FaSMEd

Raising Achievement through
Formative Assessment
in Science and Mathematics
Education

Time-distance graphs – Part 3

Subject:	Maths
Age of students:	10-14 years
Hardware:	Tablets, pc, IWB or data-projector
Software:	IDM-TClass
Functionalities:	Sending and displaying
Time:	4-6 hours
FaSMEd partner:	University of Turin
Short Abstract:	This activity is focused on **time-distance graphs**. It is focused on the matching between different graphs and the corresponding stories.

Premises: theoretical tools

In presenting our methodology and the way of developing this activity we refer to two main theoretical tools.

The first theoretical tools are the Formative Assessment (FA) strategies proposed by Wiliam and Thompson (2007):

1) Clarifying/ Understanding/ Sharing learning intentions and criteria for success,
2) Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding,
3) Providing feedback that moves learners forward,
4) Activating students as instructional resources for one another,
5) Activating students as owners of their own learning.

The second theoretical tools are the Functionalities of Technology (FT) introduced within the FaSMEd Project (see the complete description on FaSMEd website https://microsites.ncl.ac.uk/fasmedtoolkit/theory-for-fa/the-fasmed-framework/):

(a) sending & displaying,
(b) processing & analysing,
(c) providing an interactive environment.

1. Content

The activities "Time-distance graphs_part 1" and "Time-distance graphs_part 2" are propaedeutic to this one, which focuses on the matching between different graphs and stories that are represented by these graphs. This requires the ability to be able to efficiently activate conversions from the graphical to the verbal register and vice-versa (Duval, 2006).

2. Activity

This activity is an adaptation from activities developed within the Mathematics Assessment Program (http://map.mathshell.org/materials/lessons.php). It can be developed referring to a set of *five worksheets*.

2.1 The worksheets: focus and aims

This activity aims at implementing and consolidating the different competences developed during the previous ones (interpretation of horizontal/ascending/descending lines within a time-distance graph, interpretation of a point as a bearer of information regarding the distance from home and the time spent, interpretation of the slope of a line as indicator of the speed…).

The activity requires students to match 5 stories with 5 graphs that could represent them.

Worksheet 7 introduces the task, asking students to write down their matches together with the reasons underlying their choices. It is specified that one graph could not be matched with any provided story, so students have to invent a story that could be matched with the graph. This is a new kind of task for them. It is aimed at making students refer to previous experiences within the sequence of activities "Time-distance graphs" to correctly describe a possible motion that could be represented through a specific graph.

Together with this worksheet, you will receive 10 cards, on which you will find 5 graphs and 5 stories that could be matched with the graphs. **Match the stories with the graphs that represent them.** **Attention!!!** There could be graphs without a corresponding story. **If you find this kind of graph, invent a story.**

Write your matches, explaining how you chose the stories to be matched with the graphs.
If you found a graph without a story, **write the missing story.**
Make a picture of your matches and send it to the teacher.

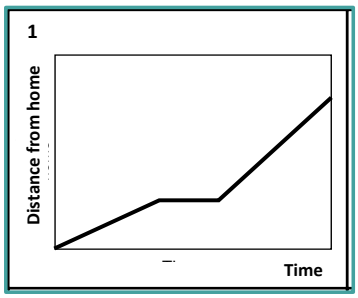
We matched graph … with story … because …
We matched graph … with story … because …
We matched graph … with story … because …
We matched graph … with story … because …

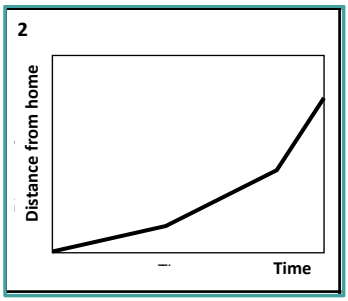
No story could be matched with graph …
This is the story, to be matched with this graph, that we invented: …

