CASE STUDY 2 - Istituto comprensivo di Carcare

REPORT OF THE ACTIVITIES

This part consists of 4 sections:

1) Contextual information: the school context, teacher demographic, class demographic;
2) Report and analysis of three lessons;
3) Teacher's perception: interview after a series of lessons, final interview on classroom teaching;
4) Pupils' perception: q-sorting and interviews with two groups of students.

1. Contextual information

1.1 School Context – Scuola Secondaria di I Grado "G. Mameli"

School name	Istituto Comprensivo di Carcare – Scuola Secondaria di I Grado (lower secondary school) "Goffredo Mameli"
Subject (Maths/physics/biology/chemistry)	Mathematics
Activities used	Our adaptation of the activity "*Interpreting Distance-Time Graphs*", from the Mathematics Assessment Project
Technology/tools used	The networked classroom technology IDM-TClass
School Context	
School Roll (number of pupils)	Approximately 1100 students in all the Istituto Comprensivo.
Staff Roll (number of teaching staff)	4 mathematics and science teachers in the lower secondary school "Mameli"
Geographical location (urban/rural, etc.)	Rural
Relationship to other schools (e.g. cluster/Feeder/Part of a group of schools)	Cluster of kindergarten, primary and lower secondary schools. It is an Istituto Comprensivo, this

	means that it is organized in different school levels, from kindergarten to primary school (grade 1-5) to lower secondary school (grades 6-8), all under the same school Head. Due to the nature of the municipality, which is located in small mountains, the Institute is organized in 12 schools, located also in the nearby (municipalities of Altare, Cosseria, Mallare, Pallare, Bormida, Plodio).
Age range	3-14
Single or mixed gender	Mixed gender
Ethnicity	There are children of immigrant families (from Eastern Europe, Africa and South America).
Mixed ability or selected (could include Special Educational Needs)	Mixed ability classes
Socio-economic intake (with local contextual indicators, e.g. UK Free School Meals)	In the past, the area was developed due to some industries, but now it suffers the economic crisis. The lower secondary school is the only one in the area; there are students from different social classes.
How the school is judged to be performing in local context	The school is the only one in the area. The school is judged a good quality one in the region.
Past experience of using formative assessment	No specific project concerning formative assessment.
Past experience of using technologies/tools	All the classes of the lower secondary school are equipped with an interactive whiteboard and all lessons are performed using it. All the mathematics teachers followed teacher training programs on the use of new technologies. The school was one of the centers for teacher professional development (projects M@t.abel and project ISS for mathematics and science); it hosted the main project on the use of interactive whiteboard and connected classroom technologies in Italian schools (projects LIM and

	Cl@ssi 2.0).
Previous experience of working within other research projects	The Institute is currently collaborating with the University of Genoa on a long-term project on argumentation and mathematical proof titled "Language and argumentation".

1.2 Teacher demographic (Monica Testera - MT)

Subject area (science or mathematics)	Science and Mathematics
Role (e.g. Head of Department/Teacher, etc.)	Teacher; Assistant of the Head of the Istituto Comprensivo, with responsibility for the lower secondary school "Goffredo Mameli"; Head of the mathematics and Science Department of the school "Goffredo Mameli"
Gender	Female
Age range (under 20; 21-30; 31-40; 41-50; 51-60; over 60)	51-60
How long has he/she been teaching	Since 1986
How long has/she been working at this school	Since 2005
Past experience of using formative assessment within lessons	No specific project, but formative assessment characterizes her way of teaching (see the interview to the teacher in paragraph 3).
Past experience of using technologies/tools within lessons	She regularly uses interactive whiteboard. She was involved in the project "Classi 2.0", funded by the Ministry of Education. She planned and implemented activities with the use of new technologies in mathematics.
Past experience of working in a research project	She is currently involved in the "Language and argumentation" project with the University of Genoa, aimed at planning, implementing and

	analysing teaching activities with a focus on argumentation.

1.3 Class demographic

Class	2A – IC Carcare
Age range	11-12
Number of students in the class	22
Gender split within class (male/female)	12 males, 10 females
Ethnicity	One student comes from South America.
Mixed ability or ability set	Mixed ability class
Any relevant contextual information	The students work well together, there is a good climate. They are used to discuss and to group-work. Here are some information on the groups of students, as outlined by the teacher during the preparation and implementation of the activities. **Group 1: Anita and Tina, Alice and Debby** The first two students recently received a diagnosis of dyslexia. They work regularly with the other students; the teacher provides them help, when required, and proposes adapted tasks for individual assessment. They took part to all the FaSMEd activities. Alice is low achieving. Debby is intuitive and involved, but she suffers from frequent absences from school. They were put in the same group because of the frequent absences of Debby and the difficulties of Anita and Tina. **Group 2: Mil and Pon**. Low achieving students. **Group 3: Olaf and Remo.** Medium-achieving students. **Group 4: Mark and Mario.** Mark is medium-

	achieving, Mario is high-achieving but a very "traditional" student, he likes solvig exercises by his own rather than taking part into the discussions. When the activity is less traditional, he is less involved and less brilliant. **Group 5: Rob and Cate**. High achieving students, they like taking part into discussion and argumentation activities. **Group 7: Brown and Paul.** Medium-high achieving students, they like taking part into discussion and argumentation activities. **Group 8: Ur and Mary**. Low achieving students, they get lost when faced to non procedural activities. Mary is very involved, and she produced interesting power presentation summarizing the experience with sensor detectors. **Group 9: Lea and Em.** Low-medium chieving students. **Group 10: Lol and Lola**. Medium achievers. Lola is good at maths but she doesn't intervene very much. **Group 11: Flo and Carlo.** The two students have special needs. They are helped by a dedicated teacher, who assists them during the lesson. They took part to the FaSMEd activities with the help of their teacher, working willingly during group work. Their productions were not selected for discussion. They did not intervene into the discussions but listened to the discussions.

2. Report and analysis of three lessons

The case intervention under analysis refers to the second cycle of experimentation performed by the teacher MT.

Since in the first cycle of experimentation, performed with three classes of grade 7, we had observed that the students had worked mainly adopting a holistic view of the graph, rather than focusing on specific parts or points, in this second cycle the teachers proposed to anticipate worksheet 5, further modifying it ("*Every morning Tommaso walks along a straight road from home to a bus stop, a distance of 160 meters. The graph shows his journey on one particular day. Describe how Tommaso has walked on the road from his home to the bus stop. What could have happened to him?"*), so as to work primarily on a holistic comprehension of the graph.

Totally, 9 lessons were performed, and the following table provides and overview:

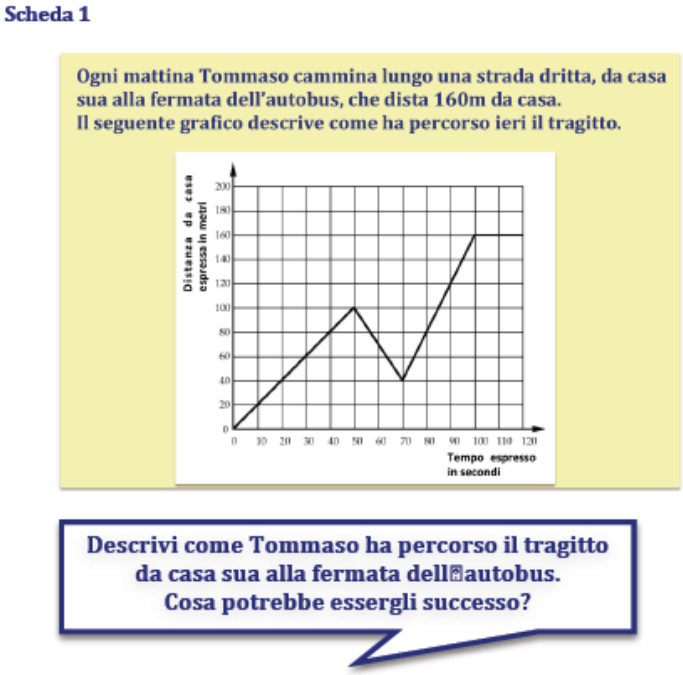
Lesson 0	October 13th, 2 hours		Activity with the motion sensor
Lesson 1	October 20th, 1 hour	Worksheet 5 and discussion	The students are given the graph, they are asked to reconstruct the story of Tommaso from a global point of view.
Lesson 2	October 27th, 2 hours	Worksheets 2A, 3 and 4 (each one followed by a discussion)	Specific questions on some parts of the graph representing Tommaso's journey
Lesson 3	November 3rd, 2 hours	End of discussion on worksheet 4. Worksheet 6 and discussion. Worksheet 6A assigned as homework	Students have to choose the corresponding story to a given graph.
Lesson 4	November 9th, 2 hours	Discussion on Worksheet 6A.	
Lesson 5	November 10th, 2 hours	Worksheet 7 and discussion	Students are required to match a set of cards of time-distance graphs with a set of cards with their possible interpretations
Lesson 6	November 16th, 2 hours	Discussion on worksheet 7	
Lesson 7	November 23rd, 2 hours	Individual written class test	The text of the class test contains also worksheet 8 (see below)*
Lesson 8	November 30th, 2 hours.	Discussion on the written test (including worksheet 8)	

* After the task sequence on time-distance graphs, the teacher proposed an individual written class test containing three tasks inspired by the task sequence.

For this case study, we focus on the analysis of lesson 1, 2 and 3.

2.1 Lesson 1

The first episodes we analyze come from the lesson 1 (October, 20th). The students worked in small groups on the first worksheet (that corresponds to worksheet 5 of the task sequence described in the general part) for about 18 minutes. Here is the original worksheet 5 (adapted) as was sent to the groups, and the English translation of the text.

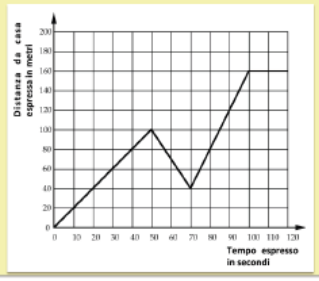


"*Every morning Tommaso walks along a straight road from home to a bus stop, a distance of 160 meters. The graph shows his journey on one particular day. Describe how Tommaso has walked on the road from his home to the bus stop. What could have happened to him?*"

While the students were facing the task, the teacher and the two researchers monitored the groupwork through the IDM-TClass software, but also going directly to the groups' desks. Once produced a written answer, each group sent the document containing the answer to the teacher's laptop. In this way, the teacher could quickly read the answer and select some productions to start the discussion.
After all the groups have sent their work, the teacher shows to the whole class, using the ***sending & displaying functionality of the technology***, some written productions. The students' answers are usually selected in order to: (a) highlight typical mistakes; (b) discuss effective ways of processing the tasks; (c) compare different ways of justifying claims. Such productions are read and discussed by the whole class.
As a starting point, the teacher displays the written answer produced by Mil and Pon:

Scheda 1

Ogni mattina Tommaso cammina lungo una strada dritta, da casa sua alla fermata dell'autobus, che dista 160m da casa.
Il seguente grafico descrive come ha percorso ieri il tragitto.



Descrivi come Tommaso ha percorso il tragitto da casa sua alla fermata dell autobus. Cosa potrebbe essergli successo?

RISPOSTA: Tommaso camminava lungo alla strada fino a quando ha incontrato i suoi amici che gli hanno chiesto di andare con loro a scuola(allungando il tragitto)
Quindi ha percorso piu'di 160 metri per andare alla fermata dell'autobus.

"Tommaso was walking on the street, until he met his friends who asked him to go to school with him (making the journey longer). Then he did more than 160 meters to get to the bus stop".

At first, Mil clarifies that they thought about a meeting with friends to give meaning to the second part of the graph:

7. Mil: We wanted to add that he was walking to the bus but he saw his friends then he went back to his friends and after they went all together to the bus stop, because that segment that went down… to say that… following his friends.

From Mil's sentence and other students' interventions, we may say that students are making reference to the former experience with motion sensors in order to interpret the new graph. More precisely, they interpret the increasing parts of the graphs as movements towards the bus stop and descreasing parts of the graph as movements back home.
Cate asks for clarification about the way of interpreting the second segment of the graph:

21. Cate: But nobody knows that the graph… I mean, it is not like the one of the last lesson, that when you got ahead it went straight and… we followed a straight line and instead when you got back it went down, but nobody knows it now.
22. Researcher: what do you mean by "nobody knows it"?
23. Teacher MT: nobody knows what?
24. Cate: that the graph changes direction when… for instance, if Tommaso gets farther the graph goes on and up, if he gets closer the graph gets down.

Two issues emerge as relevant for the discussion. At first, it is important to assess whether students understood the new situation and thought about the possibility of applying what was understood in the former experience with motion sensors. For instance, it is important to make the students reflect on the fact that Tommaso walks on a straight street (and this information makes the situation similar to what they experienced with motion sensors). Furthermore, it important to move students to a deeper level of justification: from one side, it

is important that students are able to link the new graph to the previous experience; from the other side, it is important that they approach a more theoretical level, moving from an interpretation based on the memory of the former experience to an interpretation based on the meaning of the graph.
Cate's intervention is caught and used to pursue these goals.

