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This contribution is framed in a European project on the use of technology to foster formative assessment strategies (FaSMEd project) and addresses the crucial issue of feedback therein. The theoretical framework refers to formative assessment, with specific focus on different levels of feedback. By analyzing data from teaching experiments in grades 5 and 7, we identify strategies employed by the teacher to provide feedback during class discussion and investigate the effect of such strategies on the enactment of formative assessment.

Keywords: formative assessment, technology, feedback, teacher, peers.

Introduction and theoretical background

Formative assessment and feedback

This contribution is framed within the European Project FaSMEd ("Improving progress for lower achievers through Formative Assessment in Science and Mathematics Education"), aimed at investigating the use of technology to promote formative assessment (FA) practices in the mathematics and science classroom. FA is conceived as a method of teaching where

> "[...] evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited" (Black & Wiliam, 2009, p. 7).

Wiliam and Thompson (2007) describe five key FA strategies: (A) Clarifying and sharing learning intentions and criteria for success; (B) Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding; (C) Providing feedback that moves learners forward; (D) Activating students as instructional resources for one another; (E) Activating students as the owners of their own learning.

Feedback is a crucial issue in FA. Hattie and Temperley (2007) define feedback *as* "*information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding*" (p.81) and identify four *major levels of feedback*: (1) feedback *about the task* (concerning how well a task is being accomplished or performed); (2) feedback *about the processing of the task* (concerning the processes underlying tasks or relating and extending tasks); (3) feedback *about self-regulation* (concerning the way students monitor, direct, and regulate actions toward the learning goal); (4) feedback *about the self as a person* (consisting in positive (and sometimes negative) evaluations and affect about the student). Hattie and Temperley also point

out that feedback is a consequence of specific actions and that *can also be sought by students, peers, and so on, and detected by a learner without it being intentionally sought*." (p.82).

Enhancing formative assessment: technology and tasks

Specific theoretical and methodological assumptions of the Italian team (the three authors) within FaSMEd concern the importance of fostering students' development of ongoing reflections on the teaching-learning processes, and helping students to make their thinking visible (Collins, Brown and Newmann, 1989), sharing their ideas with the teacher and the classmates. These basic assumptions entail specific choices concerning the technology and the tasks.

Concerning technology, each class is equipped with a Connected Classroom Technology (CCT) through which the students' tablets and the teacher's laptop are connected. In order to foster collaboration and sharing of ideas, students are asked to work in pairs or in small groups on the same tablet. By means of the CCT equipment, students are able to receive worksheets from the teacher, send back their written answers, and answer to instant polls proposed by the teacher; the teacher can easily collect the students' opinions and reflections during or at the end of an activity, as well as the written answers, and receive the statistics concerning the answers to the polls. The teacher's computer is connected to an Interactive White Board (IWB) or a projector, so that it is possible to select and display written productions and the results of polls.

Concerning the tasks, students are asked to work on sequences of activities with a strong argumentative component: they are required to provide their answer and explain it in a written text. In this way, they are encouraged to make their thinking visible and to provide the teacher and the peers with a written text that will be shared and analysed during mathematical discussions (Bartolini Bussi, 1998). The mathematical content at issue is relationships and functions, and their different representations (symbolic, tabular, graphic). Activities are adapted from the ArAl project (Cusi, Malara & Navarra 2011) and The Mathematics Assessment Program (http://map.mathshell.org).

Summing up, the typical lesson starts with a peer activity on one worksheet. After having collected all the students' written answers, the teacher promotes a class discussion, starting from the analysis of some written answers (selected and displayed on the IWB). The discussion concerns the task level (correct answers and typical mistakes), the task processing level (effective ways of approaching the task) and the communicative level (effective ways of communicating the answer and the explanation). Comparison between different solutions is especially promoted. For further details on the organization of the lessons, see (Cusi, Morselli and Sabena, 2016).

