Fig. 1). Q6

Research ethics

The students and their parents were informed about the research. It was emphasized that all participation was voluntary. The research followed the ethical code of the Swedish Research Council.

[2] VETA (literally: KNOW) is a Swedish commercial company specializing in offering education in mathematics, physics, language and nursing- and healthcare education through Web-based educational software (cf. http://www.veta.com/ or http://www.veta.com/skola.php). Q5

[3] In mathematics textbooks and exercise books in Sweden, there is generally an answer book section (Swedish: Facit) at the end of the book. This implies that Swedish students are used to checking their calculations by comparing them with the answer given in the Facit. What the students are discussing in several of the excerpts we will present as the possibility that there is a mistake in the Facit.

[4] The data are taken from a larger project, which contains extensive additional material, including interviews with teachers and participants, additional recordings from usage of Web-based learning software in other subjects, etc.

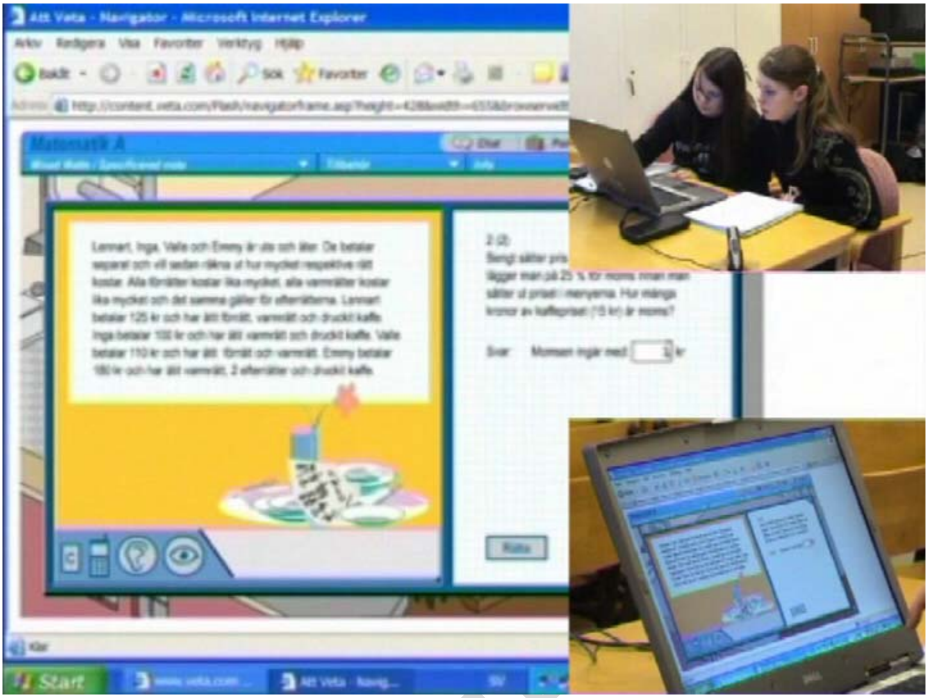

Fig. 1 Screenshot illustrating data material

Results

The example of the two students in this article was chosen as it clearly illustrates a recurring interaction pattern in the data of the students' negotiation about how to understand breakdown situations. The transcripts are organized in a system with columns to make it possible to document participants' talk and actions as well as the activities on the screen (Linderoth 2004). As will be seen, the tool is not a passive element in the students' work; rather, it becomes an important resource in the framing of the activity. How the students temporarily and continuously shift frameworks in the process of solving tasks will be illustrated. This will be done by means of a case study where two students encounter difficulties in problem solving. These excerpts show situations where they do not get the response they expect. When students are grappling with mathematical word problems with this specific educational software and get the feedback that their answer is "Incorrect", they become hesitant about the nature of what is wrong. There is a question of where the difficulty is to be located, that is, understood. The question for the students is what the relevant framing of the situation could be, and the analysis aims at scrutinizing what the frameworks employed imply in relation to how they deal with the difficulties they encounter and how they proceed with the activity.

