FaSMEd

Raising Achievement through Formative Assessment in Science and Mathematics Education

Time-distance graphs “Walking a graph”

Subject:	Mathematics
Age of students:	11-12 years
Hardware:	Pasco data logger with echo sound motion sensor. Computer.
Software:	Pasco SparkVue
Functionalities:	Measuring time, distance and velocity of an object and sample data through echo sound technology. Automatic recording of data and plotting of graphs from the data logger.
Time:	Approx. 90 min.
FaSMEd partner:	Norwegian University of Science and Technology (NTNU)
Short Abstract:	Objectives of the lesson in terms of knowledge and competencies to acquire was: to be able to connect a graph and a situation given by a story, and vice versa, and to recognise and discuss different graph shapes related to the students walking speed and distance from the echo sound sensor. Type of formative assessment used: Establishing students’ prior knowledge in beginning of session, feedback to student groups during their group work, and feedback to groups of students presenting their results on the screen.

1. Content

The topic is mathematical graphs, in particular time-distance graphs.

1.1 Aims

The aim of the lessons is to promote students understanding of functions and graphs.

Learning outcomes:

Content knowledge:

- Interpretation of graphs
- Time distance graphs
- Connect real life situations to mathematical graphs

Process:

- Students will learn to explain their solutions and argue their case
- Students work in pairs or groups
- Students use their own body to make mathematical graphs

Skills:

- Connect a graph and a situation, given by a story or by a movement
- Explore which type of movements that corresponds to which type of graph
- Collaborate and work together with other students
- Give a presentation about work done

The core theme of this lesson is to work with time distance graphs using two different approaches. One approach involves pairing stories and graphs which are already given on sheets of paper.

The other approach involves the use of graph plotting technology where students themselves move in front of an echo sound sensor to create a graph. These two approaches work well in tandem, and each of them contributes to student understanding of functions and graphs.

As a stand-alone activity, the echo sound graph plotting is very useful in giving the students hands on experience in using technology and use their own movements to create something.

The technology allows students to walk back and forth in relation to a logging device, such that a graph is drawn on the computer screen indicating the distance from the device during a time lapse of ten seconds.

The proposed activity prompts good discussions among students and enhance their understanding of mathematical graphs.

1.2 Structure / Methodology

The theme of the sessions is graphs, in particular time-distance graphs. Prior to this lesson, we recommend that students have been through one introductory lesson about graphs and the connection to real life situations.

The objective of the lesson for the students is to be able to connect a graph and a situation given by a story, and vice versa. The lesson consists of two parts.

In one part of the lesson, students experiment with technology for visualization of time-distance graphs. The students try out how to make a graph by walking in front of an echo sounder connected to a computer. The computer gives a live display of graph in a time – position coordinate system.

The other part of the lesson is spent on a task about connecting graphical representations and stories.