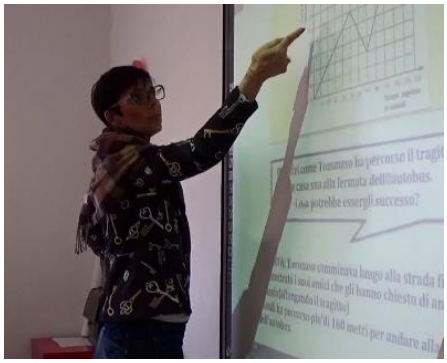
Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback***
33) Cate: but for me, I mean, we wrote something like that, that he does many meters, but… it is not that… it is not written that the graph changes direction when he gets farther or closer…	Cate expresses her doubt concerning the written answer that is displayed on the interactive whiteboard. In this way, she provides a ***feedback about the task***, commenting the classmates' written production.
34) Researcher: wait, you are saying: we said this because we remember what we saw last time, but is it true that also here we can interpret it in this way? Was this your doubt?	The researcher reformulates Cate's doubt, so as to establish *where the learner is in her learning* and also to involve all the classmates in the subsequent discussion. Her aim is therefore to activate ***strategy 2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*). We may also say that Cate is *activated as resource for her classmates* (***strategy 4***).
35) Cate: yes, that's it.	
36) Researcher: ok, did you all understand the doubt of…	The researcher involves the classmates in the discussion, so as to *activate them as resources* for Cate (***strategy 4***).
37) Cate: Cate.	
38) Researcher: of Cate? Who tells that we can say that when the graph goes up it means that he is going farther and when it goes down…	By rephrasing Cate's doubt, the researcher is giving in implicit way a positive feedback to the girl (***feedback about the processing of the task***), recognizing the legitimacy and the importance of her question.
39) Cate: is it because it is getting closer again?	
40) Researcher: can we say this or not? What do you think? (*to all the students*)	The researcher involves the classmates in the discussion, so as to activate them as resources for Cate (***strategy 4***).
41) Rob: for me yes. Yes, because it it written, there is exactly…	Rob answers, trying to clarify to Cate how to interpret the graph.
42) Teacher MT: it is written where?	The teacher encourages Rob to make explicit his explanation to Cate, and also pushes him to clarify what he is saying, so helping him to properly be an *instructional resource for his mates* (***strategy 4***).

43) Rob: in the y axis.	
44) Teacher MT: what is written on the y axis?	The teacher is near the interactive whiteboard, where the graph is displayed. All the students can look at the y-axis.
45) Rob: the distance from home expressed in meters	
46) Teacher MT: then?	
47) Rob: then the distance from home and… the closeness, then… looking at the graph you can understand that he gets farther and you see that also time, I mean, in 50 seconds… in 50 seconds he gets farther of 100 meters and then in 70 seconds, from 50… in 20 seconds he gets closer of 60 meters…	Rob explains to Cate in which way to interpret the graph, focusing no more on the former experience with motion sensor but on the meaning of the two axes. Rob *activates himself as a resource* for Cate (***strategy 4***).

In this short excerpt we see the use of the technology in its ***sending and displaying*** functionality: the teacher, once received the files from the students, selects and displays to all the class, thanks to the interactive whiteboard, some written answers. The excerpt refers to a short episode of discussion starting form the analysis of one written answer. During the discussion, the answer and the original task (text and graph) are always ***displayed***, allowing the teacher, the researcher and the students to make reference to them.
The FA process "*establishing where the learners are in their learning"* is at issue. Cate is encouraged to express her doubt, which is reformulated by the researcher so as to involve all the class into the discussion. The FA strategies employed by the teacher and the researcher are ***strategy 2*** (*engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*) and ***strategy 4*** (*activating students as instructional resources for one another*). The student Rob intervenes to explain Cate how to look at the graph in order to understand the link between the shape of the graph and the journey of Tommaso. Rob activates as resource for Cate, under the guidance and encouragement of the teacher and the researcher.
Concerning the agents of the FA strategies, we may say that Rob acts as a resource for Cate, then the "***peers***" dimensions is present. Moreover, Rob is encouraged to explicit his explanation by the researcher and the teacher, then also the ***teacher*** dimension is present.

The discussion goes on with the analysis of the same written production. Paul expresses a new doubt, still connected with the link between Tommaso's movement and the graph.

Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback***
68) Paul: at the beginning he (*referring to Rob*) also said: when he went back, it (*referring to the graph*) went… it went back to 40, but in order to get back shouldn't it go towards the… y axis?	Paul expresses his doubt concerning the link between the backward movement (towards home) and direction of the graph. He asks whether the graph should not go towards the y –axis. Paul expresses his doubt, thus acting as *owner of his own learning* (FA ***strategy 5***).
69) Teacher MT: well, that is the time that goes on…	The teacher gives an immediate feedback to Paul. Focusing on time, she addresses the fact that a movement towards the y axis would be a

	movement on the x axis and gives an important ***feedback about the processing the task***.
70) Paul: eh, indeed, if this is the nearness (*he indicates the distance from the y axis*)… the closeness to home, this is the home (*he indicates the y axis on his notebook, where he has copied the worksheet*), it must get back to the y axis and not go down… not go…	Paul makes his doubt more explicit.
71) Teacher MT: but if I get back here… you say, in this drawing it should get back.	The teacher reformulates Paul's doubt, with the aim of *establishing where the learner is* and involving all the class into the discussion (***strategy 2***).
72) Researcher: shall we let someone speak? Who wants to help him? Did you understand his doubt?	The researcher involves all the class into the discussion, encouraging the other students to understand Paul's doubt and help him. Reformulation and direct question are two key strategies to involve all the students. FA strategies are: ***Strategy 2*** (Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding); ***Strategy 4*** (Activating students as instructional resources for one another).
73) Teacher MT: did you understand? He says: "if he gets closer to home, for me, it (*the graph*) should get closer to the y axis" (*she does the gesture of a horizontal line from point (50, 100) to the y axis*). 	The teacher reformulates Paul's doubt, using also her gestures to better make clear the reference to the y axis in Paul's interpretation (line 70).
74) Cate: for me no, because the graph in this way means that he (*Tommaso*) turned himself and he goes back… it does not have to get back… to make understand that he get back, it (*the graph*) goes down (*she simulates with her finger the movement from up to down*), without getting back this way (*she simulates with her finger the horizontal direction from right to left*)	Cate intervenes and explicitates the link between the movement of Tommaso and the direction of the graph. We may note that Cate had expressed doubts about the link between movement and graph (see previous excerpt). In this episode Cate is able to *activate herself as resource for another student* (FA ***strategy 4***).
75) Researcher: why does it (the graph) doesn't have to get back to the y axis?	The researcher relaunches the question to all the class, with double aim of involving other students and obtaining a more theoretical explanation. Also, through this question she gives a

	feedback on the task, by confirming in implicit way that the graph has *not* to get back to the y axis
76) Teacher MT: Ur?	
77) Ur: instead, for me, I don't know but I think that he did not really get back home, he got back for a part of the path because it (*the graph*) did not really get the bottom.	
78) Teacher MT: but do we know how much…	The teacher intervenes and asks directly how much meters Tommaso went back.
79) Rob: 60 meters, that is to say he went back for 60 meters to 40 meters.	
80) Teacher MT: he (*Tommaso*) got closer up to 40 meters, what you say is right, but let's answer to the fact that, who was saying this, that it (the graph) goes back. Brown?	The teacher gives a quick feedback to Rob (***feedback about the task***) and relaunches Paul's doubt.
81) Brown: it cannot… the graph can not get back, because, how could we know how much time did it take? 82) Paul: well, we would go back in time. 83) Teacher MT: what would mean if I would… 84) Paul: we would go back in time! 85) Teacher MT: going back in time!	Brown activates *as a resource for another student* (FA ***strategy 4***). Such an intervention is efficient, as evidenced by Paul's answer. The teacher repeats Paul's answer, to give him a *feedback* about the rightness of the explanation.

The second excerpt refers to another moment when, starting from the analysis of a ***displayed written production***, one student expresses a doubt concerning the link between Tommaso's journey and the graph.

We may say that Paul, expressing his doubt spontaneously (he is not questioned by the teacher, and the discusses written production is not the one produced by his group), activates himself *as the owner of his own learning* (FA ***strategy 5***).

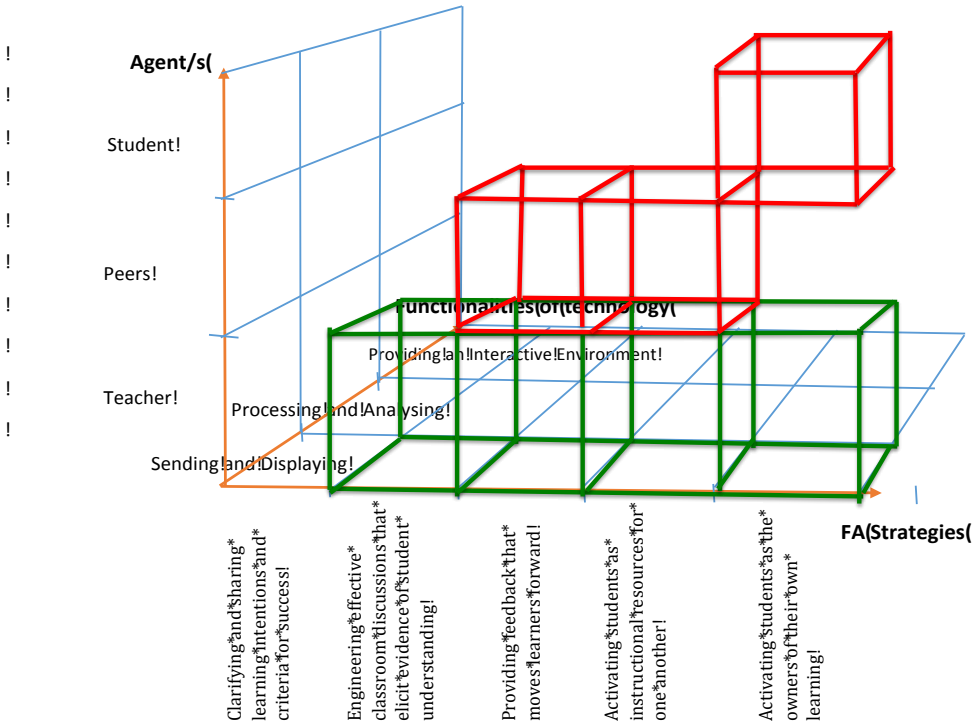
The functionality of technology at issue is ***sending and displaying***, since the students, the teacher and the researcher refer to what is displayed on the interactive whiteboard (a written answer, the text of the task, the graph).

The agents involved are the ***student*** (Paul), ***the teacher and the researcher***, the ***peers***.

The teacher and the researcher have the goal of establishing where the learner (the student Paul, who expresses his doubt) is and helping him to move forward. In order to accomplish this aim, they adopt two FA strategies: ***strategy 2*** (*engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*); ***strategy 4*** (*activating students as instructional resources for one another*). Reformulation of Paul's doubts and direct questions to the audience (*Who wants to help him? Did you understand his doubt?* …) are used in order to activate such FA strategies.

The students Rob, Cate and Brown intervene and help Paul to understand the link between the movements and the graph. We highlight Cate's intervention: while in the former excerpt Cate had expressed her doubts, in this excerpt she turns herself as responsbile of her own learning. We may say that the previous *feedback about the processing of the task* helped her to understand the way of addressing the task.

The following diagram highlights how the sending and displaying functionality of the technology enabled the teacher and the other agents to activate a wide range of formative assessment strategie during lesson 1.



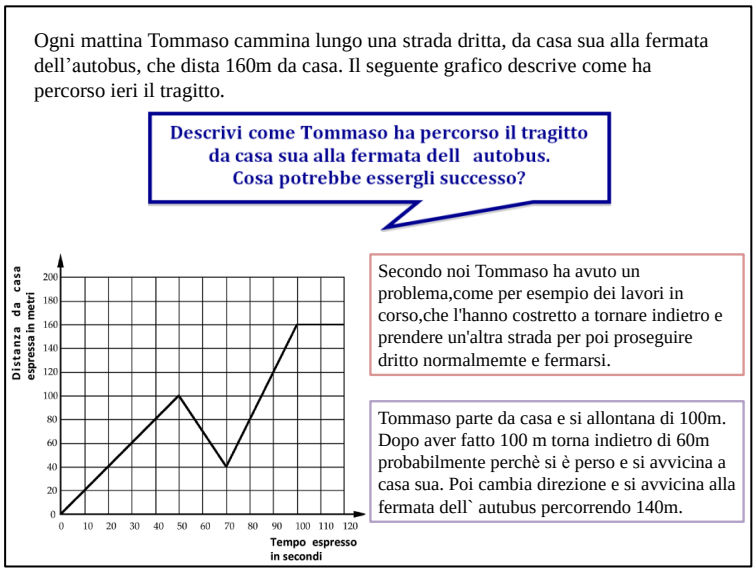
2.2 Lesson 2

The subsequent selected episodes refer to lesson 2 (October 27th). Lesson 2 starts with a short summary of what was done in the previous lesson, afterwards a new selection of group answers to worksheet 5 is displayed to the whole class. It is worth mentioning that, while in the previous lesson the group productions had been selected on the spot, in this lesson the teacher displays some productions that she selected in a quiet moment between the two lessons. As outlines in the former lesson, the students' answers are usually selected in order to: (a) highlight typical mistakes; (b) discuss effective ways of processing the tasks; (c) compare different ways of justifying claims.
The functionality of technology is ***sending and displaying***, since the discussion concerns the analysis and comparison between two group productions that are displayed.
The two productions are:

1. *For us, Tommaso had some problem, for instance some men at work that made him go back and take another road and after go on normally and stop.*

2. *Tommaso leaves home and goes on for 100 meters. After having done 100 meters he goes back of 60 meters, probably because he got lost, and he gets closer to his house. Afterwards he changes direction and he gets closer to the bus stop, walking for 140 meters.*

Here is the original power point slide that was displayed to the students, with the two answers reported at the right of the graph:



One author of the second answer, Rob, immediately amends the last part, recognizing that Tommaso walks for 120 meters.
Afterwards, the students highlight that, in both answers, Tommaso is said to return closer to home, but only the first answer mentions also the last part of the journey (when Tommaso doesn't walk anymore).
Afterwards, the discussion focuses on the decreasing part of the graph, that the students interpret in terms of returning closer to home. In the first production Tommaso is said to have changed his way, while in the second one Tommaso is said to have gone back, still on the same road. The student Brown observes that Tommaso did not change his way, only the direction:

74. Brown: For me, anyway, he (*Tommaso*) did not take another road, he could have… I don't know… forgotten something… he lost his pencilcase in the middle of the street, he just went back, there he changed his direction, for this reason there is a peak, but he did not necessarily change the road… take another road, because maybe it (*the graph*) would have noted more distance.

