



FaSMEd

Raising Achievement through
Formative Assessment
in Science and Mathematics
Education



Time-distance graphs – Part 2

Subject:	Maths
Age of students:	10-14 years
Hardware:	Tablets, pc, IWB or data-projector
Software:	IDM-TClass
Functionalities:	Sending and displaying
Time:	2 hours
FaSMEd partner:	University of Turin
Short Abstract:	This activity, focused on time-distance graphs , requires students to identify a story that could be represented through a given graph. A specific focus of this activity is the interpretation of the slope of as an indicator of the speed.



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 activity “Time-distance graphs_part 1” is propaedeutic to this one, which focuses on the identification of a story that could be represented through a given graph. This requires the ability to be able to efficiently activate a conversion between the graphical to the verbal register (Duval, 2006). In particular, a correct identification of the story involves the interpretation of the slope of a line, within a time-distance graph, as an indicator of the speed.

2. Activity

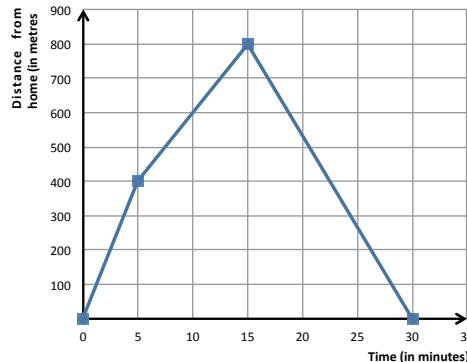
This activity is an adaptation from activities developed within the Mathematics Assessment Program (<http://map.mathshell.org/materials/lessons.php>). It can be developed referring to a set of *three worksheets*.

2.1 The worksheets: focus and aims

In **Worksheet 6** a graph and three possible corresponding stories are presented. Students are asked to identify, among these stories, the one that could correspond to the graph.



What is the story represented in this graph?
How did you identify it?



Story A: Tommaso takes his dog for a walk to the park. At the beginning he walks slowly, then he increases his pace. When he reaches the park, he decides to come back home.

Story B: Tommaso rides his bike from his home up a steep hill. After a while the slope eased off. At the top he raced down the other side.

Story C: Tommaso goes out for a jog. At the end of his road, he bumps into a friend and he slows down to walk with him for a while. When Tommaso left his friend he goes back home.

Fig. 1: Worksheet 6

The choice of story B could highlight the typical mistake of interpreting time-distance graphs as drawings of a hill. An interesting aspect is related to the main reason why this choice is not correct: the story implies that the distance from home should increase, while the last section of the graph represents a return to home.

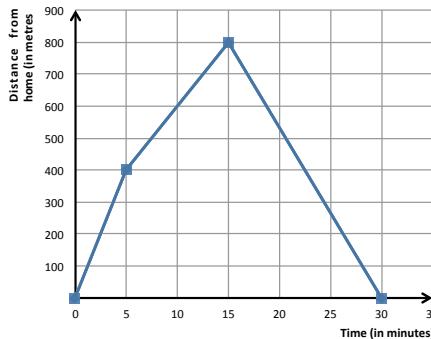
Story A and story C are very similar. The choice of the correct one (story C) requires students to observe that the graph represents, through the changing of the slope from the first to the second section, a decreasing of the speed.

The question on *worksheet 6* requires also highlights the reasons underlying the choice of the correct graph.

Worksheet 6A and **6B** are helping worksheets. They could be sent to the students that face difficulties in facing the question on *worksheet 6*.



What is the story represented in this graph?
How did you identify it?



Story A: Tommaso takes his dog for a walk to the park. At the beginning he walks slowly, then he increases his pace. When he reaches the park, he decides to come back home.

Story B: Tommaso rides his bike from his home up a steep hill. After a while the slope eased off. At the top he raced down the other side.

Story C: Tommaso goes out for a jog. At the end of his road, he bumps into a friend and he slows down to walk with him for a while. When Tommaso left his friend he goes back home.