Multiplicity of framings—the ambiguity of incorrect answers

In this session, the word problem is about VAT, value-added tax. In the excerpt, two girls are discussing quite intensively how to do the calculation of how much VAT is included in the coffee price of SEK 15. The context of this specific problem in the software is that of a restaurant. In the first word problem (to the left in the screenshot below), there is a task about dividing the bill between friends. The girls have already finished this task when they start working on the target task for this analysis. In this second task, the story is that the restaurant owner has added 25% VAT, and the price he has come up with is SEK 15. The question is: *How many kronor of the coffee price (15 kronor) does VAT consist of?* This is a classical exercise in this context in that it implies a shift in the reference of the value used for making the calculation.

Excerpt 1 from session 9

Nr	Name	Speech	Activity in the room	Activity on the screen
1	Elin	0, 25…0, 25 [said at the same time as pressing the keys on the calculator] eh…times 15…3, 75 should I write that? ... are you with me on that?	Elin takes the calculator and counts 0.25×15	
2	Maja	yes…but…	Elin writes 3.75 in the answer box	Gets the answer “Incorrect” as feedback
3	Elin	or should it be in whole kronor, maybe?		
4	Elin	if you take fou…[overlapping]		
5	Maja	don’t think that matters…but just that…		
6	Elin	just testing [whispers]	Elin writes 4 in the answer box	Gets the answer “Incorrect” as feedback
7	Maja	of the coffee price…that is…		
8	Elin	15 kronor, yes		
9	Elin	Isn’t it that way, you take 0, 25 times 15?		
10	Maja	yes, that’s what I would have done and that is the only logical thing I can find… but… before he enters the price [reads the word problem]		
11	Maja	the VAT is included with [reads the word problem with emphasis]…does that mean how many kronor it is?		
12	Elin	eh, what?		
13	Maja	when it says that it is included in…the VAT is included in [reads the word problem]…does that mean that it…?	Maja points at the screen to the text she is reading	
14	Elin	no, I don’t get it [whispers]		
15	Maja	before you enter the price in the menus…how many krosor [giggles] … kronor of the coffee price is VAT?		
16	Maja	…of the coffee price	They both watch the screen	
17	Elin	mm		
18	Maja	and that is 15 kronor		
19	Elin	and then I only take 0.25 times 15 and that gives me …	Elin counts first on a paper and then on the calculator	
20	Maja	3.75		
21	Elin	it is 3.75…so I don’t get why we get it wrong…now it should be right	Elin writes 3.75 in the answer box and presses the enter bottom several times	Gets the answer “Incorrect” as feedback
22	Maja	giggles…[inaudible]		
23	Elin	I know, but I get irritated		

In Excerpt 1, the girls have calculated 25% of the total sum of the coffee price (instead of setting up an equation or knowing that when counting the VAT “backwards”, when the VAT is already included, you multiply by 20%). They consider the right answer to be 3.75. The beginning of this excerpt illustrates that the students operate under the assumption that they have made some kind of mistake. From an analytical point of view, the framing of the situation is as an activity where the girls position themselves as responsible for managing to solve the task. Elin, in utterance 1, starts by telling Maja how she counts, asking her if she agrees. In her response, Maja displays uncertainty which is shown in her use of the word “but”, and she keeps reading the word problem. Elin seems to be quite certain that her problem solving is correct. In receiving “Incorrect” as feedback in turn 2, Elin shifts the framing—that is, they have done modelling correctly but the software is demanding something else, such as a round sum. In doing this, Elin is reframing the activity and understanding the solution to be due to the design of the software, and the issue is, then, not about her mathematical modelling. In what follows next in turns 3 to 8, Maja and Elin continue this framing by testing various options on the assumption that the technology does not respond to decimals.