Brown *activates herself as a resource for the other students* (FA ***strategy 4***), because she points out something that doesn't work in the second answer, giving a ***feedback about the task*** to the classmates. Brown is efficient in explaining that Tommaso did not change his road, but only direction. Anyway, for the teacher it is important to make clear that this is the only possible interpretation, since the text of the task reports that Tommaso moves along a staight line.
The discussion on this crucial issue is illustrated in the following excerpt:

Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback***
94) Teacher MT: but, the information, does only the graph give us information? Was the task made up only by the graph? 95) Paul: there was also the text. 96) Teacher MT: ah, there was also the text, shall we read again the text? Go on, Rob. *97)* Rob *reads again the text of the task.* 98) Teacher MT: have we got some more information? 99) Cate: ah, but Tommaso walks along a straight road. 100) Student: yes, indeed	The teacher brings to the fore that, in order to fill the task, it is important to take into account both the graph and the text. Apart from ***strategy 2*** (*Engineering effective classroom discussions*), she activates two FA strategies: ***Strategy 1*** (*Clarifying and sharing learning intentions and criteria for success*); ***Strategy 3*** (*Providing feedback that moves learners forward*). The teacher involves the students in a careful reading of the text. In this way, she pursuits a double goal: working on the task (***feedback on the task***) and promoting a careful reading of the text as an efficient strategy for solving any problem (***feedback about the processing of the task***).
101) Teacher MT: that is to say? 102) Mark: Then, yes, he changed his way necessarily… then.. 103) Teacher MT: did he change his way? 104) Student: no! 105) Teacher MT: Brown? 106) Brown: I wanted to say that he did not change his way, because, the road is straight, if the road were straight and after there were a little road here, the motion sensor would not have caught him…	

107) Teacher MT: yes, let's imagine to observe him, not that there is a motion sensor, we take the times and we measure his distance from home, but the text gives you another information: that he was walking on a straight road. Then, in reality, I know the…that he was walking on a straight road. This fact, that he was walking on a straight road, can I undertand it from the graph or not? 108) Rob: not. 109) Teacher MT: because the graph just tells me… what? 110) Rob: the distance and time.	The teacher gives a quick feedback to Brown (***feedback about the processing of the task***), and encourages her and all the students to focus on the text (***feedback about the processing of the task***). FA ***strategy 3*** is activated.

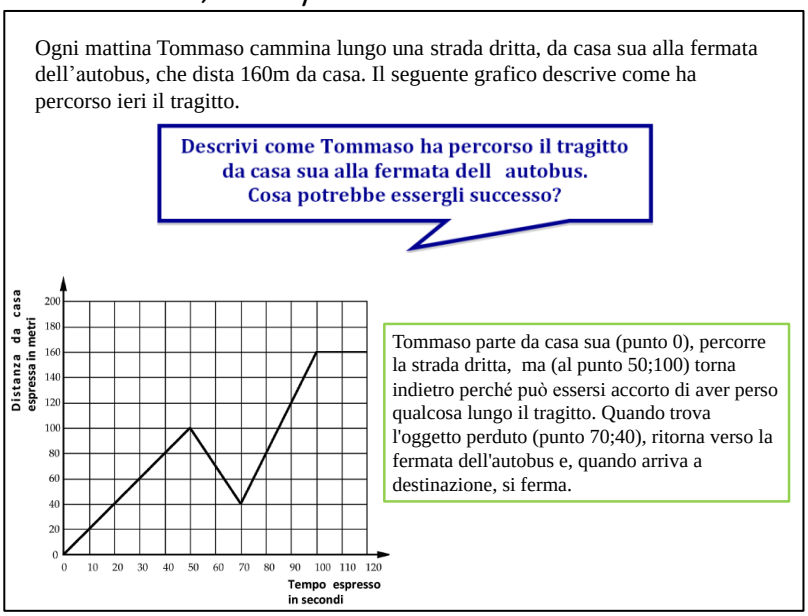
In the former excerpt the teacher has two goals: at the task-level, she wants to clarify that only one interpretation (Tommaso changes his direction, going back towards home) is possible, since the text explicits that Tommaso is walking on a straight road; at meta-level, she wants to highlight the careful reading of the text as an efficient problem solving strategy. This means that she wants to give ***feedback about the processing of the task***.
In order to pursue this double goal, she activates the following strategies:
Strategy 1 (*Clarifying and sharing learning intentions and criteria for success*);
Strategy 2 (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*);
Strategy 3 (*Providing feedback that moves learners forward*).
Also the peers are agents of the formative assessment process: Brown and Rob intervene, thus *acting as resources for one another* (***strategy 4***).
The functionality of technology is that of ***sending and displaying***, since the discussion starts from the analysis and comparison of some written answers, which are displayed via the ineractive whiteboard.

Afterwards, some students observe that, in the experience with the motion sensor, if one student moved away from the straight line, the sensor was no more able to detect him and the graph resulted with some gaps. They use this experience as an argument for the fact that Tommaso moves along a straight line: since the graph is like the graph they obtained with the motion sensor, they infer that Tommaso walked along a straight road.
The teacher clarifies that in principle, just looking at the graph, Tommaso could also have moved to another road. Indeed, without using the motion sensor but measuring the distance from home second after second, it would have been possible to have a graph without gaps even in that situation. Only the information given by the text warrants that Tommaso moved along a straight road.

119. Teacher MT: […] anyway, why did they write "along a straight road"?
120. Debby: To make us understand that Tommaso did not change his way.
121. Teacher MT: but is it important to know that he did not change his way?
122. Debby: yes, because anyway if we have to describe the journey it is important to know whether he changed his way or not.
123. Researcher: at least there is only one interpretation.
124. Teacher MT: there is only one interpretation.

Once established that the first written production is not correct (because it reported about men at work and changing the road), the teacher invites to read and discuss another selected answer:

> *3. Tommaso starts from his house, point zero, he goes on a stright road, but at point (50,100) he goes back because he might have forgotten something along the path. When he finds the lost object, point (70,40), he goes back to the bus stop and, when he arrives to the destination, he stops.*



The analysis of the selected answer is a good occasion for the teacher to check whether the students understood the previous issue concerning the information on the staight road and the fact that Tommaso in the second trait comes back. The process at issue is "*establishing where the learners are in their learning".*

The functionality of technology is still ***sending and displaying***, and the first activated ***strategy*** is ***2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*).

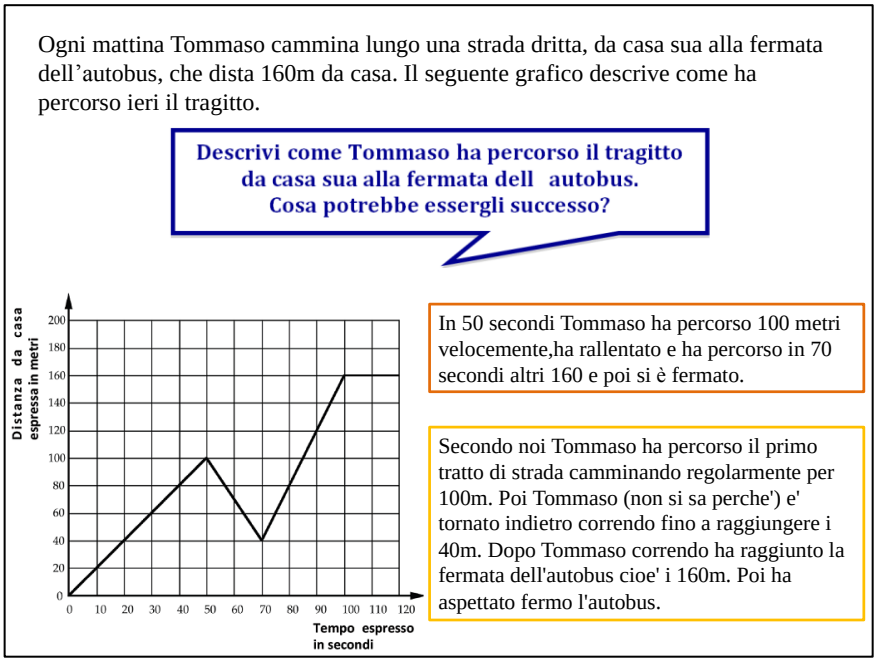
Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback***
141) Researcher: does this story tell us something different, in comparison to the ones we read before? 142) Paul: it tells that the road is straight.	
143) Teacher MT: it reports that the road is straight, an information from the text.	The teacher reformulates Paul's intervention, so as to underslne the importance of taking into account all the information from the text. The activated ***strategy*** is ***1*** (*Clarifying and sharing learning intentions and criteria for success*).

144) Mark: then, that he doesn't go back, that he doesn't change his way. 145) Teacher MT: that he doesn't change his way but…? 146) Debby: he comes back. 147) Teacher MT: he comes back. 148) Debby: but for another reason. 149) Teacher MT: for another reason. 150) Mark: he could have lost something.	Mark and Debby intervene, showing that they udnerstood the previous discussion on the road that does not change.
151) Rob: but I did not understand why he wrote "at the point (50,100)". 152) Teacher MT: what is that? What does it mean? 153) Pon: those are the coordinates. 154) Teacher MT: those are the coordinates.. of the point (50,100) 155) Rob: ah, yes! 156) Teacher MT: then the 50 is… 157) Voices: the time. 158) Teacher MT: and 100? 159) Voices: the distance from home. 160) Teacher MT: then those are the coordinates of the point. Then they (the authors of the answer) imagine that he (Tommaso) lost something, from that point he goes back, and then?	Rob asks for clarification for the presence of the coordinates on the written answer. The teacher encourages other students to intervene as resources for Rob (***strategy 4***). Pon intervenes, activating himself as resource for Rob.
161) Cate: then he says that "he comes back" and not that "he changes his way".	Cate points out that the written text correctly says that Tommaso comes back, not that the road changes.
162) Teacher MT: he comes back… and after? 163) Ur: he comes back because when he finds the object he had lost he goes back to the bus stop, walking again on the same road and when he comes to the bus stop he stops. 164) Teacher MT: he stops, ok? I would say that… are you all ok with this? May we take this as a complete description, for you? Exhaustive?	The teacher concludes by a series of questions, to make sure that the students understood; in this way, she implicitly gives a **feedback about the task**.

The work goes on with the analysis and comparison of the last two selected written answers:

> *4. In 50 seconds Tommaso walked along 100 meters quickly, he got slower and did in 70 seconds 160 more meters, after he stopped.*

> *5. For us, Tommaso did the first part of the path walking regularly for 100 meters. After, Tommaso (we don't know why) went back running until he reached 40 meters. After, Tommaso, running, reached the bus stop that is to say the 160 meters. After he waited for the bus without moving.*



Transcript
203. Teacher MT: OK. Which further information do these two answers give us?
204. Cate: that he (*Tommaso*) ran and got slower and got faster.
205. Brown: the speed.
206. Teacher MT: The speed: some information on the speed, on the way of moving, something we had not yet seen.

From the last two short excerpts we may observe that the activity of analysis and comparison of written production is efficient for the work at content level (***feedback on the task***) and also at meta level (***feedback about the processing of the task***), since the students may grasp a better insight into the task and at the same time reflect on the possible ways of addressing the task. Answer 3 exemplifies the way of dealing with coordinates to give a more detailed description of Tommaso's journey, answers 4 and 5 bring to the fore that Tommaso's movement may be described also in terms of speed, not only in terms of time and distance.

Once again, a crucial point is to move from the interpretation of the graph in reference to the former experience with the motion sensor to a more theoretical explanation for the interpretation in terms of speed. Such a goal is pursued in the following excerpt. The functionality of technology is ***sending and displaying***, since the class discusses the written answers that are displayed on the IWB.
The agents are the teacher and the researcher, but also the peers, that intervene, thus *activating themselves as instructional resources for the mates*.
Relevant FA strategies are: ***strategy 1*** (*Clarifying and sharing learning intentions and criteria for success*); ***strategy 2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*); ***strategy 3*** (*Providing feedback that moves learners forward*).

Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback***
215) Researcher: and… I ask you two questions,	The researcher encourages all the class to

	you already said it, but why when we look at the third trait we say that Tommaso run, that is to say, why do we link this to an increased speed?	explain the link between the graph and the speed, activating ***strategy 2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*).
216)	Mark: because you see the difference between the first and third trait: the first trait is more towards the horizontal line, instead the third trait is more towards the vertical line.	The first explanation, proposed by Mark, relies on the comparison between the traits and, implicitely, to the former experiences with the motion sensor.
217)	Mario: no, for me in the last part he (*Tommaso*) goes faster because maybe he was late and then he run.	Mario seems to focus on the story (Tommaso was late because he had to go back to recover the pencilcase, then he proably run in the last part of the path) rather than on the interpretation of the graph.
218)	Teacher MT: yes, but from the graph, besides this inclination…	The teacher encourages the students to focus on the graph, activating ***strategy 3*** (*providing feedback that moves learners forward*).
219)	Lola: you see also that in the first trait he (*Tommaso*) spent a "tot" of seconds while in the third one he spent less seconds.	Lola proposes another kind of explanation, based on the amount of time spent to walk in the two traits.
220)	Teacher MT: then, should we look at the time he spends to do what…?	The teacher encourages the students to develop Lola's proposal, thus giving in an implicit way a positive ***feedback*** on it.
221)	Mark: because going up to 100 meters he spent 50 meters, and then he spent 50 more seconds to go to 40 meters and to go to 160 meters.	Mark works on the graph, but, differently from Lola, he focuses on the amount of meters walked in the same amount of time (50 seconds).
222)	Teacher MT: then…	
223)	Researcher: can you show us?	The researcher encourages Mark to show his reasoning at the whiteboard, so as to involve all the students and then activating mark as a real *instructional resource for the other students* (***strategy 4***)
224)	Teacher MT: come here. So, your classmate says: "He spent…"	The teacher's intervention is aimed at involving all the students in understanding Mark's explanation.