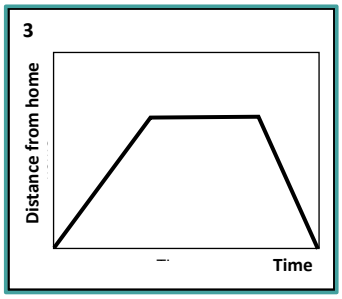
Fig. 1: Worksheet 7

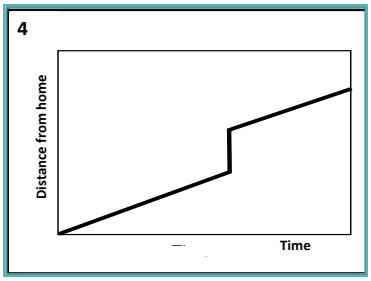
Students are also provided with paper version of the cards to be matched (in fig. 2 the graphs and in fig. 3 the stories). They are asked to match the cards, complete worksheet 7 summarising the matches and explaining their choices and, finally, to take a picture of the matches and to send it to the teacher's computer.

CARDS – GRAPHS









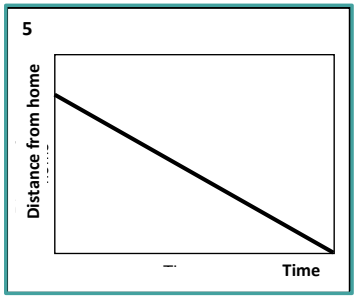


Fig. 2: The set of cards to be matched – Graphs

CARDS – STORIES

A) Marco goes out and walk along a road. He stops to check the time and understands that it is late, so he starts running.

B) Luca goes out to take the train. When he reaches the train station, he sits on a bench while waiting for the train.

C) Alice goes out from the dance school and walk home.

D) This is an impossible graph.

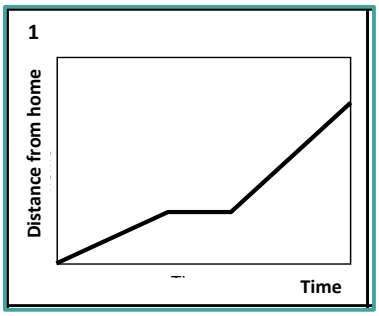
E) Giulia goes out and climbs up the hill in front of her house, at the beginning slowly, then more quickly. After having reached the top of the hill, she runs quickly down the other side.

Fig. 3: The set of cards to be matched – Stories

The selected graphs require students to reason at different levels. Some of them (graphs 1, 2, 3) are similar to the one they had to analyse during the previous activities (part 1 and part 2): students have to recall the meaning of a horizontal/ascending/descending line within a time-distance graph and the interrelation between the increasing/decreasing of the slope of a graph and the corresponding variation of speed. Graphs 4 and 5 present new elements that students are asked to interpret. Graph 4, in fact, is an impossible one because it contains a vertical line. Students are asked to notice that this situation is impossible since it describes a movement during which a person is in different places at the same time. Graph 5 is different from the previous ones in that the origin of the movement is not home.

Worksheets 7A, **7B**, **7C** and **7D** are helping worksheets. They could be sent to the students that face difficulties in matching the graphs with the stories or in constructing the story corresponding to the 'unmatched' graph (graphs 3). Moreover, they can also be sent to the whole class, after the working group activity, as a tool to check the correctness of the matches.

Worksheet 7A represents a help to match graph 1 with the corresponding story.

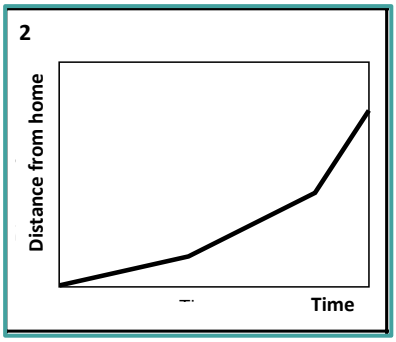


Observe graph 1.
The second section of the graph is a **horizontal segment.** What does it mean? The first section of the graph is **less steep** if compared to the third section. What does it mean? **Where is the speed grater?** After these observations, **can you discard some of the stories?**
What is the story that could be match this graph?

Fig. 4: Worksheet 7A

Through *worksheet 7A* students are suggested to recall the meaning of a horizontal segment within a time-distance graph and to focus on how the increasing of the slope is an indicator of an increasing of speed. Moreover, they are suggested to start their search for the story to be matched to the graph by discarding the stories that are not in tune with this information.

Worksheet 7B represents a help to match graph 2 with the corresponding story.