In turn 9, Elin makes a shift in framing to the sphere of mathematical reasoning again by repeating her modelling to Maja. Here, Elin shows that she is uncertain about her mathematical skill, which could be costly for her self-esteem concerning mathematics, if Maja did not agree. Because Maja’s response is that it is logical, Elin’s mathematical competence is still not questioned. There seems to be a change in the interaction here, where Maja takes the lead and reads the word problem, emphasizing the words “included in” which could indicate that she is looking for the answer within the framing of mathematical modelling. However, Maja never suggests another solution. Elin then reveals her uncertainty about how to understand what has gone wrong and does not seem to follow Maja’s reasoning. This expression of uncertainty could be understood as ambiguity of framing or a conflict of framing since she does not understand what the nature of their difficulty is: Does it have to do with their mathematical reasoning and modelling or is it something in the design of the software? Finally, in this excerpt, Elin writes 3.75 in the answer box several times, pushing the enter button repeatedly, which could be interpreted as indicating that she is convinced that their modelling should result in a correct answer. Analytically, this behaviour could mean that she is operating within a framing where she understands the technology to be responsible for the failure to solve the task. When the situation is understood this way, the students do not talk about what they might have misunderstood in the narrative of the problem, but more or less guess in an iterative manner.

Trying to please the technology

After this excerpt, the students try the numbers given in the word problem in another way; they take 15 and subtract 3.75. At first, they calculate this by hand incorrectly as 11.35. Writing that sum in the answer box gives them “Incorrect” as feedback. Then they use the calculator and get the answer 11.25, which also gives “Incorrect” as feedback. For a few minutes they try these different answers, saying that they believe they have made a correct calculation. Analytically, this could be seen as the girls acting within frameworks where their modelling and mathematical skill matter. Thus, the girls think that they have modelled and calculated correctly. When they realize that they are wrong, they start reasoning about other possibilities, so in the next excerpt they start discussing whether the unit might be wrong.

Excerpt 2 from session 9

Nr	Name	Speech	Activity in the room	Activity on the screen
1	Elin	it might be mixed so that you should… no it doesn't say that you should write it with both [both here meaning two digits as in fractional numbers]		
2	Maja	we can always try		
3	Elin	eleven and one quarter, should we try that?	Elin bends forward and writes 11 1/4 in the answer box	Gets the answer "Incorrect" as feedback
4	Maja	mmm and then we could try with …eh… three and one quarter		
5	Elin	yes		
6	Maja	three quarters [inaudible] write three and three quarters		
7	Elin	three and three…four	Elin writes 3 3/4, clicks on the correction button	Gets the answer "Incorrect" as feedback
8	Elin & Maja	no! [in unison]		
9	Maja	Well, one shouldn't do it like that either		

What we see at the beginning of the excerpt above is that the girls shift from a framing within mathematical reasoning to a framing where they search for the difficulties in the technology. When Elin, in turn 1, suggests that "it might be mixed", she is using her previous experience of the software's syntax sensitivity, that is, her knowledge about the software which is sensitive to the units of the answer. For example, sometimes the software is sensitive if the answer is given in fractional numbers or as a percentage, and sometimes even to the smallest elements, for example, punctuation marks, such as the use of a comma or dot in the mathematical answers. Even though Elin mentions that nothing is said about using both (i.e., both digits in fractional numbers) in the last part of turn 1, Maja agrees and suggests that they could try. In turn 3, they write 11 1/4 and in turn 7, they write 3 3/4, saying that they should proceed by trial and error. Thus, in this second excerpt, they look for an alternative way of writing their answer, which was also seen in the first excerpt when they discussed whether they should write their answer in round figures. When they bring up the possibility of writing the answer in fractional numbers, it is interesting because the unit *kronor* is already written as the correct unit in the answer box (see Fig. 2), and using fractions in the context of an exact unit of currency is rare, at least in an everyday setting. But because this is a mathematical classroom setting it makes sense to them to try this. The framing of the situation could then be described as shaped by their previous experience of framing in connection to institutional mathematical word problems, and as an example of *suspension of sense making* (Verschaffel et al. 2000). Again, they interpret the situation as having nothing to do with their problem-solving

