Two FaSMEd case studies on assessing and teaching graphs with the help of the Digital Assessment Environment

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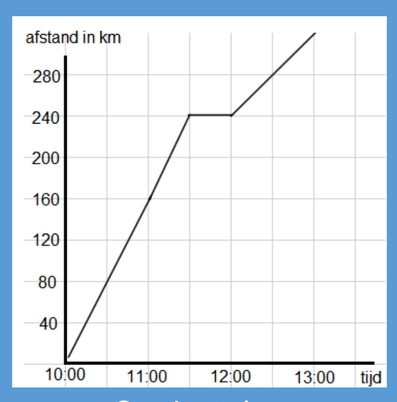
Introduction

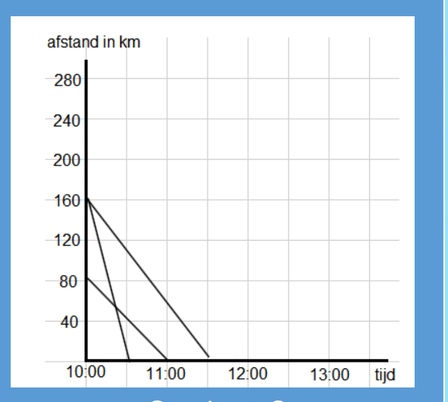
The Digital Assessment Environment (DAE) is an online environment for formative assessment. It provides teachers with information about students' strategies when solving mathematics problems. In two case studies, a fifth-grade teacher's and a sixth-grade teacher's use of the DAE was investigated. The focus was on graphs. Of each teacher two consecutive lessons were observed after the teachers had their students work in the DAE. The lessons were based on the information the teachers got from the DAE. The DAE module on graphs consists of two parallel tests (Test A and Test B), each containing seven problems about graphs. The problems increase in complexity and contain a digital scrap paper on which the students can write down their calculations, by which the teachers are informed about their students' understanding and strategies (for an example, see Box 1). Based on this information, the teachers are taking next steps in their instruction. To guide the teachers in their use of the DAE professional development meetings were organised and a written manual for the use of the DAE was provided.

Box 1: Example problem from the DAE

Draw the graph of the following train ride: The train leaves at 10:00. Then the train drives for half an hour at 160 km per hour. Then the train drives for half an hour at 80 km per hour. Then the train stands still for half an hour. Then the train drives for half an hour at 160 km per hour.



Student 1



Student 2

Here is shown how two students tackled this problem. Student 1 has some elementary understanding of using the two axes to express at what time a particular distance is covered, but has difficulties to derive values from the giving ones (half an hour at 160km/h means 80km in half an hour). Student 2 does not have a clue of using a time-distance graph. He/she is interpreting speed values as distance values and is connecting these to time points.

(From Case Study 1)

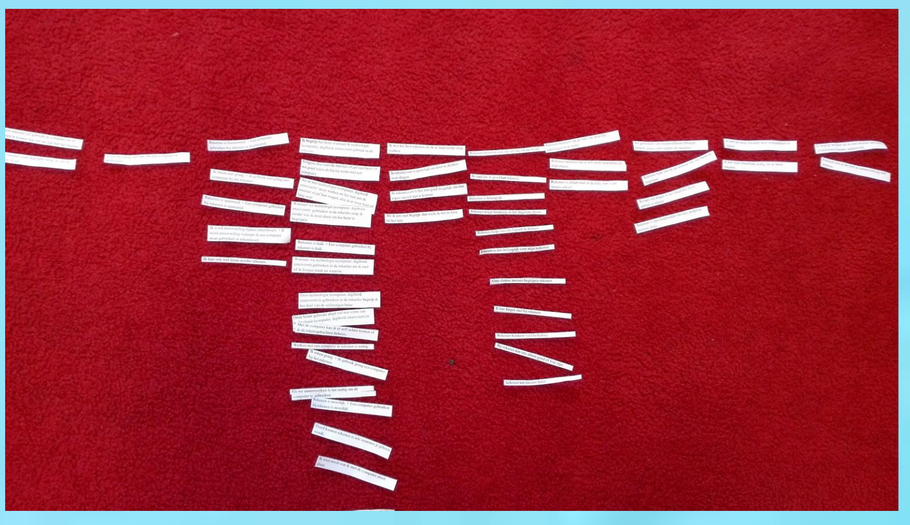


Figure 2: Q-Sort Output of UU Case Study 2

Case Study 1

In Case Study 1, the teacher (M) administered the Graphs Test A individually using tablets available for the students, and called in the help of the researchers during one of the professional development meetings. In collaboration with the researchers, he analysed the results of his students and then planned two lessons on graphs.

In Lesson 1, the teacher used the assessment problems presented in the DAE, printed on worksheets. All the students took part in the lesson, during which the teacher helped the students to gain a better understanding of the problems by dissecting the text of the problems and explaining how various parts of the written text are related to the graphs presented alongside the text. The teacher then asked the students to present their answers and to explain their reasoning, to which he gave immediate feedback. The teacher ended the lesson by asking the students what they had learned from solving the problems and helped them to rephrase this into more general descriptions of what they had learned.

In Lesson 2, students worked on an extra set of graph problems in the DAE made specifically for the case studies. The students worked alone or in pairs. During this, the students discussed the problems with each other, and if necessary, asked the teacher for instruction. The teacher walked through the classroom and helped students with their work when asked. When students asked for help, he asked questions (e.g.: what does the problem say; so how many kilometres had been covered after the first half hour) and pointing out information based on the students' questions and work on the screen (e.g.: it does not drive 120km in half an hour, but in a full hour). After completing the problems, students started working on the Graphs Test B. The lesson ended when the bell rang.