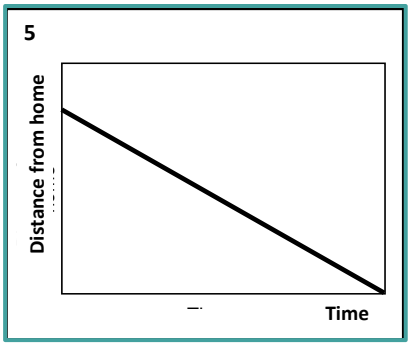


Observe graph 2.
The slope, in the three parts of the graph, is increasing. What does it mean? **Is the speed increasing or decreasing?**
After these observations, **can you identify the story that could match this graph?**

Fig. 5: Worksheet 7B

Through *worksheet 7B*, students are suggested to focus on the interrelation between the increasing of the slope in the three sections of the graph and the corresponding increasing of speed.

Worksheet 7C represent a help to match graph 5 with the corresponding story.



Observe graph 5.
The point (0,0) is not the initial point of the graph. What does it mean? **The person who is moving is going near home or away from home?**
Do these observations enabled you to identify **the story that could be matched with this graph?**

Fig. 6: Worksheet 7C

The suggestion provided in *worksheet 7C* make students observe that, differently from the other analysed graphs, the initial point of the graph is not (0,0). Moreover they are guided to recall the meaning of a descending line within a time-distance graph to highlight that the person that is moving is going back home.

Worksheet 7D represents a help to understand that graph 3 cannot be matched with any story. The provided suggestions could also help students in the construction of a story that could be represented through this graph.

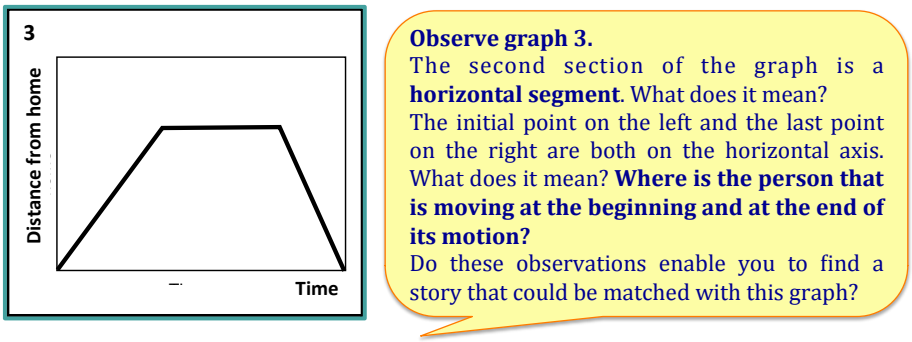


Fig. 7: Worksheet 7D

The suggestions and guiding questions within *worksheet 7D* help students recall the meaning of a horizontal line within a time-distance graph and to highlight that, since the initial and the final points of the graph have the same y-coordinate (0), the motion begins and ends at home. This observation can help students, on one side, to highlight that the stories in the cards cannot be represented with this graph, and, on the other side, to give them some important information to create a possible story to be matched with this graph.

2.2 Methodology

Our hypothesis is that, in order to raise students' achievement, Formative Assessment (FA) has to focus not only on basic competences, but also on metacognitive factors (Schoenfeld, 1992). Accordingly, we planned and developed class activities with the aim of: (a) fostering students' development of ongoing reflections on the teaching-learning processes; (b) focusing on making thinking visible (Collins, Brown & Newmann, 1989), through the sharing of their ideas with the teacher and the classmates.

For this reason, we suggest that, during the activities, the teacher guides the students to focus on the analysis and comparison of not only their *products* but also the *processes* that led to these products. In particular, the class should be led to discuss, on one side, the written productions and, on the other side, the strategies developed to carry out the tasks.

As regards the collective analysis of the students' written productions and the developed strategies, in particular, we refer to *argumentation* as a possible FA tool in the interaction between teacher and students. Specifically, argumentation is promoted to support the development of effective class discussions, starting from questions such as: "Explain what you did", "Explain why your approach is effective", and to guide students in assessing the correctness, the clearness and the completeness of given explanations (their own or others).

The methodology adopted is in tune with these hypotheses. It will be clarified in section 2.4, after the introduction of the technology used (section 2.3).