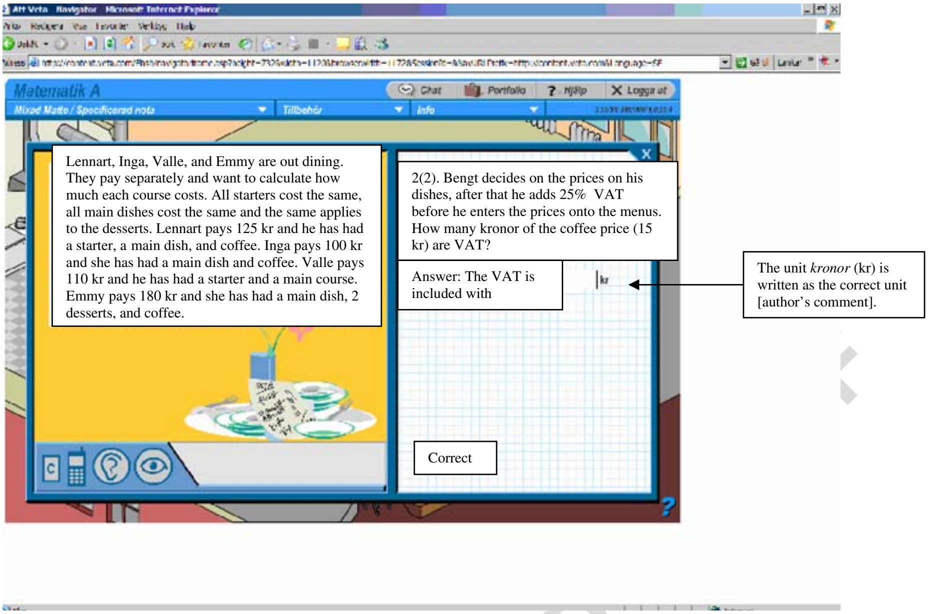

Fig. 2 Screenshot of the task in the educational software. [Author's translation into English from Swedish of the text in the boxes above

ability, and instead, they try different ways of writing the same answer in order to "please" the technology.

This iterative method of working is quite common in the research material. Because there is no information about the nature of what is wrong, and there is no reciprocity in the technology, ambiguity and uncertainty exist in the activity. The students are placed in a situation where they are given some information but not given a clear picture. This implies they can draw a variety of conclusions. Whatever is said about the meaning of the given information, the right to interpretation (i.e., the right to claim what is meant by the expression) is, in this institutional setting, reserved for someone else (Goffman 1983). With the support of the analytical concept of frameworks, it could be said that the iterative approach has to do with the fact that the agency is understood to be within the technology, which is a very complex system. Thus, the activity could occasionally be framed in a way that ascribes the difficulties they encounter to the tool and its design.

The agency is understood to be in the digital design

Before the next excerpt, there is an instance of framing where the students consider themselves to be accountable for modelling the mathematical content again. They read the word problem one more time, discuss whether they should calculate in another way, for example, 15 divided into 25, and reason about that for a few minutes. Elin suggests that they should perhaps leave the task and move on to another one, but Maja says that this task is the second of two and she really wants to finish it. In the next excerpt, they start discussing if there could be an error with the software.

Excerpt 3 from session 9

Nr	Name	Speech	Activity in the room	Activity on the screen
1	Maja	there couldn't be an answer book error, could there? but we haven't heard that?	Elin counts on the calculator and Maja watches the screen.	
2	Elin	no, but on the other hand we haven't done this for such a long time…	They watch each other.	
3	Maja	noo		
4	Elin	there could be an answer book error		
5	Maja	sure		
6	Maja	it was like that in the other task … and we didn't solve that one, did we	They watch each other.	
7	Elin	well, should we…we have written it down for later anyway	Elin puts the calculator down.	
8	Maja	mmm, let's take another task		
9	Elin	yes, let's do that…	Elin clicks back to the main menu.	The picture of the main menu is visible.
10	Elin	ask Anna about it later		