Help to identify the story:

Collect, in the following table, the information provided by the graph:

Time	Distance from home
0 minutes	
5 minutes	
15 minutes	

Answer to the following questions:

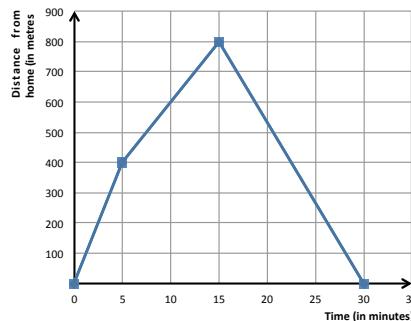
- What is the distance that Tommaso has walked through during the first 5 minutes?
- What is the distance that Tommaso has walked through in the period of time from 5 minutes to 15 minutes?
- Which is the period of time (among those analysed in the previous answers) during which Tommaso walks quickly?
- What is, therefore, the story represented in the graph?

Fig. 2: Worksheet 6A

Worksheet 6A represents a first help for those students who have difficulties in facing Worksheet 6. Students are suggested to collect, within the given table, the distances from home next to the corresponding times (0 minutes, 5 minutes, 15 minutes). Guiding questions are also proposed in order to make students refer these distances to the period of times within which they were walked by Tommaso. In this way students can observe that the same distance (400m) was walked in different period of times, highlighting when Tommaso was quickly.



What is the story represented in this graph? How did you identify it?



Story A: Tommaso takes his dog for a walk to the park. At the beginning he walks slowly, then he increases his pace. When he reaches the park, he decides to come back home.

Story B: Tommaso rides his bike from his home up a steep hill. After a while the slope eased off. At the top he raced down the other side.

Story C: Tommaso goes out for a jog. At the end of his road, he bumps into a friend and he slows down to walk with him for a while. When Tommaso left his friend he goes back home.

Second help to identify the story:

Time	Distance from home
0 minutes	0m
5 minutes	400m
15 minutes	800m

We observed that, at the beginning, Tommaso walks for 400m in 5 minutes. Afterword, he walks for 400m in 10 minutes. For this reason he moves quickly during the first 5 minutes, because it takes him less time to walk through the same distance.

What is the story that, surely, is not represented by the graph?

Fig. 3: Worksheet 6B

Worksheet 6B provides a further help to the students that are not able to correctly interpret the table constructed thanks to helping worksheet 6A and to deduce from it the information on Tommaso's variation of speed. The table, within which the distances from home are next to the corresponding times, is completed. Students are explicitly suggested to observe that Tommaso walks faster during the first period of time because it takes him less time to walk through the same distance. Students are therefore requested to highlight what story is in tune with this observation.

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 6, 6A and 6B.

The activity starts with a worksheet focused on one or more questions (in this case **worksheet 6**), sent from the teacher's laptop to the students' tablets (functionality *Sending and Displaying*). Students work in pairs or small groups of three.

After facing the task and answering the questions, the pairs/groups send back their written productions (functionality *Sending and Displaying*) to the teacher. 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 **6A** (and, later, **6B**) could be sent to support the students in focusing on the distances through which Tommaso walks during the different period of times represented in the graph.

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, a poll could be constructed as a starting point of the discussion on worksheet 6 to highlight the numbers of pairs/groups that matched a specific story to the graph. Moreover, it could be possible to propose polls about the most complete justification of the correct matching or about the possible mistakes subtended to incorrect matchings.

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 **worksheet 6**, it is important to read the stories with the students and to stress that the reasons underlying the choice of a specific story should be clearly communicated.

It is also important to propose a meta-level discussion on the helps provided by **worksheets 6A** and **6B** on order to foster students' development of awareness about the effective strategies to face this kind of tasks.

4. References

Collins, A., Brown, J.S., & Newman, S.E. (1989). Cognitive Apprenticeship: Teaching the Crafts of Reading, Writing and Mathematics! In L.B. Resnick (Ed.), *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum Associates.

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