STUDENTS' DISCUSSIONS ON A WORKPLACE RELATED TASK

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This study is situated in a mathematics course in the vocational education programmes in Norway. The students worked in small groups to make a budget for a hair salon. The real world connection made the students puzzled by the big numbers they calculated, and offered the students opportunities to discuss and evaluate their answers. They did not trust their own calculations without checking with others and, unsolicited, the students started comparing answers and discussing with other groups. The students are in the first stage of an inquiry process, but rarely moved on to ask their own questions and question their own estimates.

Key words: vocational education, real world, inquiry, task design, discussion

BACKGROUND

In Norway most of the adolescents (over 90%) continue with education after the compulsory 10 years of schooling (Statistics Norway, 2012). About half of them study in vocational education programmes to get a trade certification. These vocational education programmes are mostly structured as two years of school based courses, and two years apprenticeship. In the vocational education programmes less than half of the students finish on time (The Norwegian Directorate for Education and Training, 2011), and one of the reasons for this is that they fail in mathematics (Norwegian Ministry of Education and Research, 2010).

During the first year all vocational students attend a mathematics course consisting of 84 hours course work. It is a stated goal from the government that this mathematics course should be oriented towards their vocation (The Norwegian Directorate for Education and Training, 2010a), though the content of the curriculum is the same for all nine vocational education programmes. The course consists mostly of topics the students have met before, numbers and algebra, proportionality, percentages, and geometrical shapes. There are some new topics, mainly price indices and budgeting. In observations of lessons and from talking to teachers I get the impression that the students have forgotten, are confused about or have never understood parts of the mathematics they have met earlier. The mathematics teachers are usually unfamiliar with the mathematics of the students' future jobs.

In a collaborative project with mathematics teachers from different vocational schools in the county, we, didacticians [1] and teachers have started to build a community for improving the teaching and learning in the mathematics course in the vocational programmes (MTPL research group, 2011). This paper is about how a task connected to their future employment encouraged students in a vocational education programme to discuss and use inquiry in mathematics. The research is

based on findings from the pilot study of my doctoral research. My (provisional) research question is how and in which situations do students show an inquiry approach on a work place related task?

THEORETICAL PERSPECTIVES

The project is based on the key ideas from the LCM/ICTML and TBM-LBM projects (Carlsen & Fuglestad, 2010; Jaworski et al., 2007) about creating learning communities of teachers and didacticians. This learning community is supported by workshops, discussions between didacticians and teachers and school visits. Inquiry is an important concept in our community (Jaworski, 2005), both as inquiry into mathematics teaching and learning, and as a goal for student activity. Wells (1999) describes inquiry as ‘’a willingness to wonder, to ask questions, and to seek to understand by collaborating with others in the attempt to make answers to them (Wells, 1999, p. 121)’’. We want the students to experience an inquiry approach to mathematical activities. This inquiry approach can for instance be that the students investigate, experiment, ask their own questions and try to find their own answers.

Skovsmose (2001) writes about different milieus of learning, and make distinctions between the paradigms of tradition of exercises and landscapes of investigations. In both educational paradigms there is the possibility for division into mathematics, semi-reality and real-life references. Inspired by Skovsmose and the inquiry goal we aimed to design a task that would be in the landscape of investigations and connected to real-life. The task should be possible to develop in different directions, and encourage the students’ use of inquiry during the problem solving activity.

To try to make the students aware of some of the mathematics they might encounter in their workplace, the task was connected to the students’ future vocation by use of articles like receipts and authentic rental fees. Williams and Wake (2007) note that teachers, students and workers find it difficult to identify mathematics in the workplace. In addition research has shown that students have difficulties with word problems based on real-world situations (Greer, Verschaffel, & Mukhopadhyay, 2007; Verschaffel, De Corte, & Lasure, 1994). The students often disregard the context and give answers that do not make sense in the real world, for instance that one needs 31 reminder 12 buses to transport soldiers (Silver, Shapiro, & Deutsch, 1993). This signalled that we had a challenge to make the students aware of and to use the real world connection when they solved the task. The given task was intended to encourage the students to use realistic assumptions and give them the possibility to evaluate their answers.

METHODOLOGY

I first met the teacher in workshops at the university, and he volunteered his class for the pilot study. Information about the research project was given to all participants.

One student declined to participate in the research, and therefore worked apart from the class during the research period. My case is situated in a class of 15 female students aged 16 and 17 who study in the vocational education programme 'Design and Crafts.' This programme aims at education for jobs like jewellers, dressmakers, hairdressers and florists. According to the teacher, the students' performance ranges across all attainment levels and there are some low achievers in his class, which is typical for the vocational mathematics courses. There are episodes in the collected data where this is evident, for example one of the students sang the multiplication song to calculate nine times five after saying she is not good at the nine times table.