If we view the excerpt above analytically, the students again could be said to employ a framing where the agency is understood to be due to the digital design. In turn 1, Maja suggests that there could be an answer book error, which is an attitude that is shared by the students in the research material, that is, the students' awareness of errors that have occurred in the answer book (for a discussion of this phenomenon, see Lantz-Andersson et al. 2008), and as a result, they take this possibility into account when their solution is false. When Maja brings this up in turn 1, she also says but we haven't heard that, meaning that they do not know if there was an error in this specific assignment. In this utterance, she reveals their mutual understanding that errors found by other students are quickly reported and discussed in class. In turn 1, Maja, also, expresses uncertainty about how to understand the feedback, which, in Goffman's terms, could be interpreted as if they are captured in-between frames, not knowing what is going on. However, in turn 2, Elin points to the fact that this is a rather new area and there still might be an error that has not yet been discovered. The underlying meaning might be that they could be the ones to detect it. Elin gives reasons for their framing, claiming that this is a new task and, in turns 3 to 5, they build up a mutual agreement on the agency being in the technology. In turn 6, Maja brings up an occasion where there actually was an answer book error. This could be interpreted as if they experienced that they could not solve the lack of clarity by means of different modelling, because the error actually was in the technology. In turns 7 to 9, they formulate a rationale for being able to continue, saying both that they have written it down for later (turn 7) and that they could ask their teacher about it later (turn 10). The framework employed, where the agency is understood to be in the design of the digital tool, gives them the opportunity to postpone their understanding and to continue with their work. In educational settings, this finding is of importance because one of the foremost agendas for schoolwork is to get tasks done, and being stuck on one task for a long time is neither desirable nor reasonable. In concluding the task by framing the activity this way, the students are able to continue their work on other mathematical tasks without considering their problem-solving skill and mathematical ability because the agency is understood to be in the technology.

At a general level, the conclusion would be that the students sometimes search for the answer *within their mathematical reasoning* and sometimes they believe that the answer is *in the design of the technology*. At first, when the students are unpacking the word problem, they are oriented toward a mutual understanding, and their trust in each other is greater than their trust in the software. They show confidence in their reasoning and modelling. During their efforts to carry out the task, they negotiate and renegotiate how to understand the situation, and throughout their work they shift the framing several times. When they have tried different solutions in a framing where their own capability is most important, there is a breakdown in the situation, and they face the fact that there is something wrong. What happens then, in several occurrences in the empirical material, is that they shift their interpretation of the situation. They frame the activity by looking for a solution within the technology or in the design of the software, instead of working with the educational content.

Discussion and conclusions

The findings in this case study show that when technology such as educational software is introduced as a support in the activity of learning, the activity changes and the tool itself becomes a constitutive element of the activity that the students engage in. Hence, when there is a new resource at hand, this resource will also involve different conditions for people to consider in their sense-making process. In this particular study, I have seen that the students frame the situation with the work of mathematical tasks as the carrier of a mathematical tradition into which they are socialised, which provides a working pattern where the impact of their own agency in solving the tasks is very strong. However, in classrooms where digital technology is used, the activity is sometimes framed with the agency situated in the design of the technology, which implies that the students operate on the assumption that they cannot solve the difficulties they encounter with mathematical reasoning. When the activity is framed this way, it is not clear whether mathematics is learned at all (Lantz-Andersson et al. 2008).

Goffman (1974/1986) suggests that when we face situations that we "logically" should be able to define but are uncertain about how we should act, we end up with a conflict of frames. As in the examples from this case study, when you have solved a mathematical problem and get the feedback "Incorrect", you should be able to frame the situation as if you had made a wrong mathematical calculation, wrong modelling, or understood the word problem incorrectly. However, because there are other possible ways of framing the situation, you end up not knowing how to define the situation.

> The concern, rather, is the special doubt that can arise over the definition of the situation, a doubt that can properly be called a puzzlement, because some expectation is present that the world ought not to be opaque in this regard. (Goffman 1974/1986, p. 302).

In situations where students face tasks that are problematic and receive the feedback "Incorrect" when they give their solutions, there is a breakdown in the situation, and they show uncertainty about how to continue. In their effort to understand what the difficulty is, they temporarily shift between frameworks. But what are the qualities of the frameworks employed, and what do they imply as regards the students' further interactive work? In the present study, the characteristics of the different framings of the activity resemble characteristics related to *natural* and *social* frameworks (Goffman 1974/1986). By using the concept of frameworks, the analysis could be more focused, and the different roles these frameworks play in helping the students to understand and interpret the activity could be even more distinct. Furthermore, these concepts outline the difference between which one is employed, in how the students accomplish and proceed with the task at hand. *Social* frameworks imply a background understanding of situations that "incorporate the will, aim, and controlling effort of an intelligence, a live agency, the chief one being the human being" (Goffman 1974/1986, p. 22). If a situation is framed within *social* frameworks, it clearly includes human motive, intent, competence, honesty, efficiency, tactfulness, good taste, and so forth. *Natural* frameworks, on the other hand, are seen as purely physical, with no human agency involved. When framing the situation within natural frameworks, events are regarded as just happening with no social influence operating behind them.

