‘WE HAVE LEARNED TO THINK MORE DEEPLY AND THOROUGHLY’

Monique Pijls and Rijkje Dekker
Graduate School of Teaching and Learning,
Universiteit van Amsterdam

Abstract: We investigated the role of the teacher in the senior general secondary education (HAVO) grade 4 Mathematics A course as part of the project on collaborative mathematics learning using the computer. The students in one of the two conditions were supported only on their interactions (process help) and the teacher provided no technical (mathematical) help. Students had considerable difficulty with this way of working and expected that the teacher would provide more explanation. However, two students also said that they learned ‘to think things through more deeply and thoroughly for themselves’. In this workshop we will illustrate how these two students gained their insights through the process help that was provided. The results were obtained by analysing audio recordings of the students and their written exercises. Both the students and the teacher appeared to find the process difficult, important aspects of which were the students' motivation and attitude to work.

Two students in an educational experiment in HAVO grade 4 mathematics A (see Pijls, Dekker and Van Hout – Wolters, in press), in which students collaborated on mathematics tasks using the computer with less support from the teacher than usual, stated that they had learned to think things through more deeply and thoroughly. These students were not representative of the entire student group. The learning results showed considerable progress of one and average progress of the other. However, what was striking about these students was the change in their attitude to work. Indeed, the individual construction of mathematical knowledge was a major problem for most of the students. The two students had produced something fundamental that the entire group found difficult. We focus in this workshop on how this change in the attitude to work came about. We will show the resistance experienced by even these two students and their teacher the first time the teacher refrained from explaining the mathematics to the students. The aim of restoring the students' momentum through their own efforts was ultimately successful. What factors contributed to the success of these two students, but not the others?

When the learning material and the computer simulation allow students to learn independently and with each other, the teacher's role can be minimal. Dekker and Elshout-Mohr (2004) investigated which type of teacher help led most effectively to raising the level of VWO grade 5 Mathematics B students. The pupils worked in heterogeneous groups of three on tasks related to geometrical transformations. The impact on raising the level of the following two types of teacher help were compared:

1. product help: teacher help oriented to the mathematical product on which students work (mathematical hints);
2. process help: help oriented to the interaction between students, in particular the occurrence of the key activities.
It appeared that the students who received product help while working on the tasks made more products on a conceptual level. Nonetheless, the level of students who were given process help was raised higher. Dekker and Elshout-Mohr say that the teacher that provided process help only sustained the collaboration and thus created an opportunity for reflection, but the process help did not interfere with the students' thinking.

The two students in our study, Rose and Stella, attend a Montessori Lyceum, where students are accustomed to independent learning. They were selected because they had exhibited a change in their attitude to work, which was absent in the other students. Figure 1 shows how they themselves viewed the lessons.

Figure 1. The answers given by Rose and Stella to the question on what they have learned from these lessons ‘We have learned to think more deeply and thoroughly by ourselves’

The teacher who participated in the investigation has taught at the Montessori lyceum for many years. He was keen to experiment with this new way of supervising students. It was not natural for him to provide process help exclusively. Product help is more common in everyday school practice. This form of mentoring was practised by means of role play in a number of meetings. There was also some discussion of the teacher's thoughts on the possible pitfalls of process help. The first to be raised was that students might wrongly develop, or fail to learn, a given concept. The teacher was willing to accept the risks of this educational experiment.

The process help was structured as follows. The teacher gave instructions at the start of the lesson: ‘I will not be helping you with the actual maths. I want you to talk together a lot, to show each other your work, and to explain things to each other, which is how you will learn. Offer each other criticism, so that the work improves.’ When students were working together and requested help the teacher would say: ‘I want you to decide for yourselves, to think about and to be critical of each other's ideas.’

We have selected critical episodes in our audio recordings, that show the development in the change of attitude from the students.

**EPISODE 1**

Stella is unsure about calculating the probabilities and wants to ask the teacher.