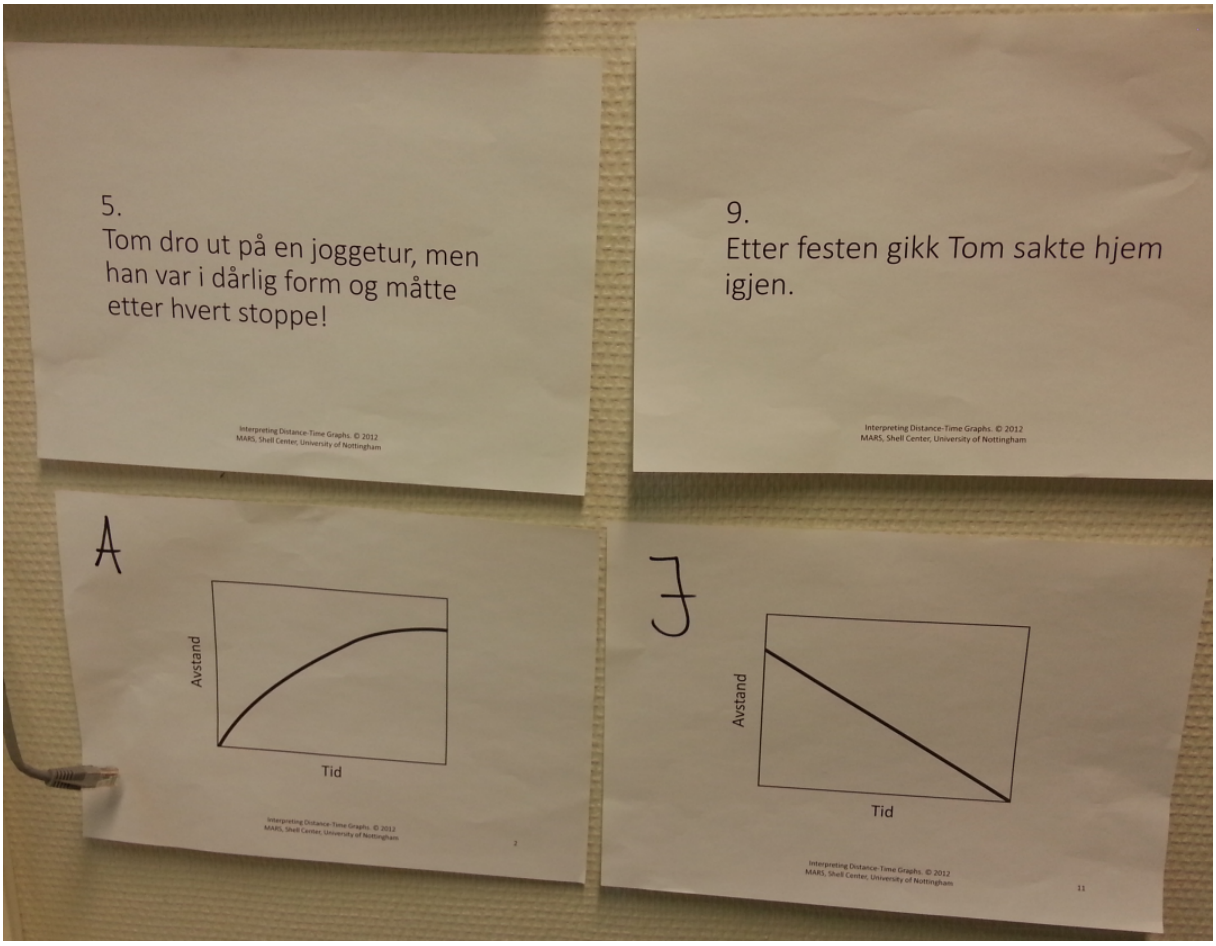

Figure 1. Examples of results from a student task where the students connected stories and graph representation. Story 5: Tom went on a morning jog, but he was in poor physical condition, and had to stop. Story 9: After the party, Tom walked slowly back home.

For the “walking a graph” activity, you need a Pasco data logger system connected to a laptop, a motion sensor based on ultrasonic pulses, and an app with premade tasks. The

tasks were a mix of practical tasks, “Walk a graph”, and open-ended questions about interpretation of the graphs from the walks. All the results should be saved, and can then be used by the teacher for assessment and feedback to the students.