> Natural frameworks identify occurrences seen as undirected, unoriented, unanimated, unguided, "pure physical". Such unguided events are ones understood to be due totally, from start to finish, to "natural" determinants. It is seen that no wilful agency causally and intentionally interferes, that no actor continuously guides the outcome. Success or failure in regard to these events is not imaginable; no negative or positive sanctions are involved. (Goffman 1974/1986, p. 22)

So in the breakdown situation one could either place the agency within one's own actions and capability, which could be costly in relation to one's self-esteem, or frame the situation in such a way that the unresolved problem has nothing to do with one's own competence. When framing the situation within natural frameworks, the computer and the educational software become agents outside the individual's control. This implies that students are able to regard the events as just happening, which indicates that failures in connection with activities framed this way are not the issue. They simply face a situation where they can "blame" the circumstances and can proceed with another task. Understanding a situation within natural frameworks then becomes a legitimate way of being able to go on working without resolving the nature of the difficulty and with a renunciation of agency. From an educational point of view, the opportunity to learn about mathematical reasoning is missed.

Relating technology to the concept of *natural frameworks* is, of course, not altogether unproblematic because technology itself consists of sociocultural artefacts made by humans with a human intent. However, the purpose is, by no means, to dismiss all interaction in relation to technology as unguided events. Nor is the purpose to attempt to describe the activity as dualistic by using these concepts. Rather, the activity could be described as a constant shift in framing where the participants continuously modify and alter their ways of understanding what the difficulty might be. It could be argued that technological environments are classically hybrid, neither purely physical nor totally under the control of a human being. However, the point here is that in their uncertainty about how to understand what the difficulty is, the students act from time to time in relation to technology in a way that resembles an approach to unguided events. So in describing the activities from this analytical perspective, it is possible to underline aspects of interaction with computer-supported work and interaction patterns that are valuable for understanding some parts of new learning situations with technology.

A number of modified design elements would undoubtedly change the interaction patterns, and one question could be if the software is designed to support the task effectively. Another question of importance could be: What is left of the mathematical word problem dilemma and what become new dilemmas in connection with the technology? In order to elaborate understanding of the complexity involved in these questions, one important aspect could be that the digital technology for many of us is like a black box and the more sealed the tools become, the greater is the ambiguity of how to frame a situation.

The more options there are in a system, the greater would be the multiplicity of things to choose between. For most of us, today's technology is a very complex system which leaves us with a lot of options. Following this line of reasoning, I argue that the main issue is not about how the software could be improved, but about the fact that its functions are hidden, which makes us uncertain about how to understand the nature of difficulties in breakdown situations. As an illustrative example, the ancient farmer would probably only understand a situation within natural frameworks when it comes to the weather, which is something he could not possibly influence himself. The modern farmer, however, surrounded with high technology where the mechanical functions of the tools are hidden, could also understand situations in relation to natural frameworks, that is, something that he neither understands nor has an influence over, when facing difficulties with these tools. Thus, human knowledge gets more complex when digital technology is introduced and when the world becomes less transparent. Given that a lot of modern knowledge is built into technology, there is an increased ambiguity of how to frame situations. It seems that the more knowledge that is built into the tool, the more opaque it becomes, and the greater the tension between social and natural frameworks. When both the knowledge and the process are hidden, it seems that it is easier to frame the activity within natural frameworks. This is an important finding to consider when developing an understanding about learning in relation to digital technology.

An observation emanating from this study is that there is a tension between solving problems and mathematical reasoning. This tension implies that when students encounter difficulties, they tend to frame the activity as if it had to do with the design of the technology, and in these situations they do not seem to engage in mathematics at all, being very procedurally oriented. When operating within this framing, the students do not think of themselves as being accountable for their lack of understanding the difficulties they encounter. In this way, they could be excused from solving a certain problem and go on to another task with a sense of "face-saving". A conclusion to be drawn is that sense making, communication, and social patterns could, in this context, be based on an understanding of the activity that diminishes human agency at the expense of technology.

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