FaSMEd

Raising Achievement through
Formative Assessment
in Science and Mathematics
Education

Time-distance graph in a tablet-using classroom

Subject:	Mathematics
Age of students:	14 - 15 years
Hardware:	Tablets and teacher PC (internet), IWB
Software:	NetSupport School (CCT), OneNote and Maple TA for tablets
Functionalities:	Sending & displaying, processing & analysing, providing an interactive environment
Time:	3 lessons of 60-90 minutes
FaSMEd partner:	Ecole Normale Supérieure de Lyon
Short Abstract:	This sequence aims to construct the notion of graph of a function, starting from its interpretation. The process of formative assessment relies essentially on working in groups, sharing students' work, and working individually in an interactive environment.

1. Content

Time-distance activity comes after two learning sequences implemented in the classroom, and in parallel with a third one. The different sequences overlapped throughout the lessons.

First sequence: introduction of the notion of function (modelling; optimisation; different forms of representation: algebraic, table of values, graph; use of paper and pencil; use of excel and GeoGebra).

Second sequence: mobilisation of grade 8 geometrical notions and introduction of the Intercept Theorem.

Third sequence (in parallel with time-distance activity): problem solving with equations of first order.

In this context, time-distance sequence aims to construct the notion of graph of a function, starting from its interpretation. It develops in three lessons, organised for collecting and understanding students' interpretation of a time-distance graph, and formalising it as the representation of a certain quantity as a function of another one, by focusing the attention on what each axis represents.

2. Activity

2.1 Aims

The learning objectives that the teacher wants to construct on linear functions, working with different register of representation are:

- Calculating and detecting images.
- Calculating and detecting inverse images.
- Recognising a linear function.
- Shifting from the graphical frame to the algebraic frame and vice versa.

Students have to achieve such mathematical competencies in grade 9 (14-15 y.o.), in relation with high-level competencies about problem solving and modelling. Time-distance activity is intended to prepare the mathematical background to deal with these competencies.

2.2 Structure / Methodology

First lesson

Activity 1 (Journey to the Bus Stop): Students work in groups of three or four to write a story that corresponds to the given graph. Teacher gives the task: "Tell what could have happened (using maths)". Everyone has to note down the proposal shared in his/her group, and one student per group has to write it on his/her tablet using OneNote.

The teacher collects the production of each group and displays some of them on the IWB. In this way, the different groups' productions are shared in the classroom. The teacher reads all of them without evaluating them, and he asks to students to note down any element they find interesting or different from what they have done.

Activity 2 (Matching a Graph to a Story): An individual question is proposed on the platform Maple TA. The time-distance graph has been copied and pasted to create a Maple TA question and the students have to enter A, B or C as an answer.

Second lesson

The teacher comments the class' scores regarding the Activity 2. While doing so, he displays the scores and the class' percentage of success on the interactive whiteboard.

The teacher then displays the time-distance graph of the Activity 1 and asks to two students to come and tell their story to the classmates, using the projected graph as a support. The story telling aims to make emerge two students' difficulties/misconceptions: the graph as a map and the misinterpretation of the constant part of the curve. The teacher do not validate the stories and invites the classmates to ask questions to the students at the whiteboard.

Activity 3 (Matching ten graphs to ten stories): Students solve individually the activity on paper and then discuss in their group their matching. After that, they have to submit their answers individually on Maple T.A.

Third lesson

The teacher goes back on the time-distance graph of the Activity 1, he displays it at the whiteboard and sends it as a pdf file on the students' tablets through the NetSupport School. He asks the students to detect on the graph where Tom's house is.

Students work individually on the pdf file on their tablets. The teacher collects and displays some students' works. The discussion allows him to notice that many students have placed the home at the origin. He detects a particular point on the graph (the first pick) and asks the following questions: which are its coordinates? what does it represent?

The students work alone or in groups and the teacher walks through the classroom. After few minutes, they answer together to the first question, giving the coordinates of the point. Then, the teacher reformulates the second question as what information does this point give us?

The students work alone or in groups and the teacher walks through the classroom. They finally share the meaning of the two coordinates of the given point (distance to home and time). Then, the teacher asks where is Tom's home at that point. Several students come to the interactive whiteboard for detecting the home on the graph. They finally place the home on the axis of abscissas and the bus stop on a horizontal line where the distance to home is constantly equal to 160 m. The teacher institutionalises an important methodological indication for reading a graph: every point contains two pieces of information, so it is important to read carefully what each axis represents.