225) 226) 227) 228) 229) 230) 231) 232) 233) 234) 235)	Mark: to go to 100 meters he spent 50 seconds because the coordinates are (50,100). Teacher MT: OK Mark: but after, going 40 meters he spent 20 seconds and then he went back up to 100 meters and then he spent 30 seconds. To get back and get back to 160 meters he spent 50 seconds. Teacher MT: can we understand how many meters he walked in those 50 seconds? Mark: from 40… 120! 120 meters. Teacher MT: 120 here (*she indicates the whiteboard*). Mark: yes. Teacher MT: and this little trait? Mark: ah, he did … 180! Teacher MT: 180… then in 50 seconds… Mark: he did 180 meters running and instead…	
236)	Teacher MT: how do I understand that he is running? Or that anyway he is going faster than before? Because in the first 50 seconds how many meters did he do?	The teacher encourages Mark to synthetize and conclude his reasoning, making explicit the comparison between the amount of meters walked in the same amount of time. She therefore activates ***strategy 3*** (*providing feedback that moves learners forward*).
237)	Mark: only 100.	
238)	Teacher MT: only 100. Ok.	
239)	Researcher: ok, is it all right?	
240)	Teacher MT: did you understand? He (*Mark*) says: "in the first 50 meters he did 100 meters because he geta way from home until 100 meters, in the subsequent 100 meters actually he (*Mark*) does 60 meters to come back, get what had been lost, and then he does 120 more meters to reach the 160 meters of distance from the house, which is the bus stop, then totally it gives 180 meters… in 50 seconds, in the same 50 seconds, then the time is the same, but the walked meters are more in the second trait, then it is clear that he goes…?	The techer reformulates to give ***feedback on the task*** and also ***on the processing of the task***.
241)	Rob: faster	
242)	Teacher MT: really faster.	
243)	Researcher: I wanted to say that it is important to link our evaluation of the speed to the numbers that we can get from the graph, because let's imagine somebody who did not do the experience with the mtion sensor, you can not just tell him "yes, that's because we saw with the motion sensor that the more we run the	The final comment of the researcher gives a ***feedback about the processing of the task***, underlining the importance of producing "theoretical", rather than empirical, explanations. She also gives some feedback about self, because she points that referring to the former experience with the motion sensor is

	more the line moved"; it must be something that somebody finds looking at the graph, without having done the experience with the motion sensor, ok? Then, a first explanation is to say "because we saw it last time", and it is good that you refer to that experience, but furthermore you can explain it with the data.	anyway a very good starting point. We may say that the researcher activates the FA ***strategy 1*** (*Clarifying and sharing learning intentions and criteria for success*).

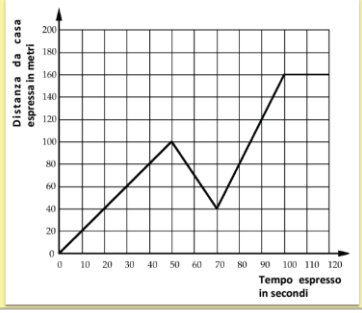
Once finished the discussion on the selected written productions, the work on a new task (worksheet 2) starts. The teacher, as planned a priori with the researcher, chooses to propose an instant poll:

In this poll three justifications, given by fictitious students, are proposed, with the request of identifying the most complete one among them:

> *(a) During the last 20s, Tommaso is not walking because we have already said that he has reached the bus stop.*
>
> *(b) I think that, during the last 20s, Tommaso is not walking because, from the graph, it is possible to understand that, in the period between 100s and 120s, he is always at the same distance from home, that is 160m.*
>
> *(c) I understood that, during the last 20s, Tommaso is not walking because the line of the graph is horizontal.*

Scheda 2A

Ogni mattina Tommaso cammina lungo una strada dritta, da casa sua alla fermata dell'autobus, che dista 160m da casa.
Il seguente grafico descrive come ha percorso ieri il tragitto.



Domanda 2: Cos'è successo durante gli ultimi 20 secondi? Come hai fatto a stabilirlo?

Durante gli ultimi 20s, Tommaso è fermo perché prima abbiamo detto che è già arrivato alla fermata.

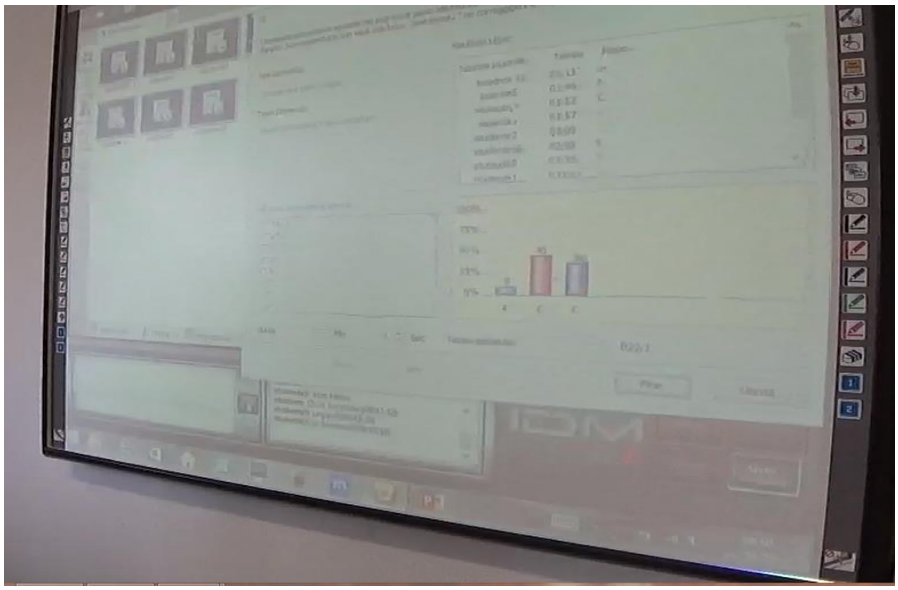
Secondo me, durante gli ultimi 20s, Tommaso è fermo perché dal grafico si può capire che, da 100s a 120s, resta sempre alla stessa distanza da casa, cioè 160m.

Ho capito che, durante gli ultimi 20s, Tommaso è fermo perché la linea del grafico è orizzontale.

Alcuni studenti di un'altra classe hanno dato queste risposte. Qual è la più completa?

RISPOSTA:

The students worked in small groups. All the groups answered in less than 8 minutes. The picture shows the distribution of answers, as displayed to the class at the end of the groupwork.



All the subsequent part refers to the ***functionality of technology "processing and analyzing"***, since results from the instant poll are processed and the results of such a processing are displayed to all students and used as a starting point for the discussion.
The FA process "*establishing where the learners are in their learning"* is at issue. Furthermore, the teacher aims at giving feedback at content level (***feedback about the task***) and also at meta level (***feedback about the processing of the task***), namely about the way of providing an explanation that is not only correct but also complete.
The FA strategies that the teacher activates are: ***strategy 1*** (*Clarifying and sharing learning intentions and criteria for success*); ***strategy 2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*); ***strategy 3*** (*Providing feedback that moves learners forward*). Moreover, students intervene, thus turning themselves as *instructional resources for the peers* (***strategy 4***).

After a brief analysis of A, justifications B and C are compared.

Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback***
353) Teacher MT: let's look at B and C. Let's hear some motivation of those who chose C, why did they chose C, and some motivation of those who chose B. 354) Brown: we chose B because B specifies also that he (*Tommaso*) stayed still from 100 to 120 seconds, while C doesn't say this, saying that they were only 20 seconds they could have been 150, 170, 180 and so on… 355) Student: B is the most complete. 356) Teacher MT: B is the most complete.	The teacher encourages the students to discuss the reasons behind the choices of the poll. Brown suggests that answer B gives more information on the last trait. Another student, echoing Brown, affirms that B is the most complete.
357) Mario: for me the B is not right	Mario challenges the former evaluation: in

because, we understood that, when we used the motion sensor, let's say, you understand that a person stops when the line is horizontal, and there (*justification B*) it doesn't say this, then it is not the most complete. 358) Researcher: could you say it again, please? 359) Teacher MT: yes, please. 360) Mario: for me the B is wrong, because when we did the experience with the motion sensor we discovered that, let's say, staying still we did a horizontal line, and that is not written there. 361) Teacher MT: he says "we loose the information of the horizontal line".	his opinion, answer B is not complete because it does not refer to the experience with sensor detectors. This is a good occasion to discuss again the role and value of the empirical experience with sensors. This issue is discussed in the subsequent hour of lesson (see below).
The lesson in interrupted because time (one hour) is finished. The students attend to two hours of lesson of technology; afterwards they continue their mathematics lesson (one more hour). The teacher displays again the different options A, B, C.	
388) Brown: well, looking at the question now I would say that also C is right, maybe B is more complete because it explains everything, but, "How do you know it?", it is C that answers because the line of the graph is horizontal, then in this case it would be C.	Brown comes back to her former observation. Influenced by Mario's former intervention, she says that C is the most complete. Mario's intervention acted as a ***feedback*** for her.
389) Teacher: OK, but the question was "What is the most complete?", then actually they are both correct, we wonder which is the most complete. 390) Lollo: but if we had not done that activity before… 391) Teacher MT: the activity with the motion sensor. 392) Lollo: we could not have known that if you are still the line is horizontal 393) Teacher MT: Could not we have known it? Let'd think about that. 394) Researcher: then are you saying that maybe the justufucation C, the third one, requires the fact that one has done the experience with the motion sensor? 395) Lollo: yes.	The teacher's aim is to promote a discussion on the role and value of the activity with sensors. She also wants to focus on the completeness of the two options (***Strategy 1****: Clarifying and sharing learning intentions and criteria for success*). Lollo intervenes, suggesting that one cannot refer to the experience with sensors, since the answer should be intelligible also by a reader who did not do such an experience. Lollo seems to have taken advantage from the previous discussion on speed (the interpretation in terms of speed can not be justified in reference to the experience with sensors, it should be justified in a more theoretical way). This suggests that he got from the previous discussion a fruitful ***feeback about the processing of the task***.
396) Teacher MT: then, we know from the experience with the motion sensor that if the line is horizontal it means that the person does not move.	The teacher reformulates Lollo's intervention so as to involve the other students. In this way she also activates ***Strategy 3*** (*Providing feedback that moves learners forward*).

397) Cate: but teacher, if… we told that if the person goes on the line goes on straight and goes up, and if instead the person changes direction and gets closer to the motion sensor the line goes down; then one can say "if the line is horizontal it means that anyway the person doesn't move, doesn't change direction". 398) Teacher MT: Ok, all right. 399) Rob: and anyway from the graph you can understand why the distance is always the same but the seconds, let's say, go on… 400) Teacher MT: ok… then, even if we had not had the experience with the motion sensor, that made you understand in an experimental way that if I stay still the line is horizontal, your classmate (*Rob*) says: "from the graph I can understand it anyway". Why? Rob, could you please repeat it? 401) Rob: because from the graph you can understand that when you don't move, that is to say when there is the horizontal line… 402) Teacher MT: what doesn it mean? 403) Rob: the meters remain the same but the seconds go on, let's say. 404) Teacher MT: Ok, then the seconds go on, but the meters that indicate… what? The… 405) Cate: distance from home. 406) Teacher MT: from home. They remain… 407) Cate: the same. 408) Teacher MT: the same. Then, what does it mean? 409) Cate: that Tommaso does not move. 410) Rob: instead, before, when the person goes farter or closer… let's say that both seconds and meters are moving.	Cate suggests an explanation based on the empirical experience with sensors. Rob intervenes, affirming that in the horizontal trait the distance from home is always the same. This is a shift from an explanation based on the experience with sensors to a theoretical explanation, based on the meaning of the graph. Rob provides Cate (and the other students) a feedback to move forward (***strategy 3***), turning himself as an *instructional resource for his classmates* (***strategy 4***). The teacher reformulates Rob's intervention, giving him a ***feedback about the processing of the task*** and to all the students a *feedback that moves them forward*. Reformulation is also a means to activate Rob as *resource for the others* (***strategy 4***).
411) Teacher MT: ok, that both meters and seconds change, while he (*Rob*) says "from the graph I see that horizontal line, it explains me that the meters remain the same while the time goes on", then the time goes on, my distance from home is always the same, and this means… that I don't move, is it clear? Then, what is the most complete, after this observation? Those who chose C agree that B maybe is less linked to the experience with the motion sensor?	The teacher asks again the question concerning completeness. Cate answers that B is more complete, thus showing that Rob's ***feedback*** was really helpful for her.

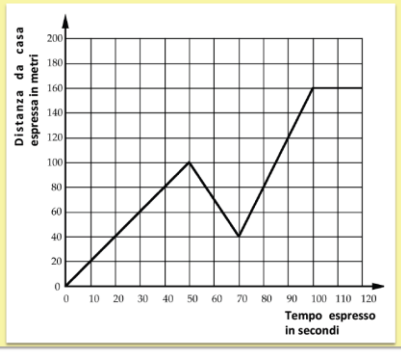
	That is to say, does it explain me why the graph is horizontal, the line is horizontal, does B explain why the line is horizontal?	
412)	Cate: yes, B does.	
413)	Teacher MT: B explains why the line is horizontal, while C just says "the line is horizontal"; B instead explains why the line is horizontal, because the meters remain the same, even if time goes on, isnt it?	As a final intervention, the teacher rephrases the result of the discussion, pointing out what makes answer B more complete. In this way she activates ***strategy 1*** (*Clarifying and sharing learning intentions and criteria for success*).
414)	It says "from the graph you can understand that from 100 to 120 seconds", then time goes on, "he (*Tommaso*) is always at the same distance from home", that is to say 160 meters.	
415)	If I stay for 20 seconds always at the same distance from home it means that I do not move, because if I moved I would get farther or closer, is it clear? Then it gives me some information, it explains me why… what does it mean to have the horizontal trait, are you ok? Then, the fact that if I don't move the segment is horizontal is right, justification B explains me why, it is more complete, because the question was "Which is the most complete?".	

In the last part of the lesson, a new worksheet (worksheet 3) is proposed in form of instant poll:

After how many seconds does Tommaso reach the bus stop?
(a) After 120s;
(b) After 50+70+100+120 seconds, that is after 340 seconds;
(c) After 100 seconds;
(d) After 50 seconds.

Scheda 3 - SONDAGGIO

Ogni mattina Tommaso cammina lungo una strada dritta, da casa sua alla fermata dell'autobus, che dista 160m da casa.
Il seguente grafico descrive come ha percorso ieri il tragitto.