1 S: Are we allowed to ask you some questions? …

2 t: I, no, you can, no you are working well together, carry on as you are, you can find out everything yourselves.

3 S: Yes, but are we also allowed to ask you some questions

4 t: What do you mean, what do you want to ask me, then?

5 S: Well, in b) here, we don't really understand how we have to calculate that
Oh yes, no, but that's right, try to think of something together where you can say something about it.

Yes, we have thought of something, but…

Well, if you think that's the right answer, that's fine as far as I'm concerned. If you agree with each other that that's your answer, you have to write it down.

The students are clearly not accustomed to a mathematics teacher giving them no hint whatever on the calculations to be performed. They appear to be unsure how to deal with the fact that they are receiving no help with their calculation. At the same time the absence of explanation from the teacher does not yet completely stall the students, because the tasks are not prohibitively difficult. We can observe the teacher wrestling with giving an answer without addressing the mathematical content of the question. He emphasized that the students themselves had to find a solution, and tries to encourage them.

**EPISODE 2**

Rose and Stella are now working on a question on how Pascal’s triangle can be used to solve a counting problem on free days in a week. They cannot answer the question and both of them are convinced neither of their own answer, nor that of the other person. They decide to step back from the question, and take a break. After the break they summon the teacher.

Albert, could you tell us one thing? (…) How can you apply Pascal's triangle if you have two days free, which is the same principle as five blue and two red, but we get a different answer.

Well, you have to decide together which of the two is right.

Yes, but they are both right.

So put both of them down.

Yes, but that can't be right.

Yes, but you can't, can't you decide between yourselves?

Yes, but, is it all right to do this? To take the sequence of 7 and then for example to have 128 ways.

I don't quite understand what you are saying now, but you have obviously thought about it together, why all that?

This all together.

Oh that, yes, that's what it's about.

Ohrrrr (groan), it is so irritating when someone won't tell you whether it is right or not.

Yes but, I won't. I'm not going to read it, you two have to read it. You have to decide together.

Yes, we have read it, but it can.. it is so strange that you get a completely different answer here from there, although we made a whole tree diagram here and it's right, and that's right, too.

Have you also thought carefully about what those numbers mean?

Oh, it's not right at all

Oh

Then the teacher goes away. He keeps in contact with the students without telling them the right answer. They can express their doubts and at the same time confidence is maintained in their ability to answer the question themselves. It is also clear that these students continue to think and
not be fixated on hints from the teacher. The teacher has got into his role well. He supports the
students at the same time as remaining detached from the content. As soon as the students are on
track again (rule 15) he withdraws immediately.

What lesson can be learned from this? It is a widespread phenomenon: if learning is difficult,
people want an explanation from an expert, and in precisely that sort of situation it is important
for students themselves to have the motivation and to possess the necessary metacognitive skills.
It may help students to acquire these metacognitive skills by temporarily withholding technical
support. Teachers can count on resistance from students, and on their own inclination to provide
explanation and technical help. It is also important to aim for a situation in which the students can
struggle and at the same time to provide enough sustenance and incentive in the form of process
help to allow further progress.

CONTENT OF THE WORKSHOP

How can we evoke students to discuss their mathematical ideas with each other? What do we do
if students say they have no clue and want their teacher to explain the mathematics?

In a very interactive way, we will analyse some critical discussions of Rose, Stella and their
teacher. First we will observe and analyse some episodes on video. Subsequently, we will
examine and share our own experiences and ideas on supervising collaborative learning. Finally,
we will be discussing the dilemma of providing assistance without preventing students from
developing their own mathematical ideas.

REFERENCES

Dekker, R., & Elshout-Mohr, M. (2004). Teacher interventions aimed at mathematical level raising during


Raising. *Learning Environments Research.*

Monique Pijls
m.h.j.pijls@uva.nl

Rijkje Dekker
r.dekker@uva.nl