The class was about to start working on an economics unit, where the competence objective was that the students should be able to ''make budgets and do accounting using different tools'' and ''calculate taxes''(The Norwegian Directorate for Education and Training, 2010b). Together the teacher and I made a vocational oriented task about a budget for a hair salon. The task was revised several times before it was used in the classroom, mostly to make the level appropriate and the text clear. Many of the students planned to become hairdressers, related vocations like skin care workers, or other occupations where they would work in a small business. In addition the students, regardless of their future vocation, had experiences being customers at a hair salon. The students spent about two hours (three lessons) working on the budget. The teacher suggested, and I agreed, that I should present the task since I had designed it, and take the leading role in the classroom with the teacher as observer and assistant. The students worked in small groups of three or four. Both the teacher and I circulated in the classroom and helped the students.

The first task the students were given was supposed to help them reflect on their own experiences as a customer at a hair salon. They were asked to write down ''what is a usual price for a lady's hair cut?'' ''what is the highest price you could have paid to get your hair cut?'' and ''what is the lowest price YOU could have cut someone's hair for? (Remember that you do not get paid the whole price yourself).'' After a class discussion about this the students continued with the second task. This task was to ''write down the most important expenses a hair salon has in a month'' and ''write down the most important income a hair salon has in a month.'' Then they were given a sample budget on paper and information on rental fees (per square meter), sample prices on haircuts, electricity, phone prices and so on, and the third task asked them to ''use the information you are given. If some important expenses or income is lacking you need to discuss to get realistic numbers.'' They were also to calculate the loss or profit. This third task took most of the allotted time for the students.

To do these tasks the students needed to decide prices, how many and what types of haircuts they could manage in a day, which and how big expenses the salon had and so on. This is in line with the inquiry idea where the students should investigate and ask their own questions. From a mathematical point of view there are possibilities for

the students to learn about budgeting, estimation, modelling how many customers they can expect per day, calculating sales tax and area to determine rental fees. The students mostly needed 'elementary' mathematics like addition and multiplication to get started on the budget, but would be challenged to decide the important information. When the students were finished with a paper version of the budget, they started to use a spreadsheet. But they used it only to record their data, and did not make formulas to be able to alter their input. It could have been possible to make a dynamical spreadsheet for the students to encourage them to try out different scenarios. The task opened up the possibility for the students to collaboratively inquire into the mathematics of budgeting, and together decide what a good and realistic budget is. There was no definitive correct answer to the task, and the students were challenged to explain and defend their choices, both by the teacher and when the groups talked to each other.

To document the activities the lessons were videorecorded with one camera. When the task was introduced the video camera had a view of the students and the projector screen. During the students' work with the task the camera was focused on one group with three students, and their discussions with the group next to them. The students were instructed to work as normal, and try not be disturbed by the presence of the camera. After the lesson, the students' notes were collected, and I discussed the students' work with the teacher. This session was audio recorded. The recordings from both classroom and discussions were transcribed. I translated the Norwegian transcription into English aiming at the closest fit of words and meanings. In this part of the study no students were interviewed about their opinions of the tasks.

From the transcriptions it appeared that the size of the numbers often puzzled students. This made me curious, and I identified all episodes where the students discussed their answers. The episodes used below are selected from this set of episodes and are representative of the work done by the students on this task. To observe if the students began to inquire into the mathematics I looked for engagement, if the students expressed puzzlement, what they were puzzled about and if something in the task or their work triggered their curiosity. In addition I noted how and with whom the students sought to discuss and evaluate their answers, and if they asked the teacher, the other students or did something else.

SOME FINDINGS FROM THE LESSONS

In this paper I focus on the episodes where the students discussed their answers. These episodes were analysed looking for how and in which situations the students showed an inquiry approach in their work. This analysis showed that:

1. The students were often surprised by and wondered about their results.
2. The students compared and validated their results by discussing with other groups or the teacher/didactician.

3. The students evaluated their results, and sometimes reconsidered their initial assumptions.

These three observations are all possible to link to the notion of inquiry, I can see that the students sought to understand their answers, started asking questions and discussed with each other. The following excerpts are from the work of small groups A and B, which were located next to each other. The groups were working separate, but did sometimes interact. In the transcripts text written in italics are observations.