Domanda 3: Dopo quanti secondi Tommaso è arrivato alla fermata?

A) Dopo 120 secondi

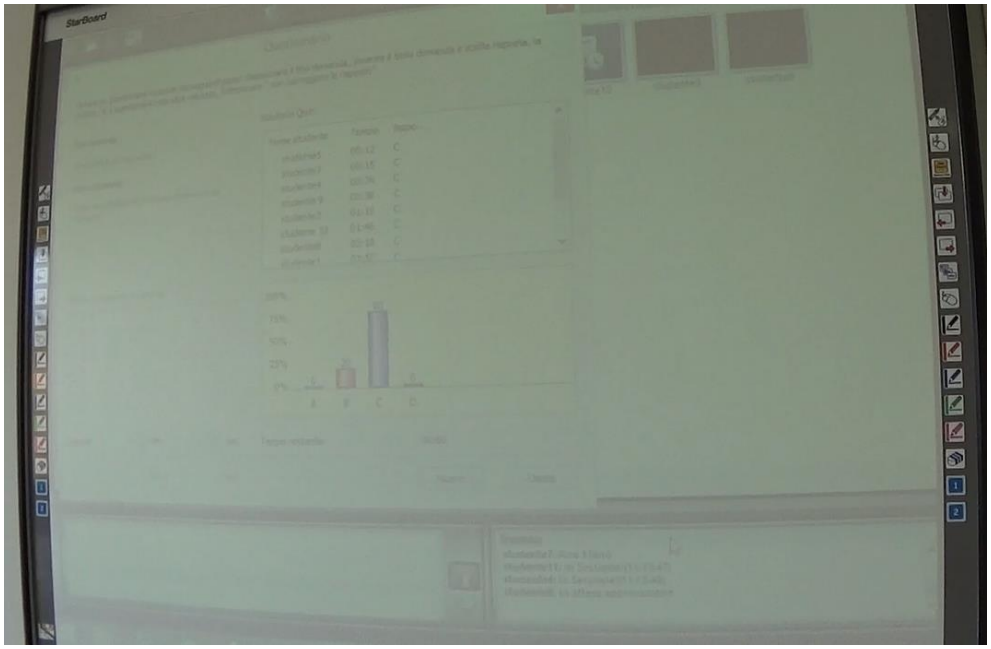
B) Dopo 50+70+100+120 secondi, cioè dopo 340 secondi

C) Dopo 100 secondi

D) Dopo 50 secondi

Students work in groups for about 6 minutes, afterwards the result of the poll is displayed on the whiteboard and all the students discuss the results.
Two groups chose option A. Another group could not answer within the fixed time for technical problems, but declare that they would have chosen option B.
In the subsequent discussion, the teacher encourages students who answered C to help their mates to understand which was the good reasoning to do. The teacher, together with the involved students, provides to the class a ***feedback about the processing of the task***. The double aim of the teacher is to make students who chose the options understand their mistake (*Providing feedback that moves learners forward,* ***Strategy 3***), and to establish the careful reading of data from the graph as an efficient way of answer the question, without any calculation.

The functionality of technology is ***processing and analysing***, since the results of the poll are the starting point for the discussion. The prevailing activated strategies are ***strategy 2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*) and ***strategy 4*** (*Activating students as instructional resources for one another*).



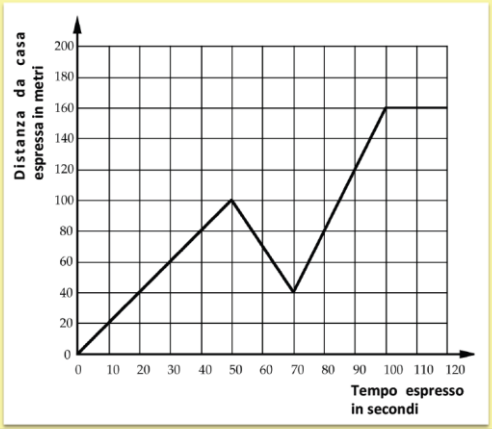
Transcript		***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback***
428)	Teacher MT: option B said "after 50+70+100+120 s". Yes, Rob.	
429)	Rob: for me no because, first of all you see immediately that… it can not be that because the graph does not even arrive to 340s, and after I saw… because… at 100s Tommaso comes to the bus stop and after at 110s and 120s he is already at the bus stop.	Rob *activates himself as resource for the peers* (***strategy 4***), since he provides a ***feedback about the processing of the task***. He points out that 340 is too much, and explains how to intepret the graph to answer the question.
430)	Debby: or you can simply do the calculation that, here you can do that Tommaso comes to 50…	Debby proposes to calculate the time spent in each part of the journey. The researcher lets her expose, afterwards she points out that doing all the calculation was not necessary. She poses the question to the class, so as to give a *feedback that moves forward* (***strategy 2***), turning the peers as resources for Debby.
431)	Researcher: please come to the blackboard.	
432)	Debby: you can do this calculation: here Tommaso comes to 50, then you keep in mind 50, then from 50 to 70 you keep in mind 20, from 70 to 100 you keep in mind 30, you do 50+20+30 and you get 100.	
454)	Researcher: but, listen, going back to what Debby was saying, one could do 50+30 and so on, but was it really necessary to do all those passages? How could we do to get the answer? I would let them answer, since they had chosen B, it now it is ok for you…	

455) 456) 457) 458) 459)	Remo: for me it was sufficient to see that 160 meters correspond to 100 s… Researcher: it is reached… Remo: then it was sufficient to see what was corresponding to 160 meters and you got the answer. Researcher: ok. Teacher MT: then it was sufficient to read how much seconds correspond to 160 meters.	Remo intervenes, *activating himslef as a resource* for Debby (***strategy 4***). He points out that a careful reading of the graph gives all the required information, without any calculation. The teacher synthetizes Remo's answer, thus giving him a positive feedback and turning him as a *resource for the class*.

The lesson goes on with the group work on worksheet 4, where this question is posed: "*Does he walk for 160m? Why?*".

Scheda 4

Ogni mattina Tommaso cammina lungo una strada dritta, da casa sua alla fermata dell'autobus, che dista 160m da casa.
Il seguente grafico descrive come ha percorso ieri il tragitto.



Domanda 4: Ha percorso esattamente 160m? Perché?

RISPOSTA:

Students work in groups for about 10 minutes. Afterwards, a first round of discussion is carried out. The following productions, selected on the spot by the teacher and the researchers, are displayed on the interactive whiteboard:

1. No, because we said that maybe he went back or he lost something and he walked for more than 160 meters.
2. No, he did not walked for exactly 160 meters because in the point where he went back he did 60 meters then totally Tommaso did 280 meters.
3. For us he did not walked for exactly 160 meters, because going back he did 40 more meters, that is to say 10 meters for each little square. Afterwards he went back in direction of the bus stop and he did 60 more meters up to the bus stop. Totally Tommaso did 200 meters.

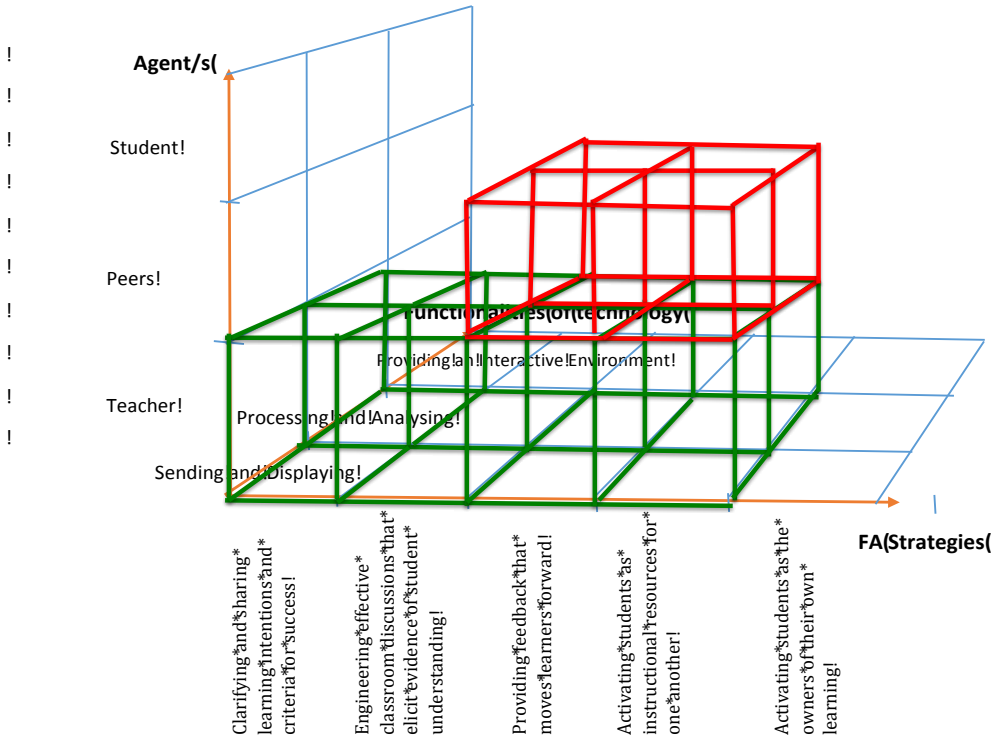
4. No because at the point (50;100) Tommaso went back of 60 meters walking then for 220 meters.

The students and the teacher observe that the first answer is qualitatively different, since it only recalls that Tommaso went back to recover something then he walked more than 160 meters, while the other three productions also try to establish how much meters Tommaso walked, but propose three different results. The last part of the discussion, strongly led by the teacher, focuses on the way of calculating how much meters Tommaso walked, getting data from the graph.

In terms of formative assessment, the teacher gives to the authors of the answers a ***feedback about the processing of the task*** (the good way of reading data from the graph). The activated strategies are: ***strategy 1*** (*Clarifying and sharing learning intentions and criteria for success*); ***strategy 2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*); ***strategy 3*** (*Providing feedback that moves learners forward*).

Since the lesson is almost over, the teacher decides to go on with the discussion in the subsequent lesson.

Lesson 2 is an example of the combination of the use of two functionalities of the technology (***sending & displaying*** and ***processing & analysing***) to foster the activation of different formative assessment strategies, as this diagram highlights:



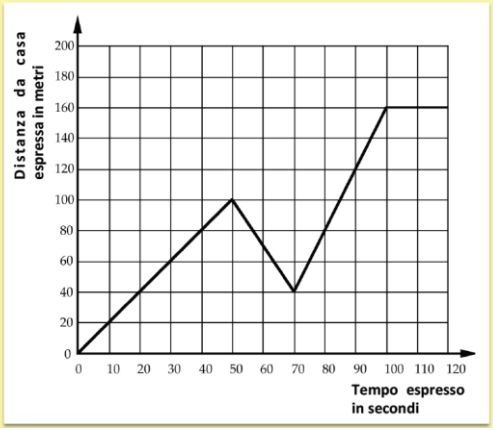
2.3 Lesson 3

The last episodes refer to lesson n. 4 (november, the 3rd). The lesson starts with the final part of discussion on worksheet 4 (the discussed had started in the previous lesson).
Here we recall the text of worksheet 4:

Does he walk for 160m? Why?

Scheda 4

Ogni mattina Tommaso cammina lungo una strada dritta, da casa sua alla fermata dell'autobus, che dista 160m da casa.
Il seguente grafico descrive come ha percorso ieri il tragitto.



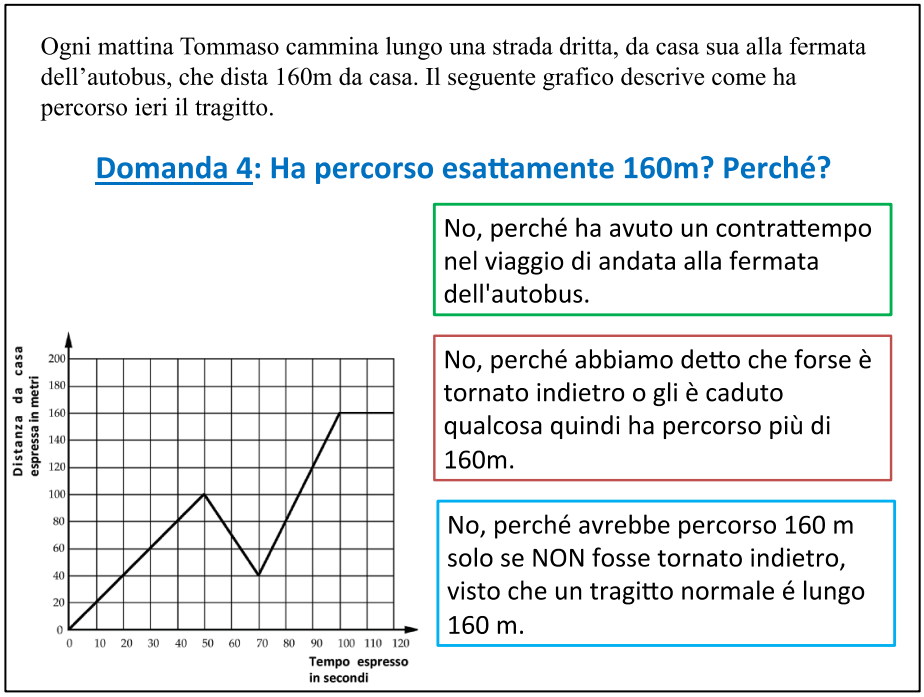
Domanda 4: Ha percorso esattamente 160m? Perché?

RISPOSTA:

Three productions, previously selected by the teacher and the researchers, are displayed at the whiteboard and the teacher involves the students in comparing them:

1. *No, because he had some unforeseen difficulty when going to the bus stop.*
2. *No, because we said that maybe he went back or he lost something and he walked for more than 160 meters.*
3. *No, because he would have walked for 160 meters only if he had not gone back, since the normal path is 160 meters.*

This is the file that was projected on the IWB:



The teacher promotes a comparison between the three answers. The students analyze them in terms of correctness and completeness of the information given.
The teacher in this way provides a ***feedback about the task*** and also the way of processing the task (how to justify the answer). The functionality of technology is ***sending and displaying***, since the discussion is performed on the displayed answers. The prevailing activated ***formative assessment strategies*** are ***2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*), ***1*** (*Clarifying and sharing learning intentions and criteria for success*), ***3*** (*Providing feedback that moves learners forward*). The ***teacher*** is the prevalent agent, but also the ***peers*** intervene to give feedback to their classmates.

Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback Transcript***
7) Teacher MT: OK, well, let's see… analogies or differences between these answers? If they are alike, if some of them says something more than the others, if you agree with them… Let's go! Do they all say the same? Yes, Paul?	The teacher promotes a comparison between the three selected answers, with the aim of fostering a reflection on what is a correct and complete justification. She poses a series of questions so as to involve all the students in a fruitful discussion (***strategy 2***: *engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*).
8) Paul: The last one says that the normal path is 160 meters.	
9) Teacher MT: What does it mean?	
10) Paul: That, if he had done the normal path without going back, he would have done 160 meters.	Paul points out that the last answer is more complete than the previous ones, because it compares the "normal" path to the actual path followed by Tommaso (***feedback about the task, given by a peer***).

11) Teacher MT: Because in the text, you remember what was written? That the bus stop…	
12) Paul: It is 160 meters far from home.	
13) Teacher MT: Then, if he had not come back, the last answer says "he would have done 160 meters"; the other answers instead, does the last one answer confirm what the other two say?	The teacher promotes a comparison between answers, in order to highlight what is the most complete.
14) Paul: It says something different.	
15) Teacher MT: Yes, Ur?	
16) Ur: It adds that anyway… it specifies that he (Tommaso) would have done 160 meters only in a normal path, if he had not had some unforeseen difficulty.	Ur is able to reformulate what Paul had already pointed out. We may say that Paul' ***feedback on the task*** was efficiently caught by Ur.
17) Teacher MT: OK, anyway it says that, it confirms that he had some difficulty and then, having come back, does it give exactly 160 meters or not?	
18) Mary: No.	
19) Teacher MT: No, because he (Tommaso) went back, then he walks more, for the fact that he went back. In the second answer there is a "maybe", do you think that "maybe" is necessary?	The teacher points out that the answer n.2 should not contain "maybe", since the fact that Tommaso went back is a sure information. Pointing out the use of the expression "maybe" she teacher gives a ***feedback about the task*** but also the ***processing of the task***, that is to say the way of organizing and presenting an explanation. The ***activated strategies*** are ***1*** (*Clarifying and sharing learning intentions and criteria for success*) and ***3*** (*Providing feedback that moves learners forward*).
20) Student: No, because we confirmed that he goes back.	
21) Teacher MT: we are sure about that, because it is the graph to tell us this, then that "maybe" should be taken away.	

Afterwards, two other sets of selected answers are displayed, compared and analyzed. The discussion focuses on the way of reading data from the graph and using them to calculate how much meters Tommaso actually walked. Rob observes that in the second trait Tommaso walks faster, since the segment is more inclined. Cate is not convinced and asks for clarification. The discussion moves to the comparison between the first and third trait. Rob and Paul, supported by the teacher, intervene to clarify this issue to Cate.

In this excerpt the functionality of technology at issue is ***sending and displaying***, since the discussion takes place in reference to the displayed answer (and text of the task). The peers are the prevailing agents, with the support of the teacher. The activated ***formative assessment strategies*** are ***2*** (*Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding*), ***4*** (*Activating students as instructional resources for one another), **5** (Activating students as the owners of their own learning*).

Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four***

	levels of feedback Transcript
134) Rob: At (50; 100) he goes faster.	
135) Teacher MT: After, he goes faster. Why, did we say? From what do we understand it?	
136) Rob: From the inclination.	
137) Teacher MT: From the inclination of the segment. OK, let's reason more on this point, those are things that we will use these observations: the inclination and the way of walking, OK? That is to say, how much space I do in how much time. Yes?	The teacher reformulates, so as to promote a reflection on the way of interpreting inclination in terms of speed. She gives a ***feedback on the task***.
138) Cate: But, teacher, I don't agree so much on the inclination, because for me if that graph represents, it represents that, at (50,100), 50 seconds are passed and he did 100 meters, of course the… line of the graph must be in that way, otherwise it doesn't get the point, and when Tommaso comes…	Cate expresses some doubts on Rob's answer. Cate activates herself as *owner of her own learning*, calling for a deeper understanding (***strategy 5***).
139) Teacher MT: It is when Tommaso comes back.	
140) Cate: And, if when he goes from 100 to 40, of course after it (the graph) must ascend in that way, because if he climbed more inclined to the right…	
141) Teacher MT (to Cate): Do you agree on the fact that Tommaso goes faster?	
142) Cate: Yes, but…	
143) Teacher MT: Are you saying that it is necessary that Tommaso goes faster?	
144) Cate: No, I don't agree on the fact that the line, that line represents the fact that he goes faster, because…	
145) Teacher MT: This trait? (*Pointing to the second trait*)	
146) Cate: The other one (*pointing the third trait*)	
147) Teacher MT: This one?	
148) Cate: Yes, because… Tommaso… for me the line must necessarily come… it comes to that point, 160… it comes to 160 meters and to 100 seconds, and then it must come to that point and it changes direction.	Cate is reconstructing the last part of the journey, looking at the graph. She points out that, since the bus stop is 160 meters far from home, once reached the distance of 160 meters, Tommaso must necessarily change his movement, and the graph changes the direction. Cate is struggling to make sense of the graph, disentangling the journey of Tommaso and the shape of the graph. Sometimes she seems to mix up the two issues, for instance in the last sentence it is not clear whether it is Tommaso or the graph to change direction.
149) Teacher MT: But your classmate… go on (to Rob)	

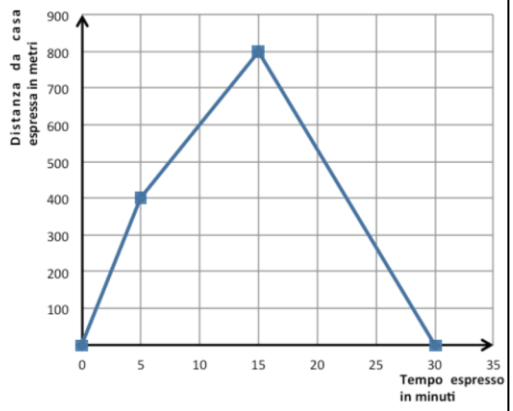
150) Rob: But they could, in order to show that Tommaso went slower, rather than making him arrive earlier and draw the straight line, to draw a oblique line that ended…	Rob, taking into account Cate's comment, explicitates that the graph could have had another shape, in correspondence to another journey. Rob is *activating himself as instructional resource* for Cate (***strategy 4***), but he is also taking advantage form Cate's comment to deepen his reflection on the graph (***strategy 5***).
151) Teacher MT: To make it to arrive exactly, you say? That is to say to come exactly at this point (*she points (120; 160)*), without stopping… But… Cate, you do not agree on the fact that this segment represents a greater speed.. let's try to answer, to convince you: Rob, what did you say?	The teacher encourages Rob, who had spoken about the inclination, to clarify this issue to Cate (***Strategy 4****: Activating students as instructional resources for one another*).
152) Rob: Because maybe they had to do… in order to show that Tommaso stopped… they also could have drawn the graph to the last square.	Rob goes on with Cate's comment on alternative drawings, rather than clarifying the issue of inclination.
153) Teacher MT: Yes, and we understood this, but now try to convince your classmate that this segment, having a different inclination from the first one, represents the fact that Tommaso went faster.	
154) Paul: In 10 seconds he does 40 meters.	
155) Teacher MT: In 10 seconds he does 40 meters? This? Please come to show it. Then…	The teacher encourages Paul to *activate himself ad instructional resource* for Cate (***strategy 4***)
156) From 70 to 80 seconds there are 20+20 meters.	Paul *activates himself as an instructional resource* for Cate and maybe also for Rob (***strategy 4***).
157) Teacher MT: Are you convinced by this, Cate?	
158) Cate: Yes.	
159) Teacher MT: In 10 seconds in the last trait he does 40 meters while before, Paul, in 10 seconds…	
160) Paul: In 10 seconds he does 20 meters.	
161) Teacher MT: Then, does it mean that I run, that I go faster than before, my speed changed, ok? Are you convinced?	
162) Cate: Yes.	

After the discussion, the students are invited to work on worksheet 6.

In Worksheet 6 the graph and the three corresponding stories are presented, with the following question: "*What is the story that this graph represents? Justify you answer.*"

Scheda 6

Qual è la storia rappresentata da questo grafico? Motiva la tua risposta.



Storia A: Tommaso esce da casa per fare una passeggiata con il suo cane. All'inizio cammina lentamente, poi più rapidamente. Arrivato al parco, decide di tornare indietro.

Storia B: Tommaso esce da casa con la sua bicicletta, percorrendo una strada che sale sopra una collina. All'inizio la strada e molto ripida, poi un po' meno. Arrivato in cima alla collina, scende giù dall'altra parte.

Storia C: Tommaso esce per fare una corsa. Alla fine della sua strada incontra un suo amico e rallenta per camminare un po' con lui. Dopo averlo salutato, torna a casa.

RISPOSTA:

The students work in group for about 22 minutes. Afterwards, there is a first discussion on some selected answers.
The first selected answer os the one by the group of Mil and Pon (two low achieving students).

> *For us the answer is B for two reasons:*
>
> *A. You cannot do 1600 meters by foot in half an hour*
>
> *B. The graph represents precisely the information given by the story. Then Tommaso climbs the hills, the first trait is the climb, the second is still a climb but less steep. When he comes to the top, then Tommaso climbs down and goes back home.*

They provide two reasons for the choice of story B: the first one is based on everyday life experience (they point out that it is not possible to walk for 1600 meters in half an hour), the second one is based on a wrong interpretation of the graph: they interpret the graph as the drawing of the hill, that Tommaso climbs and descends. For the teacher, the discussion of their production is the occasion for *establishing where the group and all the other students are, giving feedback about the task* (clarifying that the graph is a modellization of the journey and not the drawing of the hill) and *about the way of processing the task* (pointing out that the justification must be based on the anaysis of the information provided by the text and the graph, and not by everyday life experiences).
To this aim, the teacher promotes a discussion (***strategy 2***: Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding). More precisely, she encourages the other students to give Mil and Pon feedback (***strategy 4***:

activating students as instructional resources for one another). The other students, namely Rob, Lollo, Ur, Mark, Cate provide feedback that moves learners forward (***strategy 3***).
The functionality of technology is ***sending and displaying***, since the discussion takes place by starting form the analysis of the displayed written production of the group of Mil and Pon. The ***teacher*** is one agent of the formative assessment process, but also the ***peers*** activate themselves as agents.
Mario is asked to read the production of Mil and Pon; then the discussion starts.

Transcript	***Analysis according to the FaSMEd three-dimensional framework and the four levels of feedback Transcript***
217) Teacher MT: Then, answer B for two reasons. Ok, Lollo?	The teacher encourages the students to *activate themselves as resources* for Mil and Pon (***strategy 4***).
218) Lollo: We did, because… we did the experience with the motion sensor… that if the line was more oblique the… the line, if it was more oblique, it meant that he (*Tommaso*) went faster, it did not mean that the road was steeper, because if the road is steeper you go slower…	Lollo gives a ***feedback about the task***, suggesting that the different inclination of the segments should be interpreted in terms of different speed. To warrant his statement, he refers to the experience with the sensors. Lollo *activates himself as resource* for Mil and Pon (***stategy 4***). Lollo also adds that, when the road is steeper, usually one goes slower, and not faster, referring to everyday experience.
219) Teacher MT: Rob?	
220) Rob: This is a graph, it is not the drawing of the hill.	Rob explicitates that the graph does not represent the drawing of the hill, giving a ***feedback about the task*** to Mil and Pon. He *activates himself as instructional resource* for his classmates (***strategy 4***), *providing feedback that moves learners forward* (***strategy 3***).
221) Teacher MT: Tt is not the drawing of the hill, It is the graph that represents what?	
222) Rob: The… the journey of one boy, and anyway they told that it is not possible to do 1600 meters in half an hour, we already said it last time, it is a graph, it doen't have to be really real… really near to reality.	Rob also gives a ***feedback about the processing of the task***, pointing out that the justification must not rely on empirical arguments.
223) Researcher: Do you understand what he is saying?	
224) Mario: For me you can do it easily, you can even do 2 or 3 kilometers…	Mario challenges Mil and Pon's justification A, but on the basis of empirical experience.
225) Rob: For me yes…	
226) Teacher MT: Then, the fact of 1600 meters in half an hour, your classmate says that actually you can do it in half an hour, then that is not a good motivation. Somebody else was talking about the second motivation, motivation B, the fact that the graph explains us that Tommaso climbs the hill and so on. Lollo said: "No, because when we did the experience with the sensor we went on a oblique line, but the path we were doing was not on a hill, it was not steep".	The teacher synthetizes the interventions of Lollo, Mario and Rob, focusing in particular on justification B. She reformulates the intervention of Lollo, so as to give Mil and Pon a *feedback that moves them forward* (***strategy 3***).