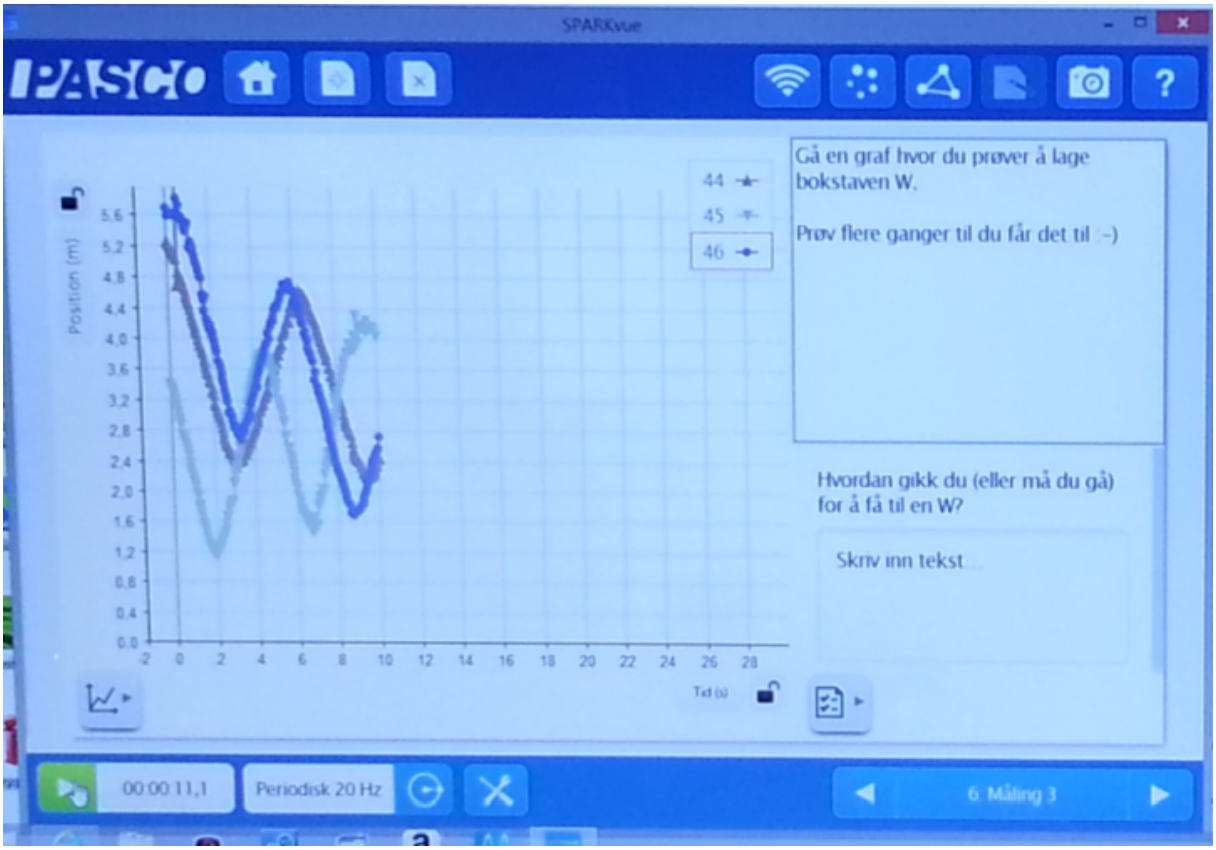

Figure 2. Screen shot from the data logger application with two student tasks: 1) Walk a graph and try to make the letter W. Try several times until you can manage. 2) Write an explanation about how you walked (or have to walk) to be able to make the letter W.

The application with 10 screen pictures is premade, so the students just need to go through the tasks from one to ten.

Each lesson is recommended to start with a plenary introduction. Thereafter the students split in two groups. One group work with a task about *connecting graphs and stories*, the other group work with the *echo sound activity*. Half way through the lesson, the groups switch.

The activity about connecting graphs and stories use the template provided by the Fasmed project, originally developed by the Shell centre[1] in Nottingham, UK.

The echo sound activity can use tasks taken from the software bundled with the Pasco data logger system, these tasks can be modified, or you as a teacher can make your own tasks within the frames and templates of the Pasco system. The technology allows students to

[1] Interpreting Distance-Time Graphs. © 2012 MARS, Shell Center, University of Nottingham https://fasmed.wikispaces.com/file/view/5_Distance_time_lesson.pdf

walk back and forth in relation to the logging device, such that a graph is drawn on the computer screen indicating the distance from the device during a time lapse of ten seconds.

1.3 Technology

The technology needed is a laptop computer connected via USB to a Pasco data logger interface system[2] with an Echo sound motion sensor [3](Figure 3).