The teacher reads again one of the proposed stories, where the students confuse the distance to home with the walked distance. Basing on this, he gives to the students a *new task: drawing the graph of the walked distance as a function of time.* The students discuss in groups and each of them gets to an individual answer (on tablet or on notebook).

Finally, students have to write individually a story for the "orphan" graph (graph B of Activity 3) on their notebook or their tablets. The teacher collects the students' work before the end of the lesson.

2.3 Technology

These lessons have been experimented in a "tablet-using classroom", that is to say a classroom in which each student has his/her own tablet and all tablets are part of a network. Students use One Note 2013 as a text editor when they have to work individually or in groups on a task (Activity 1). Students' work done in OneNote is systematically collected by

the teacher directly from his PC and is often integrated in the lesson notes that the class constructs together at the IWB. The teacher has access to students' screens from his computer through the NetSupport School, makes screenshots of the students' proposals and pastes them on a file, which is displayed at the IWB. The teacher exploits the functionalities of the tablets network, provided by NetSupport School, of sending and displaying information. The software NetSupport School is used as the main connected classroom technology for classroom instruction, orchestration, monitoring and management. It plays a relevant role in the way the teacher orchestrates the classroom activity and guides the lesson. NetSupport School allows him to collect in real-time the students' work and to send quick surveys to students, in order to immediately display results that can support and foster discussion in the classroom. The functionalities of the IWB allow the teacher to process the collected data by commenting and correcting students' proposals, which are thus integrated in the corpus of the lesson notes.

Moreover, each student can access the platform Maple TA (individual testing system) on his/her tablet. Students use Maple TA to answer individually to the questions proposed by the teacher (see Activities 2 and 3). After having submitted all the answers, each student can read on his/her tablet the percentage of success and has access to solutions: the system highlights his/her right or wrong answers, interacting with the students (the functionality of providing an interactive environment is exploited). Teacher's explanation at the IWB and comments on the results complete the feedback provided by Maple TA. The teacher then uses Maple TA to edit and send quiz to students, to collect and analyse students' answers.

2.4 Aspects of Formative Assessment

Establishing where the learners are in their learning

In the different phases of the lesson, the teacher pays makes sure of students' understanding: the individual activities on Maple TA give him such information, and he can stock it for further analysis. Drawing on students' answers, the teacher engineers effective classroom discussions and other learning tasks that elicit evidence of student understanding. At the same time, teachers' correction gives to students the possibility to position themselves with respect to the class' level and to become owners of their own learning. These FA strategies are implemented also through different tasks that the students have to solve individually in the OneNote environment of their tablets, so that the teacher can collect and share their work with the class. Discussing the proposals of one (or several) student(s) with the class by displaying them at the IWB is a FA strategy that aims to engage all students as the owners of their learning but also to encourage each student to be a resource for others. This last strategy is amplified by the fact that the teacher does not evaluate students' work, but invites classmates to note down interesting elements or to ask questions.

Establishing where learners are going and what needs to be done to get them there

Maple TA's feedback, augmented by the teacher's comments, provided a complete feedback to students. When the teacher displays the students' results to the quiz, he comments on the class' performance but also clarifies and shares the learning objectives with the students. This analysis leads him to select and engineer particular tasks for moving students forward with respect to specific misunderstandings (e.g. the graph as a plan, or the confusion distance to home vs walked distance), and to justify his choice drawing on students' work.

3. Further Information

About the use of NetSupport School and Maple TA in his classroom, the teacher declares:

"*It's much easier with NetSupport. Globally, when I use NetSupport, I can intervene individually... I intervene directly with some students and I explain again […] I deal with difficulties, perhaps not of all, but I treat answers individually and now when I use Maple TA, I don't personalise… depending on the statistical results that I get, I decide to give a feedback to the whole class or not.*"

"*The correlation between students' engagement and their acquisition of technical competencies is evident. I identify a great qualitative improving in terms of both classroom management and students' learning. The level of achievement of their competencies has considerably improved and they make progress with pleasure*."

Students have become aware of the teacher's opportunity to follow their work in class but do not necessarily make the link with the possibility of personalised help.

4. References

NetSupport School: http://www.netsupportschool.com/

Maple T.A.: http://www.maplesoft.com/products/mapleta/

For reading the whole case study in mathematics, see:

https://ife.ens-lyon.fr/fasmed/spip.php?article98