227) Ur: Teacher, but I agree with what Lollo said. I thought that if it is steep you walk slowly, while after, when it becomes less steep, Tommaso goes faster.	Ur intervenes, referring to Lollo's intervention (218). Ur *activates herself as owner of her own learning* (***strategy 5***).
228) Teacher MT: But the fact that… you say: "the fact that the road is more or less steep can give us information on the reasons why he goes faster or slower"…	The teacher gives a quick feedback to Ur, reformulating her sentence, so that other students can intervene
229) Cate: But if the line of the graph ascends it does not mean that Tommaso climbs…	Cate *activates herself as resource for the others* (***strategy 4***).
230) Researcher: Rob said before… there is a difference between the graph…	
231) Student: Normal	
232) Rob: Between the graph and the drawing of the hill	
233) Teacher MT: The drawing of the hill, he says: "actually the drawing of a hill is different from that graph".	The teacher reformulates Rob'sintervention, so as to give a ***feedback on the task*** that can move the other students forwards (***strategy 3***).
234) Mark: Teacher, moreover with the sensor we told that if we went faster… the segment went more vertically, but here if… they say that it is on a climb and he goes too, he goes fast, and then when it becomes less steep he goes less fast… I don't know, in the descent he goes really faster than on the other two traits, but if they say that he climbs up in the first trait he goes faster and then when it starts being plane he goes less fast.	Mark intervenes making reference to the experience with sensors (thus linking the inclination to the speed) and pointing out that something doesn't work in what Mil and Pon wrote. Mark expresses his own doubts, but his intervention is also a *feedback* for Mil and Pon.
235) Teacher MT: But I… this answer really tells as if the first segment, the first two parts of segment that go up described the hill, the steep climb, the less steep climb, the top and after the descent…	
236) Student: That is wrong.	
237) Teacher: Then the idea that the segments, as Rob said… "the graph is different from the drawing of a hill", or Lollo said "when we did it with the sensors we saw this kind of segments but we were not climbing, it meant that we changed the speed"… Let's remember always that the y axis describes what? The distance from home in meters.	The teacher reformulates and synthetizes the interventions of the students, so as to give a feedback to Mil and Pon. The activated ***strategy*** is ***3*** (*providing feedback*).
238) Rob: Moreover, teacher, problems with graphs are done in order to reasons and understand what they represent, not to connect to reality, for instance a graph could maybe indicate that in 5 minutes he did 2000 kilometers, anyway the point is not what is represented… yes, but you have to understand how it is represented, in a sense.	Rob provides a ***feedback about the processing on the task***, pointing out that the justification must be based on the anaysis of the information provided by the text and the graph, and not by everyday life experiences.
239) Researcher: You say: I cannot rely on experience, on the fact that 600 meters cano not be done…	
240) Teacher MT: In half an hour maybe I could walk very slow and do just 1600 meters, there	

could be such a situation…	
241) Cate: As you said, teacher, here it is written that the y axis represents the distance from home in meters, we chose the C, but here it indicates that at the beginning, from 0 to 800 he (*Tommaso*) goes away from home and then after from 800 to 0 he goes back to home, because it descends.	Cate intervenes pointing out another (good) reason to refute story B: from the graph she sees that Tommaso finally goes back home, but the story does not say this. Cate turns herself as a resource for the mates (***strategy 4***), giving a fruitful ***feedback about the processing of the task*** (it is necessary to read all the information that are on the graph).
242) Rob: The sensor would be the house	
243) Teacher: Yes, the sensor would be the house. Then, what does it mean descending?	
244) Cate: Getting closer to home	
245) Teacher MT: Getting closer to home.	

In a subsequent part, the teacher goes back to the authors of the preceding answer (Mil and Pon), *to establish where they are*; in particular, she wants to check whether they understood the difference between the graph and the drawing of the hill.

308) Teacher MT: It is not the drawing of a hill. Mil, you were saying that… you are one of those who chose B.	
309) Mil: For me no option is correct because no answer says that Tommaso climbs down… the only one finally is the B, because it says "he descends on the other side".	Mili is still interpreting the graph as the drawing of the hill.
310) Researcher: Why, what do the other options say at the end?	
311) Teacher MT: He says "In the graph he does not go home". Then let's look at the graph.	The teacher intervenes, proposing to look at the information that are on the graph. She provides a *feedback* to move the students forward (***strategy 3***).
312) Ur: For me, on the contrary, yes, because anyway if… the line is to the bottom, it does not stop at…	Ur *activates herself as an isntructional resource* for Mil and Pon (***strategy 4***).
313) Teacher MT: After 30 minutes, at which distance from home hoes Tommaso is?	
314) Student: Zero	
315) Teacher MT: Zero meters, and what does it mean? Where is he?	
316) Mil: At home	
317) Teacher MT: At home	
318) Rob: But maybe he (*Mil*) got confused and thought that in order to come back home it (*the graph*) had to come back to the starting point	In this intervention, Rob tries to interpret Mil's previous misunderstanding. This may be seen as a ***feedback about the processing of the task***.
319) Researcher: Ah, you are interpreting what could have been Mil's doubt…	
320) Teacher MT: Mil's mistake. If you climb down, anyway, if you are on a hill and descend on the other side you do not come back home, but you get less close, while you were saying "he does not come back home, instead yes".	The teacher provides a ***direct feedback*** to Mil and Pon (***feedback about the processing of the task.***).
321) Mil: Because I…	
322) Teacher MT: Ok? This point says that Tommaso is	

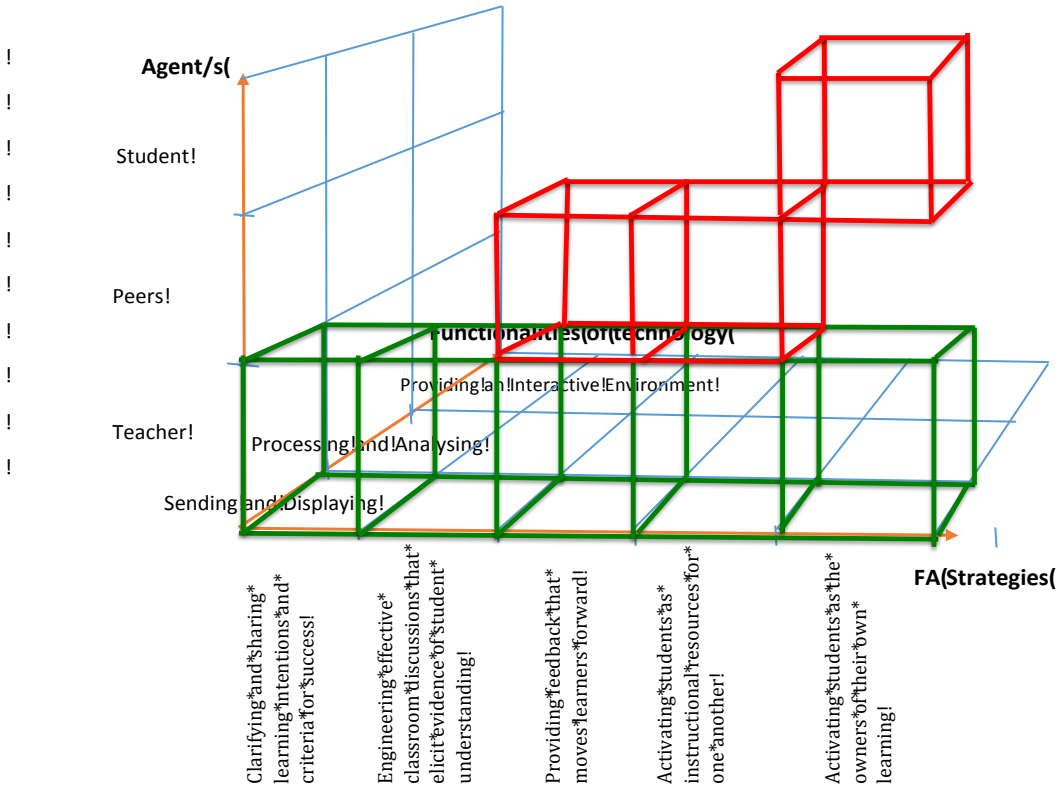
at zero meters from home, it means that I have to go back home, then it was already a reason for not choosing B, are you ok?	
323) Students: Yes.	

In a subsequent part, the discussion is again on the fact of referring to the experience with the sensors. Cate intervenes, calling for a more theoretical explanation. She is able to produce such an explanation by herself, drawing from the former feedback given to Mil.

330) Teacher MT: And moreover, with the experience with the sensor, Lollo says: also when we used the sensors we saw that line descending, but we were not descending or climbing, isnt't it? Tommaso was getting away from home, after he was getting closer to home, did we have climbs or descents? No, he did a straight road!	The teacher proposes to the students the intervention of Lollo concerning the experiences with sensors.
331) Cate: But, teacher, I wanted to say that if somebody had not done the experience with the… the…	Cate *activates herself as owner of her own learning* (***strategy 5***), calling for a clarification. She refers to the previous (see also the previous lessons) discussions on the value of the experience with sensors.
332) Teacher MT: Sensor	
333) Cate: Yes, the sensor. One could hypothesize that it was a hill, if he did not know it…	
334) Researcher: But what is that… wait, apart from the experience with the sensor, which is the information that is on the graph and that makes you surely refute B, independently from the hill?	The researcher intervenes, focusing again on the information coming from the graph that makes the story B non-acceptable. This is a ***feedback about the task***.
335) Cate: That when he comes to the bottom he is home. There (*on the text*) it says that he goes down on the other side.	

The discussion continues with a quicker analysis of the answers of those groups that chose A and C.
Since no group asked or was recommended to use the additional worksheet 6A, that contained the work on the table of data, the teacher decides to assign the worksheet as a homework, to be discussed in the subsequent sessions.

The following diagram highlights the effective activation, by the three agents, of **all the formative assessment strategies**, through the use of the **sending and displaying functionality of the technology** during lesson 3:


Agent/s(
Student!
Peers!
Teacher!
Functionalities(of(technology(
Providing!an!Interactive!Environment!
Processing!and!Analysing!
Sending!and!Displaying!
FA(Strategies(
Clarifying*and*sharing*learning*intentions*and*criteria*for*success!
Engineering*effective*classroom*discussions*that*elicit*evidence*of*student*understanding!
Providing*feedback*that*moves*learners*forward!
Activating*students*as*instructional*resources*for*one*another!
Activating*students*as*the*owners*of*their*own*learning!

3. Classroom teaching

In this paragraph we present teacher MT's point of view, reporting:
- her reflections on the three lessons documented in the previous paragraph (as answers to the interview we made after these three lessons);
- the final interview on general aspects of classroom teaching.

3.1 Interview on this series of lessons

The interview was carried out following a semi-structured interview. The teacher knew in advance the type of questions (they were used also for the first cycle of interviews), then she gradually moved from answering the questions to speaking about her perception on the lessons in a broader sense. For this reason, we report what she declared, organized by themes.

Concerning the planned and implemented teaching sequence:
The worksheets on Tommaso's journey were carried out with more awareness than in the first experimentation (with another class, without the preliminary experience with the motion sensor).
The first worksheet (worksheet 5) was carried out by all students; from the beginning they had clear in mind that what we read on the graph was the distance from home and not the journey.
Concerning our timetable, planned times were completely over.
A difference in comparison to the former experimentation is that we performed the discussion on the subsequent lesson, if possible. It is very useful to discuss in the subsequent lesson because we do a careful selection, choosing the criterion of increasing difficulty, then at first we point out that there is the production that says nothing, after the production that uses data, after the productions that speaks also of speed, gradually.
The selection done on the spot, on the contrary, is not so… careful. And also students answer better when the discussion is carefully prepared.

Concerning the use of technology (by herself and by the students)
With technology we had no problem; the students use tablets with more and more awareness, they do not get distracted, they understand that the software is used to select their answers; if we choose their answer they declare "it is mine" immediately. They take the responsibility of their production, while when we did only discussions there were some students that were not keen to narrate what they had done. Now, on the contrary, they recognize their production and want to share it with all the class.

Concerning students' processes and interventions
Besides recognizing and taking the responsibility of their production, they are able to point out the differences among productions, in an unexpected way. They catch the differences between texts, also those students that I would not expect (to be able). Student Mil, for instance, did some good intervention, and also Debby, who is not usually… she suffers from her discontinuity in frequency, but she is very intuitive and today she came back to school and she immediately understood the task even if she had not attended to the previous session.
Anyway all the students seem involved and they seem to understand what we are doing, the use of technology, the comparison of productions, they are all in the activity.

Some students intervene very much, other students only when directly asked, with some exception. I noticed that they try to find motivations for the mistake of the classmate. In general, they listen to each other more, and they answer to each other.
I noticed an increasing care in the choice of language and reflection on the use of words.
Low achievers usually did not write very much, instead here they write more and in this way it is also possible to give them a feedback.
In the passage to worksheet 6 they encountered some difficulties because they also had to take into account some elements that were not taken into account before, such as the speed, or measure units that were missing and so on.
When necessary, they always referred to the experience with the motion sensor. But they went further.

Concerning the different modalities of work
I think they got better in the group work, during the discussions also groups that last year were very silent intervened. They also got better in data presentation. They all wrote something.
Class discussion for me is the most productive moment.

3.2 Interview on general aspects of classroom teaching

1*. What is your educational background? How long have you been teaching? In this school? Why did you choose to become a teacher? What were the important steps in your professional career?*

I have a Degree in Mathematics.

I have been teaching since 1986. I have been teaching in the Istituto Comprensivo di carcare (IC Carcare) since 2005.

I obtained my certificate to teach Mathematics, Mathematics and Physics, Applied Mathematics (for upper secondary school) and Mathematics and Science (lower secodnary school). I obtained a permanent position as secondary school teacher in 2000. I moved to lower secondary school in 2004.

I have been tutor for national mathematics and science education projects since 2007.
I started my collaboration with university (University of Genoa) within the project "Language and argumentation in the study of mathematics" (since 2008).

I have been tutor for the national project "Interactive whiteboard" (LIM) since 2008.

I have been school responsible for the national project "Classi 2.0" since 2009.

I haves been school responsible for the Mathematics and Science Department since 2006.

2. Have you worked with (a) technology; and (b) formative assessment before? Please describe your experiences.

I had former experiences concerning formative assessment in the national projects I was involved and in the project on language and argumentation.

Within those projects, activities concerning basic concepts in mathematics were implemented; students' feedback was taken into account and collected, so as to promote teacher's reflective thinking and refinement of the activities themselves.
Moreover, teachers in my school have regular meetings to exchange ideas and compare what happened in their classrooms during relevant activities or new activities that were experimented for the first time. In this way, formative assessment takes place not only with students but also among teachers.

Concerning technology, I was involved in the project "Classi 2.0", funded by the Ministry of Education. My class was one of the 6 classes selected for my region. We planned and implemented activities with the use of new technologies in mathematics.
Within the project LIM, I acted as teacher educator for the use of interactive whiteboards in classroom.