Previous results and the current research questions

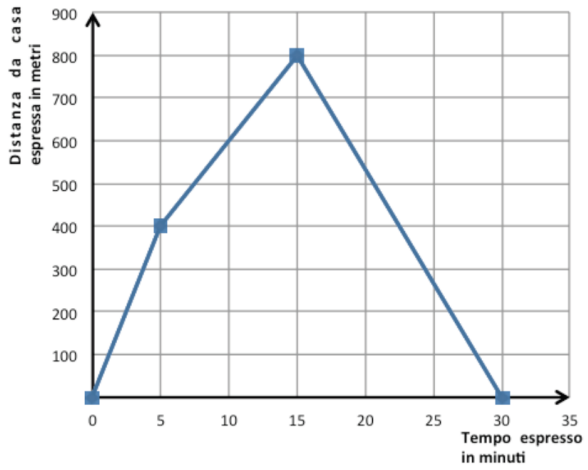
In former studies (Cusi, Morselli and Sabena, 2016) we analysed classroom discussions performed within the FaSMEd teaching experiments, and highlighted that CCT may support the activation of FA strategies by the teacher, by the peers (peer assessment), and by the student himself (self-assessment). In this contribution we focus on *strategy C* (*providing feedback that moves learners forward*) and we investigate: what are teacher's strategies that may foster FA strategy C; which level of feedback is provided; what are the effects of this strategy (in terms of activation of other strategies such as D and E).

The context

In Italy the FaSMEd project involved 20 teachers, from three different clusters of schools located in the North-West of Italy (from grade 4 to grade 7). During all the teaching experiments, one of the authors was present in the classes with the teachers, acting as a participant observer. The analysis is based on video-recordings of the classroom discussions, with the help of written transcripts and field notes by the participant observer (one of the authors).

Analysis

By analysing several episodes from the teaching experiments, we came to a first characterization of teacher's feedback strategies, that is the ways in which she gives feedback to students. In the subsequent part, we provide a short example for each kind of feedback strategy, highlighting the level of feedback provided. Moreover, we will discuss the effects of each feedback strategy in terms of activation of FA strategies. All the examples come from the third lesson on time-distance graphs, performed in grade 7. The lesson sequence on time-distance graphs (about 20 hours, 8 worksheets) was adapted from the Mathematics Assessment Program (http://map.mathshell.org) and was introduced by an experience with a motion sensor, which provided instantaneous graphical representation of a linear motion performed by the students. This lesson was chosen because it contains all the typical teacher's feedback strategies that recurred in different classes and grades in our teaching experiments. Here we refer to worksheet 6, where a graph and three possible stories are presented:



Story A: Tommaso took his dog for a walk to the park. He set off slowly and then increased his pace. At the park Tommaso turned around and walked slowly back home.

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

Story C: Tommaso went for a jog. At the end of his road he bumped into a friend and his pace slowed. When Tommaso left his friend he walked quickly back home.

The students are asked to answer to the following question: "*What is the story that this graph represents*? *Justify you answer.*" Students work in pairs and send their written answers to the teacher's computer, as soon as they feel ready. The teacher, together with the participant observer, reads the answers as they arrive at her laptop and selects some of them for the discussion. The first selected answer is the one by the group of Mil and Pon:

"For us the answer is B for two reasons:

1. You cannot do 1600 meters by foot in half an hour

2. 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".

We may observe that Mil and Pon highlight two reasons for the choice of story B: the first one is based on *everyday life experience* (they draw from the graph the information that 800+800 meters are walked, and they point out that it is not possible to walk for 1600 meters in half an hour; since it is actually possible to walk 1600 meters in half an hour, this argument is wrong), the second one is based on a *wrong interpretation of the graph*: they interpret the graph as a picture of the hill, that Tommaso first climbs up and then descends down. For the teacher, the discussion of students' production is the occasion for *giving feedback on two levels: about the task* (clarifying that the graph *represents* the relation between distance from home and time, and is not a picture of the hill, so it does not share with it any resemblance, in principle) and *about the way of processing the task* (pointing out that the justification must be based on a careful analysis of the information provided by the text and the graph). To this aim, the teacher promotes a discussion (*strategy B*). Mario is asked to read the production of Mil and Pon, then the discussion starts.