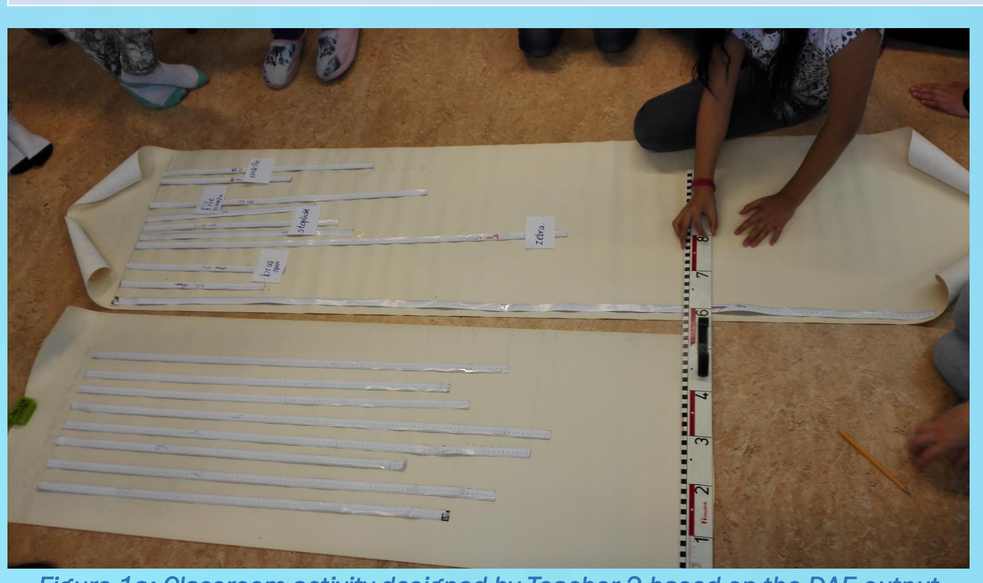


Figure 1a: Classroom activity designed by Teacher 2 based on the DAE output

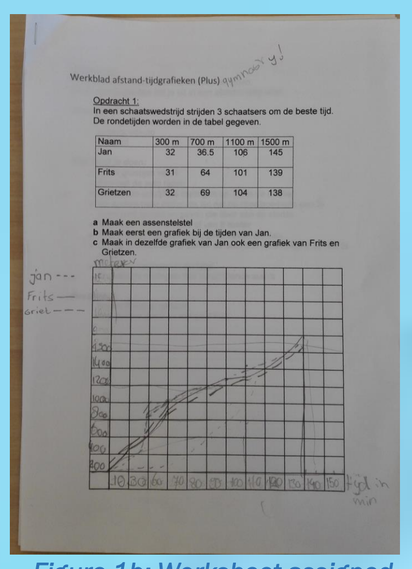


Figure 1b: Worksheet assigned by Teacher 2 based on the DAE.

Case Study 2

In Case Study 2, the teacher (F) administered the Graphs Test A using three computers available for the students. She then analysed the student answers and strategies saved in the DAE. At the start of Lesson 1, the teacher discussed the learning goals with the students. She then activated previous knowledge by recalling a previous lesson on the speed of trains and asked the students to come up with their own examples that explained variations in a train's speed. After a plenary introduction, she asked a small group of students to design a problem of graphs of their own, outside the classroom. These students were selected based on the analyses of the results in the DAE, and were all high-performing students. The other students remained in the classroom. They received additional instruction with the use of mini-whiteboards, and worked on an extra set of graph problems, printed on worksheets. The teacher first worked on the problems with the whole class, and after some problems, let most of the students proceed independently, while she worked on the remaining problems with six students who needed additional support. At the end of the lesson, the high-performing students presented their work, and the teacher summarised the lesson with the students.

In Lesson 2, the teacher first activated knowledge gained in the previous lesson by having each child draw a system of coordinates, and then discussed the objectives of the lesson. The high-performing students were then assigned a worksheet with problems from the Internet selected by the teacher, and the remaining students modelled a time-distance graph with a measurement tape and a toy car that would drive at different speeds at time intervals, which the students cut up between intervals (see Figure 1). The lesson ended with a summary on constant and variable speed given by the teacher.

Q-sorting

Directly after the observations, four students from the class of Case Study 1 and six students from the class of Case Study 2 took part in a Q-sorting activity in which they were assigned to sort cards with statements about mathematics, learning, and the role of technology in education. The two groups of students handled the activity in very different ways.

The group from Case Study 1 decided not to sort the cards, but to discuss and compare their ideas on each of the statements. They generally held positive views on mathematics and learning. The students disagreed somewhat on the role of the teacher and to what extent this influenced their performance, and liked to use technology to varying degrees.

The group from Case Study 2 sorted the cards in collaboration. The output is shown in Figure 2. The students found that a lot of statements belonged to the categories on technology and on views on mathematics, but found it difficult to group the other statements.

For more information, see:

- The Digital Assessment Environment at www.dwo.nl/dae
- UU Teacher Guide Graphs at https://microsites.ncl.ac.uk/fasmedtoolkit/tools-formative-assessment-new/one-topic-different-ways/graphs-module/
- FaSMEd Deliverable 4.3: Case Studies
  - https://research.ncl.ac.uk/fasmed/deliverables/Netherlands%20UU%20%20Case%20study%201.pdf
  - https://research.ncl.ac.uk/fasmed/deliverables/Netherlands%20UU%20Case%20study%202.pdf