The students were often surprised by their results

The students in both group A and B were often surprised and disbelieving of their results. This can be observed in the following episode in the beginning of the first lesson. Group A decided that their classrooms were about the right size for their salon, and made an estimate of the size of the room to be about 50 square meters. The rental fee was given as 1200 NOK per square meter, about 160 euro.

Student A1: We'll say 50 then. 50 times 1200. *They take up cell phone calculators.*

Student A2: First to calculate it. Damn. *Pressed something wrong on the calculator.*

Student A1: 60 000.

Student A2: *Laughter.* Okay.

Student A1: Sick. Gosh.

Student A2: In a month?

Student A1: Yes. If we have about this [size of room].

Student A2: Wow. *All three students focusing on their notes and looking surprised.*

This was also evident in the other groups. In group B student B1 claimed loudly that one cannot pay 42 000 in rent to which student A1 replied ''we have 60 000 monthly'', while the other members of group A giggled. Student B1 showed her surprise by exclaiming ''yes, wow!'' This surprise can be connected to the real world setting of the task, and that the students had a sense of how much money this is. For the students 60 000 is about equal to three or four months' salary when they start their apprenticeship. This puzzlement made group A and B compare and discuss informally their answers with each other.

The students validate their results by discussion

To confirm their numbers the students approached both the teacher or didactician and each other. Often the students first asked the teacher/didactician, and then compared with the other groups. It therefore looked like validating with their peers was at least equally important as feedback from the teacher. Here group A and B were still wondering about the rent, and asked me about it. I explain that ''well, but it is actual real numbers''. The students giggled and exclaimed ''goddamn. Oh my god''. I then tried to point the students to that ''... You get in some [money] also.

You do not earn 450 kroner one day in a month, in a way, on a lady's haircut. You earn some more'' to which student B1 contradicted with ''not 42 000 NOK''. But student A1 then said ''yes, yes, you do [earn] that. Oh my God.'' and giggled again.

The students did not appear to be satisfied with my answers, and were still hesitant about the big numbers. I did not provide a ''right'' solution, but tried to encourage the students to reflect that there may be an explanation for their seemingly big numbers. They continued working in separate groups after this exchange, but did not change their answers even though they appeared unsure. The students might also thought that since I did not say that it was wrong, their solution had to be fine.

The lesson ran out of time, and we continued the next mathematics lesson, four days later. The students then worked on deciding income from different items, like ladies' haircuts, product sales and hair colouring. After doing this they added up to get their total income and group B again asked me about the validity of their results, and started discussing with group A.

Student B1: But we have only 4 haircutters, and we earn [income of salon] almost a million a month. Is it very unlikely to earn that much in a month? *Addresses Trude.*

Student A1: We have hundred and fourteen [114 000].

Student B1: Hundred and fourteen. What?!

Trude: Then you can evaluate why you have that much difference.

Student B1: Oh my god, we have a million a month.

Student A1: What?

Student B1: Yes. *Smiles and giggles.*

Student A1: Yes, but this [114 000] is a week.

Student B1: Oh, you have calculated a week. Well then.

I tried to ask the students to evaluate why they had different answers, but the comparison between weekly and monthly income appeared to end the progress of the discussion. The students were still very interested in the numbers, and when a student from another group came by two minutes later they again discussed their income.

Student A1: Yes, we earn this much a week. Hundred and fourteen thousand.

Student 7: Week?

Student A1: *Giggles.* Yes.

Trude: Weekly?

Student A1: Yes, we calculated a week.

Student 7: We earn, about, eeh, around 75 000 a month.

Student A1: What? *Asks with a sharp voice.*

Student 7: A month. That is lots.

Student A1: That is little. They have a million. *Points to group B.*

Here I observe that the students are comparing the answers with each other, and they did not agree about what is too much income. When the group with a million in income was drawn into the comparison everything else appeared like small numbers, even though there is a big difference between the others. Student 7 commented dryly that group B had to have a big salon to generate that much income. There may also be a misunderstanding between the students about earnings, income and profit. Both the students and I used the words interchangeably, and this may have caused some of the puzzlement over the amount of money generated. The answers were discussed and validated by the other groups' answers, but the students did not change their own results after these discussions. It looks like the strangeness of the big numbers lessens when they realised that the other groups also have big numbers.

Evaluating of results and reconsidering of assumptions

There were episodes where the discussion between the students led to changes in their estimates for the hair salon. This can be seen by the following episode where group A made the budget in Excel after finishing the paper version. Their own notes did not show the students their estimates, so the group reversed the operations to figure out their earlier estimates. For instance they took 240 000 in earnings from colouring, and divided by the colouring price and got 240 persons. The students had originally assumed that they could colour four persons per employee every day, so four colourings times three employee times twenty days a month. When making the budget for a week they did not reflect over this answer, but now they started questioning their estimate.