Transcript	**Analysis**
217. Teacher: Then, answer B for two reasons. Ok, Lollo?	The teacher encourages the students to activate themselves as resources for Mil and Pon (strategy D).
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 (strategy C), 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. He activates himself as resource for Mil and Pon (strategy D). He also adds that, when the road is steeper, usually one goes slower, and not faster, referring to everyday experience.
219. Teacher: Rob?	
220. Rob: This is a graph, it is not the drawing of the hill.	Rob makes explicit 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 D), providing feedback about the task (strategy C).
221. Teacher: It is not the drawing of the hill, it is the graph that represents what?	The teacher encourages Rob to make explicit his comment to Mil and Pon's answer. This intervention is a **relaunching**: she poses another question, linked to Rob's intervention, with the aim of deepening the analysis. Relaunching Rob's intervention the teacher implicitly gives a feedback (strategy C) to Rob himself, suggesting that his intervention is worthwhile.

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 [*he refers to the lesson with motion sensors*], it is a graph, it doesn't have to be really real… really near to reality.	Rob gives a feedback (strategy C) about the processing of the task, pointing out that the justification must not rely on empirical arguments but on the interpretation of the task. The teacher's **relaunching** is efficient in turning Rob's former intervention, which provided a feedback about the task, into a meaningful feedback about the processing of the task.
223. Observer: 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, on the basis of empirical experience. Mario is giving a feedback on the task (strategy C): the first answer relies on a wrong argument.
225. Rob: For me yes…	
226. Teacher: 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, stressing that the justification 1 is not correct. Then she shifts the focus on justification 2, focusing on the correct interpretation of oblique lines within a time-distance graph. In this way, she activates strategy C, giving Mil and Pon a feedback about the task (it is a mistake to interpret the task as the picture of a hill) and the processing of the task (focusing on the ways in which the time-distance graphs should be interpreted). Here we may see instances of both **rephrasing** (the teacher reformulates some arguments so as to make them more intelligible to the mates) and **revoicing** (the teacher revoices some of the students' interventions, so as to draw the attention on specific effective parts of the given arguments).
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 first intervention (218). Ur activates herself as owner of her own learning (strategy E). This intervention confirms that Lollo became a resource for his mates.
228. Teacher: 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. This is again an example of **rephrasing**.
229. Mark: Teacher, moreover we told that with the sensor if we went faster… the segment went more	Mark intervenes making reference to the experience with sensors (thus linking the inclination to the speed)

vertically, but here … they say that he is climbing and he goes too much… he goes fast, and then when it [the segment] 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 fast, and then when it starts being plane he goes less fast. […]	and pointing out that something doesn't work in what Mil and Pon wrote: in their interpretation of the graph as a picture the first trait is the steeper part of the hill, but in the interpretation of the graph in terms of speed (as in the previous experience with the motion sensors) the segment is steeper when the speed increases. Mark expresses his own doubts about the two contrasting interpretations: in reference to everyday experience, it is not so common to walk faster in the steeper trait of a hill. Mark's intervention is an instance of strategy E, but his intervention could also act as feedback for Mil and Pon (strategies C, D).
234. Teacher: But I… this answer really tells that the first segment, the first two parts of segment that go up describe the hill, the steep climb, the less steep climb, the top and after the descent…	The teacher goes back to Mil and Pon's written answer, so as to foster the comparison between their answer and the intervention of Mark. By **contrasting** in this way the two answers, the teacher is implicitly giving a feedback to Mil and Pon (strategy C) and turning Mark as instructional resource for them (strategy D).
235. Student: That is wrong.	This intervention confirms that the contrasting was efficient in fostering the comparison between the different positions of Mark and Mil and Pon.
236. 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 intervenes with a **rephrasing**: she teacher reformulates and synthetizes the interventions of the students, so as to give a feedback to Mil and Pon. The activated strategy is C (providing feedback). In this way she is efficient in turning the feedback about the task into a feedback about the processing of the task (she draws the attention on the meaning of the two axes). We call this kind of intervention a **rephrasing with scaffolding**, since the teacher, besides rephrasing, adds some elements to guide the work on the graph.