3. In your own words, how would you describe formative assessment in maths and/or science?

Doing formative assessment in mathematics means to collect information on students' learning processes and development. Assessment is formative if the collected data are used by the teacher to improve his/her teaching so as to make it much effective as possible and adapted to those students in that moment.
Also the student, becoming aware of his/her learning process in comparison with that of his/her classmates, can evaluate himself/herself and the classmates, analyzing his/her process and shaping his/her reasoning in the way that is more adapted to the context.

4. How do you use it/them now? Please describe.

The continuous discussion I promote in classroom and the feedback I collect from my students allow me to adapt my planned teaching to my students.

5. What are the advantages/disadvantages of using FA and ICT in maths & science lessons?

I think that formative assessment in mathematics is necessary in order to carry out teaching activities that are meaningful and effective for the learning of contents and the development of reasoning.
The use of ICT, besides proposing tools that are familiar to the social reality of students, allows us to involve in the best way those students that are less motivated.
The use of specific ICT fosters the understanding of some concepts (in geometry, in graphical representations, in the use of specific functions). Moreover, having a connected classroom at disposal for the real-time exchange of documents, it is easier and faster for the teacher to assess the processes and adapt his/her teaching, and for the students to see and reflect on their activity.
Technical difficulties, unavoidable moments of lost time, different individual abilities in the use of technology, habits linked to the everyday life use of technology may create critical moments during the lessons. Moreover, the lack of technical support at school makes the preparation and maintenance of devices more difficult.

6. What are the affordances, and the constraints?

The affordance is the fact of having at disposal for the analysis complete and exact information on processes.
The constraints are the technical difficulties.

7. What are important features of your teaching?

My teaching is based on a clear didactical contract, shared with the students and their families. At the basis there a mutual, continuous and deep respect, that engenders a quiet and ordered classroom climate.
Students are continuously encouraged to take part to the lesson and the evaluation is done on the process rather than on the product.

I try to be always helpful and I introduce the concepts starting from situations that are meaningful for the students. I encourage students to search for their own ways of learning and I try to avoid frontal lessons. I like using varied strategies and adapt my teaching to the class.
I take inspiration from y activities from various sources and modify them, trying to be innovative as much as possible every year.

8. Which way/s of teaching do you consider effective?

I consider effective ways of teaching that are varied, so as to foster different types of intelligence. In general, I consider effective the following sequence of activities: individual work; comparison in small group; classroom discussion (which is, for me, the most efficient way of working in class).

9. How do you support your students in class, in particular when they do not know how to progress/go on?

I do not give ready-made solutions, but I try to analyse with them the situation, to clarify what is asked and guide them in the search for the most adequate strategies.

10. What are the difficulties that students experience, in your view?

Students in general have difficulties in becoming aware of their thinking modalities. Common misconceptions concerning mathematics lead them to look for simple ways and apply routine procedures. This leads to the well-known difficulties when it is necessary to apply knowledge in different contexts.
Moreover, linguistic difficulties, that are still widespread at this age, make the communication non precise and non efficient.

11. What are the important activities for your students in your class?

The most important activities are those that are meaningful and motivating for the students.
In general, I consider important those activities that are adapted to their age, their background and their interest, and emotionally involving.

12. Which resources, and teaching strategies, have you found particularly useful when teaching maths/science?

I think there is not a resource or teaching strategy that is more useful than another; rather, there is a resource or teaching strategy that is more adapt in a given moment, for a given class, for a givent content to teach.

13. What is important for students to learn in maths/science?

It is important that students learn the modalities and power of rational thinking.

14. How do you deal with the heterogeneity in your class; how do you attend to individual pupils' needs?

I often organize work in small homogeneous groups (students of the same group have the same level). In this way, when difficulties emerge I can help all the students of the group, through the comparison with the mates during the collective discussion.
During individual work I try to monitor continuously the individual processes, in order to intervene in a focused way.

15. What do you do when students make mistakes? Give examples.

I try to understand the causes of the mistakes, in order to intervene directly on the misunderstanding the caused the mistake. I give further examples or similar situations in order to make the mistake clear and help the student to overcome it.

4. Pupils' perceptions

For the general presentation of the Q-sorting activity, see paragraph 5.1 of the Case study 1 (Garino).

4.1 Analysis of the Q-Sorting activity

The groups for the Q-sorting activities were formed keeping together the students with similar level, if possible. We present here the Q-sorting of a medium-high achieving group (group A) and of a medium-low achieving group (group B).

4.2.1 Group A (medium-high achieving students)

Group A is constituted by the pair Mark and Mario and the pair Paul and Brown.
They are all medium-high achievers. Mario is a high achiever but, in the teacher's words, very "scholastic": he is high performing in procedural mathematics, less brilliant (and less involved) in laboratory activities, group work and discussions. During the FaSMEd activities he performed well in groupwork, but intervened rarely (only if encouraged by the teacher). In terms of formative assessment strategies, we may say that he never turned into an instructional resource for his peers.
His groupmate Mark is a good student and did some good interventions during the activities.
The students of the other group (Paul and Brown), who have a medium level, were very involved during the activities. They enjoyed the work, discussed a lot among them and intervened during class discussions.

In the first Q-sorting activity (*view on mathematics*), they organized the cards in the following way:

Completely disagree	***Not completely agree***	***Completely agree***
Mathematics is best learnt in collaboration with others.	I learn things quickly in mathematics.	Mathematics is something everybody can learn.
In mathematics there is no time for reflection.	Mathematics is difficult	Mathematics needs a lot of memorising.
I am nervous in mathematics lessons.	When I do not understand (in mathematics) I ask for help.	Everybody can learn mathematics if s/he works hard enough.
In mathematics there is no room for expressing one's own ideas.	Mathematics means exploring and experimenting.	Answers in mathematics are either right or wrong.
To learn mathematics it is necessary to solve many of the same tasks.	If I cannot solve a task, I become frustrated and give up.	I like mathematics

Only gifted people understand mathematics.	In mathematics there is only one right answer.	I am good at mathematics
	When I work on my own I learn better	Mathematics is fun
		Mathematics is a subject where one can be creative.

Looking at the columns, we may grasp a general positive attitude to mathematics in terms of emotional disposition and self-perception in reference to mathematics ("I like mathematics", "I am good at mathematics"). They also agree on the fact that everybody can learn mathematics.
The view of mathematics that emerges from their choices is promising: they agree on the fact that in mathematics there is room for creativity and for expressing one's own ideas, and recognize that doing many exercises of the same kind is not necessary. Anyway, they also agree on the fact that it is necessary to memorize timetables, formulas and so on.
There is a long discussion on the fact that in mathematics there is only one right answer (Paul: *"1+1 can not be 3!"*).
Referring to the graph tasks, they point out that more than one answer was possible.

The "Not completely agree" column is mainly due to the fact that Mario does not agree with the other mates. For instance, he strongly affirms that he prefers working by his own.

Concerning the technology used in the FaSMEd project, the students organize the cards in the following way:

Completely disagree	***Not completely agree***	***Completely agree***
When I work with IDM-Tclass during mathematics lessons, I quickly understand if and why I am wrong.	Using IDM-Tclass during mathematics lessons helps me to better understand the objectives of the activities	Working with technologies in mathematics is useful.
I never remember what to do when I use IDM-Tclass during the mathematics lessons.	If I work with friends and IDM-TClass, we can find the answers.	My friends help me to work things out, or the teacher, but not IDM-TClass.
When I work with IDM-Tclass it takes me twice as long, and cannot ask the teacher directly.	Since we use IDM-Tclass I got quicker through the exercises.	
For me, the technology does not work, or help.	When I work with IDM-Tclass during mathematics lessons, I better understand what I have to do to improve my	

	understanding	
Using IDM-Tclass during mathematics lessons helps to understand what the teacher wants us to learn.	I feel that the teacher knows much better where we are and whether we need some help, when she uses IDM-TClass.	
When I work with IDM-Tclass it takes me twice as long, and cannot ask the teacher directly.		

In general, they recognize that working with the software is useful and not difficult, but do not attribute to technology "per se" all the power and advantages. They even put in the "completely disagree" or "not completely agree" column many sentences referring to the link between software and formative assessment not because they do not recognize the usefulness of the software, but because they cannot ignore the other influent factors: the kind of activity and the contributions of the teacher and the peers.
For instance, Brown points out the importance of class discussions:

> Brown: It is the discussion that makes you learn, not the sofwtare. Everybody explain his reasoning and you learn more.

Mark is very efficient in describing the formative assessment ***strategy 3*** (*providing feedback that moves learners forward*) that takes place during the class discussion:

> Mark: On the tablet you get the worksheet, you solve it and you don't know whether it is right or wrong. When you do the discussion you can understand whether you did right or wrong.

Brown and Paul recognize the importance of having the peers at disposal and getting their feedback:

> Paul: in order to understand you need somebody that explains you.
> Brown: and the comparison with others and the moment when you listen to the other opinions are the most important because you understand what the other people think and you don't stay alone in your own logic, you can see the logic of other people and maybe put all together and understand what is right and what is wrong.

The students also appreciate very much the fact of working in group:

> Brown: working in this way is useful because you understand what other people think. Even if we always quarrelled, if I did a mistake he corrected me and if he did a mistake I corrected him and even if there was a quarrel at the end we came to an answer that we felt correct.
> Paul: it was the groupwork.
> Amato: yes, also for me. It depends on your groupmate, he can make you understand if you did wrong or correct you or you can correct him, or your mates.

4.2.2 Group B (medium-low achieving students)

Group B is constituted by the pair Lollo-Lola and the pair Mil-Pon.

Lollo is a low-medium achiever. During the FaSMEd activities, he intervened a lot, trying also to activate as owner of his learning process and, when possible as resource for the classmate. Lola is a good student and she did some interesting interventions, although not so frequent. Mil and Pon are low achievers. Their written productions were often selected by the teacher and the researcher for the class discussion, so as to give them some feedback about the task and the way of processing it.

In the first part of the interview, the students worked on the set of cards on mathematics, producing the following categorization:

Completely disagree	***Not completely agree***	***Completely agree***
I am good at mathematics	When I do not understand (in mathematics) I ask for help.	Mathematics is difficult
Mathematics is a subject where one can be creative.	Mathematics is fun	I learn things quickly in mathematics.
In mathematics there is no time for reflection.	In mathematics there is only one right answer.	Mathematics is something everybody can learn.
In mathematics there is no room for expressing one's own ideas.		Only gifted people understand mathematics.
If I cannot solve a task, I become frustrated and give up.		Mathematics needs a lot of memorising.
Mathematics means exploring and experimenting.		To learn mathematics it is necessary to solve many of the same tasks.
		I like mathematics
I am nervous in mathematics lessons.		Answers in mathematics are either right or wrong.
		Mathematics is best learnt in collaboration with others.
		Everybody can learn mathematics if s/he works hard enough.
		When I work on my own I learn better

In general, a complex attitude towards mathematics emerges. Emotional disposition towards mathematics is good (they do not agree on the fact mathematics makes them nervous or frustrated; they affirm that they like mathematics), but the self-confidence is not high (they affirm they are not good at maths). They accept that in mathematics one can be creative and

express his own idea, which can be linked to the specific didactical contract of the classroom, where discussion is usually performed and argumentation is valued. Anyway, for them learning mathematics requires a lot of exercise, and this could be linked to a procedural view of mathematics.
The sentences on the "not completely agree" column are due to the fact that Lola has a better relation to mathematics (she thinks mathematics is fun) and affirms that, when in difficulty, she prefers not to give up and try to solve the problem by herself. This may be linked to formative assessment strategy 5 (activating as owner of her learning process).

> Lola: for me it is better to do again by your own rather than asking for help. Because maybe the other are able to do it, and when you have a difficulty and cannot ask for help you don't know what to do.

The fact that in mathematics there is only one right answer is discussed by all the students, and they conclude that it depends on the activity.

Concerning the way of working in class, the students agree on the importance of working in collaboration:

> Lollo: it depends from the classmate with whom you collaborate. If you are with somebody who is good…
> Mil: also with somebody of the same level, because if you think something and the other thinks another thing…
> Lola: together you understand what is right.

Interestingly, they also say that they understand better by their own.

They also report very positive comments on class discussions. This is maybe linked to the fact that low achieving groups received a lot of feedback during class discussion.
We report a short excerpt from the interview, so as to point out the way they perceive the feedback they receive from their peers (strategy 4 of formative assessment):

> Researcher: Are discussions useful?
> Mil: yes, because you hear the opinions of the other students and you understand what was wrong in what you did, and you come back on that point and you learn how to reason.
> Lollo: Cate during the discussions was always raising her hand and sayng that our answers were wrong!
> Researcher: did she say simply that you did wrong?
> Lola: well, maybe for her something of what we did was right and something was wrong, and she corrected us.
> Researcher: but when she raised her hand what did you feel? "Oh my god, Cate is going to say something more" or "thanks god cate is going to help us"?
> Lola and Lollo: she is going to help us!
> Researcher: was there some occasions when you thought: "I'm going to intervene to help somebody to understand… "
> Lollo: yes, to Cate!
> Researcher: and the contrary, I don't intervene because I'm not sure…
> Lollo: no.

Concerning the use of the software during FaSMEd activities, this is the way they organized the cards. We point out that there were no cards in the "not completely agree" column.
The categorization was very quick. They did not agree with all the sentences referring to the difficulty or lack of utility of technology. In comparison to the first Q-sorting group of students, they tended to attribute a larger importance to the software.

Completely disagree	***Not completely agree***	***Completely agree***
When I work with IDM-Tclass during mathematics lessons, I better understand what I have to do to improve my understanding		Working with technologies in mathematics is useful
Using IDM-Tclass during mathematics lessons helps to understand what the teacher wants us to learn		If I work with friends and IDM-TClass, we can find the answers
My friends help me to work things out, or the teacher, but not IDM-TClass		I feel that the teacher knows much better where we are and whether we need some help, when she uses IDM-TClass
When I work with IDM-Tclass it takes me twice as long, and cannot ask the teacher directly		Using IDM-Tclass during mathematics lessons helps me to better understand the objectives of the activities
I never remember what to do when I use IDM-Tclass during the mathematics lessons		