Student A1: Then it is 240 we colour a month. We can't colour 240 persons a month!

Student A2: I believe we can colour about 100 persons, no, not even that.

Student A1: Not even that. Maybe 50, 70 something. Then this is wrong again. How many should we say that we can colour, 50 or 70?

They decided on 70, and continued working. There are situations where the students compared their results with other groups, and identified the factors that made the differences between the budgets. When group B had finished their budget and calculated the profit they approached group A to compare the results.

Student B1: How much did you have in profit?

Student A1: Wait a minute. First we had three hundred [300 000], now we have two hundred and eighty four. [284 000]

Student B1: *Shows her notes with the profit 122 160 kroner.*

Student A1: But you have more employees, we have a bigger salon [in square metres]. You pay 42 000 in a month, we pay 60 000 [in rent].

Student B1: We have four employees.

Student A1: We have three.

Student B1: Yes.

Student A1: Then it is a bit …

Student B1: We earn actually more [than you].

Here the students realised that one of the important variables in the budget is the number of employees and therefore the ability to generate high earnings. It seemed important for the students to have the best salon, and they gave the impression of being satisfied with having the salon with most profit. These competitions between the groups are also evident in other episodes, and the students discussed what is included in the prices in their different salons, like free coffee, and the work space and so on.

DISCUSSION

The students looked like they engaged in the task, but this could be a Hawthorne effect of the video recording in the classroom, and the novelty of a different teacher/researcher. The students were interested in the video camera, and there are instances of them singing and dancing to the camera. I will still argue that the students did not act for the camera while working. When they fooled around with the camera, they did not focus on the mathematics, until they remembered their task. When they started working again they gave the impression of being focused on the task and not the camera. I therefore believe that what they said during their mathematical activity is what they would normally express in the classroom, without the camera present.

The task of making a budget for a small business, like a hair salon, is something many of the students will encounter in their working life. It could be that the real world setting made the students willing to question their answers and discuss them with members of the other groups. This may be an indication that the students were engaging in an inquiry process and started to seek understanding with the others. The puzzlement with the answers, and thereafter discussions seemed to contradict the research on word problems where the students mostly ignored the real world setting. But this questioning and discussion could also be an effect of the novelty of the tasks, and the visit from a researcher.

At the start of the lesson the students and I spent some time discussing different prices at hairdressers, and this gave me the impression that students associated this

with their own experiences. This could have been helpful when the students made estimates and worked out the budget. The students may have been more aware of the connection to the real world, and therefore more critical of the realism of their answers. When they are making a budget in their work life they will need to estimate the customer base, and how much income the small business can generate. This task could help them have a better possibility to understand how different expenses and income are connected to each other.

The task was made to be consistent with Skovsmose's landscapes of investigations with connections to real life references. My findings show that the students displayed a willingness to wonder. They are often surprised by their results, and could be on the way toward an inquiry stance in mathematics. They were seeking confirmations from the teacher and didactician and the other groups to validate their results, and while solving the task the students discussed and evaluated their answers with the others. It looked like they were more likely to trust their calculations when they realised that the other groups had gotten answers that were similarly big numbers. After working with the task for a time they did not seem that puzzled by the big numbers. The students reconsidered and revised their answers when they discussed if they really could colour the hair of 240 persons a month. I sometimes tried to encourage the students to ask questions and stimulate them to discuss what made the differences in their answers, and therefore what would make the most impact on the budget and profit. This was not an easy process to start, and even though the students discussed their answers it rarely went further than comparisons between the groups.

To summarise, it looks like the students showed an inquiry approach in the work place related task when they got puzzling answers. When they got these answers the students tried to correct or validate their solution through asking questions to the didactician or the teacher, and by comparing or discussing with the other students. They sometimes revised their answers, but did not start asking their own questions.

To further develop the research and the real world connections one could expand the task by having the students investigate how hair salons make their budget, and what income and expenses a real salon has. They could get information on how much a hairdresser has in income in a day, and use this information to revise their budgets. This real data might prompt more discussion and evaluations of their budgets, and possibly be the start of more inquiry processes for the students. It would be informative to interview some of the students to find out what they thought about the task, and how they worked on it. I also plan to work with this and other vocationally oriented tasks with other students.

NOTES

1. As in the LCM project I use the term didacticians for the researchers/educators from the university since both teachers and university researchers can engage in the research (Jaworski, 2005).

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