Results and discussion

Within the FaSMEd project, we performed several teaching experiments in grades 5 to 7, setting up task sequences and proposing them in a CCT environment. As a first result (Cusi, Morselli and Sabena, 2016), we showed how technology may support the activation of several FA strategies. In the current paper we focused on FA strategy C (providing feedback) and explored the ways in which the teachers may intentionally provide feedback during class discussions, the kind of feedback that is provided and the possible links with FA strategies.

The analysis of several class discussions performed during the teaching experiments led us to identify typical strategies employed by the teacher to provide feedback. Such strategies are exemplified in this paper through the analysis of a class discussion in grade 7. Here we summarize the strategies and discuss further developments of our study. The first strategy is **revoicing**, that occurs when the teacher mirrors one student's intervention so as to draw the attention on it. Often, during the revoicing, the teacher, stresses with voice intonation some crucial words of the sentence she is mirroring. **Rephrasing** takes place when the teacher reformulates the intervention of one student, with the double aim of drawing the attention of the class and making the intervention more intelligible to everybody. Rephrasing is applied when the teacher feels that the intervention could be useful but needs to be communicated in a better way so as to become a resource for the others. We also found special instances of rephrasing, when the teacher, besides rephrasing, adds some elements to guide the students' work. Drawing from Wood, Bruner & Ross (1976) the term "scaffolding", we call this special strategy a **rephrasing with scaffolding.** The revoicing and rephrasing strategies are used to activate strategy D, since they turn one student (the author of the intervention) into a resource for the class. Moreover, we observed that often revoicing and rephrasing (and rephrasing with scaffolding) are efficient in promoting the evolution of the kind of feedback, for instance (as in the reported example) from a feedback on the task to a feedback on the processing of the task. **Relaunching** occurs when the teacher reacts to a student's intervention, which (s)he considers interesting for the class, not giving a direct feedback, but posing a connected question. In this way, by relaunching the teacher provides an implicit feedback (strategy C) on the student's intervention, suggesting that the issue is interesting and worth to be deepened or, conversely, has some problematic points and should be reworked on. **Contrasting** takes place when the teacher draws the attention on two or more interventions, representing two different positions, so as to promote a comparison. By contrasting, FA strategy D and E are activated (the authors of the two positions may be resource for the class as well as responsible of their own learning).

The aforementioned strategies, besides being efficient ways to boost the discussion, are powerful formative assessment tools, since they foster the activation of formative assessment strategies. When addressing one student's statement, the teacher gives an implicit feedback on it (strategy C), suggesting the intervention deserves further attention. Moreover, in this way strategies D and E are activated and the feedback may evolve from feedback on the task to feedback on the processing of the task. We deem that this kind of classification may shed light into the crucial role of the teacher in enhancing FA within class discussions. All the documented strategies seem to be intentionally applied by the teacher. Anyway, the given feedback is implicit, since the teacher does not address directly the correctness of the student's intervention. As a consequence, the feedback is not always sought by the students. We are aware of the fact that we were able to single out and discuss only some effects of a given feedback, namely when a student explicitly refers to a previous intervention or changes his mind immediately after an intervention by a peer or by the teacher. Other effects of a given feedback are less visible during a class discussion: in order to study them, it will be necessary to analyse further activities of the students or collect a-posteriori interviews.

For the moment we focused on class discussions around the analysis and comparison of students' written productions. In the future we plan to go on with our analysis, focusing on other crucial

moments of the teaching experiments, such as the discussion after a poll, or the discussion on specific helping worksheets. As a further development, we plan to compare the strategies we outlined with Bartolini Bussi (1998)'s classification of teacher's interventions during a mathematical discussion. Moreover, we aim at complementing the present study, concerning the *way* feedback is given (feedback strategies), with a study on the *content* of feedback. To this aim, we plan to deepen the categorization of levels of feedback provided by Hattie & Temperley (2007), so as to take into account the specific features of the proposed mathematical tasks.

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