2.3 Technology

In tune with the hypotheses presented in the previous section, we explored the use of a CCT, which connects the students' tablets with the teachers' laptop and allows the students to share their productions, and the teacher to easily collect the students' opinions and reflections during or at the end of an activity: IDM-TClass.

In the use of IDM-TClass to support FA processes, we in particular focused on the following three main functions of this software:

- the possibility of distributing documents to students and collecting documents from the students' tablets (related to the functionality *Sending and Displaying*);
- the possibility of creating instant polls and immediately showing their results to the whole class (related to the functionality *Processing and Analysing*);
- the possibility of displaying the students' written productions through the data projector or the interactive whiteboard (related to the functionality *Sending and Displaying*).

Each school was provided with tablets for the students and computers for the teachers, linked to IWB or data projector. In order to foster collaboration and sharing of ideas, students were asked to work in pairs or in small groups on the same tablet.

2.4 Structure of a typical lesson and Aspects of Formative Assessment

In the following, we present the typical structure of a lesson developed during the teaching experiments carried out in Italy, in this case with specific reference to worksheets **7**, **7A**, **7B**, **7C** and **7D.**

This activity involves, differently from the previous ones, also the use of paper cards. Students are provided with the two sets of cards (figures 2 and 3) and **worksheet 7** is sent from the teacher's laptop to the students' tablets (functionality *Sending and Displaying*). Students work in pairs or small groups of three. They have to work with the cards to match them, to complete worksheet 7 and to take a picture of the matches, to be sent to the teacher's computer together with worksheet 7 (functionality *Sending and Displaying*).

The teacher can decide to send helping worksheets (*FA strategy 3*, aimed at the activation of *FA strategy 5*) to some groups, or the groups can ask for them. In this case, the helping worksheet **7A**, **7B**, **7C** and **7D** could be sent to support the students in matching some of the graphs with the corresponding story and in constructing the story to be matched with the 'unmatched' graph. These helping worksheets could also be sent to the whole class, after the working group activity, as a tool to check the correctness of the matches.

After all groups have sent back their answers, the teacher sets up a classroom discussion (*FA strategy 2*) in which the students' written productions are shown (functionality *Sending and Displaying*) and feedbacks are given by the teacher and by classmates (*FA strategies 3 and 4*, aimed at the activation of *FA strategy 5*). The discussion is engineered starting from the teacher's selection of some of the received written answers, shown on the IWB. The discussion aims at highlighting (*FA strategy 3*): (a) typical mistakes; (b) effective ways of processing the tasks; (c) the comparison between the different ways of justifying claims. In this, the criteria for success could be clarified through the analysis and comparison of the different written productions (*FA strategy 1*).

Polls (functionality *Processing and Analysing*) could also be used to prompt the discussion (*FA strategy 2*, that could lead to the activation of other FA strategies, such as 3, 4, 5) during different parts of the lessons. In this case no worksheets aimed at prompting polls were constructed, but it is possible to organize instant polls. For example, polls could be constructed, as starting points for the discussion on worksheet 7, to highlight the matches between specific graphs and stories proposed by the different pairs/groups. Another interesting poll could be proposed to make students reflect on the different stories that could be created to be matched to graph 3. Students can, in fact, be requested to evaluate

the adherence between some of the stories created by the pairs/group and the graph to which they have to be matched.

3. Further Information

We recommend that, when the teacher introduces the worksheets that are going to be sent to the students, she stresses some aspects. This is especially crucial with younger students (grade IV and V).

As regards this set of worksheets, it is important to clarify to students what they are asked to do, clearly explaining what kind of information has to be inserted to complete **worksheet 7**. Moreover, some technological support should be done to students when they have to take pictures and send them to the teacher's computer.

During the teaching experiments few students asked for the **helping worksheets**, so we sent them to the whole class stressing that they can be useful also as tools to check the correctness of their matches. As regard this, it is very important to make students reflect on the role of these worksheets in supporting the matching between graphs and stories.

A specific part of the discussion on worksheet 7 should be focused on the interpretation of an impossible graph, making students explain why a vertical line could not represent any kind of real movement.

4. References

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Further information about the software IDM-TClass can be found on the webpage
http://www.tecnilabedu.com/prodotto05EN.html