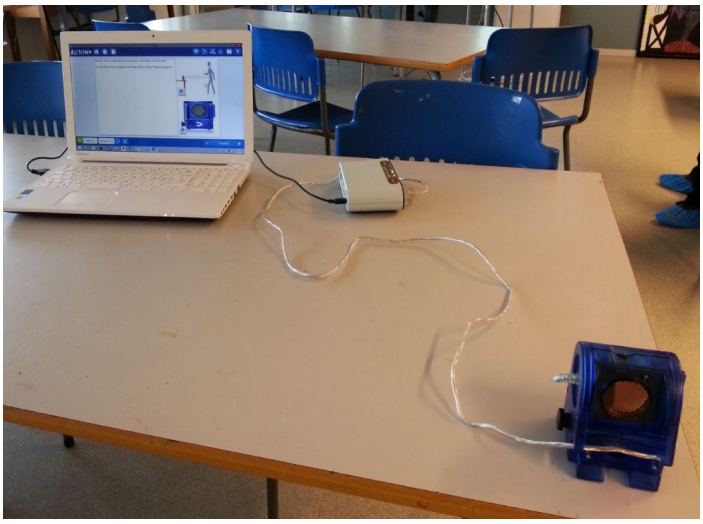

Figure 3. The echo sound logger setup

The technology is used for playing with time-distance graphs in a “Walk-a-graph” exercise. The computer program displays the graph on the computer screen as the students are walking away from or towards the echo sound sensor. The students are supposed to make certain graphical shapes with this tool, and will get immediate feedback from the tool in the form of the graph sketched on screen. They will then have to adapt their walking according to how the graph sketched was similar to the shape they want to make.

As a teacher you have the possibility to design your own applications within the data logger software bundled with the Pasco software, you can use premade tasks or you can modify the premade tasks. Your own introduction texts and tasks can be combined with templates for different types of time/distance/velocity graphs.

We recommend a concluding part of the lesson, student graphs can be displayed on the big screen, and student groups can explain their graphs, with questions and feedback from teacher and peers.

Since there are some technical issues connected to the sensor system, and since only few students can work at the same time with the echo sound sensors simultaneously, it is wise that one part of the lesson has another non-technical activity (the “connecting graphs and story” task).

[2] https://www.pasco.com/prodCatalog/PS/PS-2011_sparklink-air/index.cfm
[3] https://www.pasco.com/prodCompare/motion-sensors/

1.4 Aspects of Formative Assessment

Formative assessment is meant to have an important role thorough these lessons.

Feedback during the introductory lesson can be used to carefully plan the lesson were the echo sound logger is going to be used. During the opening parts of this lesson, students can discuss homework tasks, giving you as a teacher knowledge about students’ current knowledge.

Peer discussions during the activity were the students shall find which graph fits which story, enhance and develop student understanding about the connection between real situations and graphs, and about time and distance. Feedback from the teacher in the form of questioning or prompts to explain their choices, enhance their understanding further. The task were they should make their own story to a given graph solidify their understanding, and gives the teacher valuable insight into the students’ understanding of the topic.

Formative assessment also plays a role through the work with the data logger and application, which gives immediate feedback to the students’ graph walks, through the possibility to comment in the application and then get feedback from the teacher after the lesson, through comments from the teacher during the work with the data logger, and finally through the comments from the teacher when students present their graphs on the screen in the concluding parts of the lesson.

Feedback from the software and teacher during the echo sound activities is meant to improve students understanding about the connection between time and distance and the graphical representation.

At the concluding parts of the lesson, selected student groups should be asked to present their work in plenary. During the lesson the teacher should make notes about the different groups’ work, so as to be able to select groups purposefully, with a view on getting different solutions and different approaches presented. There are some typical misconceptions about graphs, and these should also be presented and discussed.

2. Further Information

These lessons are recommended to be done as student group work (2-4 students per group). The lessons have been carried out with both higher and lower achieving students. Both groups performed very well and worked really seriously withy the tasks, showing great enthusiasm. All students said they had enjoyed these sessions enormously and that it had been great fun to learn about graphs. They confirmed that they had learned to see the connection between a graph and a text description of a situation.

3. References

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