FAMT&L

FORMATIVE ASSESSMENT IN MATHEMATICS FOR TEACHING AND LEARNING

Work Package 3 - *Educational/learning needs analysis: practices of teaching and formative assessment of the mathematics' teachers*

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1. Introduction: formative assessment in mathematics teaching and learning

Recent international researches (OCSE/OECD, 2012; 2015; Eurydice, 2012), show a very diffused crisis in mathematics education, in particular in secondary school. In many studies it is highlighted "good teaching" as an important variable that affects students' results (Fenstermarcher & Richardson, 2005): many researches show that using different teaching methods has a substantial impact on students' outcomes (Kane et al., 2011; Hattie & Anderman, 2013). In mathematics teaching it is particularly important, because in this teaching discipline there are more gaps in the use of innovative teaching methods to foster students' learning and the use of strategies as formative assessment and feedback become very useful (Hattie & Tymperley, 2007; Hattie, 2009; 2012).
In particular, formative assessment in classroom – aimed to monitor, regulate, support and promote each student's learning process –is a useful tool to ensure good quality of teaching because its correct use both at the beginning and during the process of teaching-learning, can point out students' learning difficulties and then allows to change teaching actions according to the objectives and aiming a good level of teaching equality (Bloom, 1968; Vertecchi, 1976; Black & Wiliam, 1998; Weeden et al., 2002; Guskey et al. 2005; Crahay, 2013).
In international scientific debate, the main function attributed on formative assessment (FA) is to be an assessment *for* learning (Allal, 1993; Weeden, Winter & Broadfoot, 2002) because it helps the teacher to gather information, to improve and make her/his teaching more effective by following the students' needs.
Furthermore, it focuses on the "errors" of the student and of the teacher, but considers them as *resources* for the design and re-design of interventions in order to achieve teaching objectives.
The assessment practice requires three steps of actions (Gattullo, 1967):

- a cognitive representation of which data we want to collect ("what we are trying to measure");
- the gathering of data, by empiric observation ("how we collect evidence");
- an interpretation of the data ("how we make sense of the evidence").

These considerations, in this report, help to highlight the importance of teacher practices in classroom: the moment in which the data on the students' results are collected and analysed, the phase of interpretation of data, the actions done for feedback, etc.

2. FAMT&L research: information about teaching practices

Traditionally, the assessment of mathematical learning in school practices, is oriented to a summative function, performed by means of written open tests and oral-at-the-blackboard interviews. Therefore, it is an assessment focused mostly on students' *products* (results of calculations, presentations of proofs etc.), contrasting, formative assessment is mainly focused on the students' *processes*.
In many studies, and FAMT&L research confirmed, it emerges that mathematics teachers have no formative assessment tradition and there is no systematic presence of it in their pre-service training, and it is sporadic also in in-service training.
In our research, it has been very important to know in detail the teachers' assessment beliefs and practices to understand their specific learning needs and to design adequate interventions of teacher training.
In particular, we investigated teachers' practices through classroom observation, and especially through the use of the video recording. This because the use of videos allows

analyses of assessment practices in a classroom environment (Casabianca et al., 2013). On the other hand, many researches show the importance of video-analysis as a tool for teacher training (Meyer, 2012) in order to mediate between reflexivity and practice (Rossi et al., 2015).

2.1 The data collected

The FAMT&L research started with observational studies and surveys in order to understand analytically Mathematics teachers' and students' beliefs and practices (Michael Chrysanthou and Gagatsis, 2015). In this way it has been possible to detect training needs to design specific courses aimed at promoting a correct use of methodologies and tools to conduct correct formative assessment activities.

The first explorative phase of the work started with the administration of questionnaires to Mathematics teachers and students of each Partner's Country to gather information about beliefs and practices on assessment. Furthermore, we conducted some case studies, with the help of video recording, to develop and try out an observational tool (a structured grid) to analyse assessment practices in the classroom (that will be described in the next paragraph).

The Survey

Despite the fact that much has been written about the purposes of assessment,

research about the teachers' beliefs about the purpose of assessment and the use

of the information collected during the assessment process is still rather limited. In relation to the purpose of our research, an extensive study of literature in the fields of beliefs and assessment in mathematics education was done. The results of this literature review were used for determining our axes of investigation and for constructing questionnaires for examining the students and teachers' beliefs about different dimensions of formative assessment.

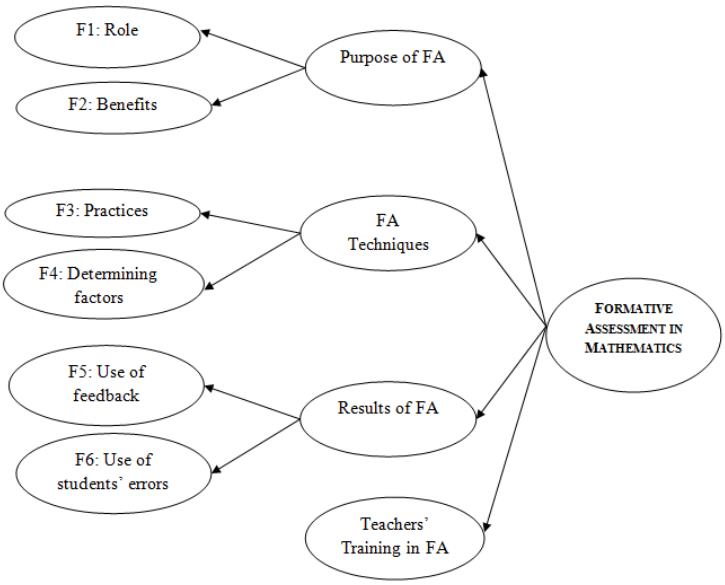

Fig. 1: Devised structure teachers believe formative assessment

This resulted in four main research Axes:

The teachers' beliefs about

1. purpose
2. techniques
3. results
4. training

of formative assessment in mathematics.

At the half way stage of the project the results of the questionnaires of both teachers and student are used for further development of the training model in the second half of the project. The analysis of the questionnaires were done using special software in order to see relations between different statements and expressions. This resulted in conclusions, for example the following relationship:

- the results' of formative assessment should be discussed between parents and teachers if teachers believe that that errors made by students are associated with the way they study and prepare themselves;
- providing feedback to a student can be achieved by showing students how they can adjust their approach to the task;
- the attribution of errors to the way the student studies also leads teachers in considering that the results' of formative assessment should then be discussed between the pupil and the teacher;
- providing feedback to a student can be achieved by showing students' specific misunderstandings or errors that frequently occur in a particular mathematical content area or a skill set.

Another relation that should be mentioned is that if the teachers believe that errors are due to the fact that an inappropriate question for the ability of the student is given, they also believe that formative assessment during instruction helps the teachers identify and implement instructional correctives. This relation reveals the importance of the teachers' beliefs about errors influence their beliefs about the use of formative assessment.

The relations in the examples above indicate the importance of studying the teachers' beliefs about the source of errors, as they appear to be influencing the way of providing feedback and how they can use effectively the information they get when using formative assessment for helping their students overcoming their difficulties. Thus, the teachers' beliefs seem to have an effect on the formative use of errors in the teaching and learning of mathematics.

The data from videos

In the second phase, we have carried out a systematic observation study on a larger sample of video sequences of teachers in the five Partner countries involved (Italy, Switzerland, France, and Holland) with the use of a specific tool. The tool was defined by using indications from international literature and experiences of in-service training and it is useful to gather many different indicators on good and bad practices for the formative assessment of Mathematics teachers (their habits about gathering information on the students' learning process, correcting errors and using feedback to support learning). With the videos collected about formative assessment situations, researchers created a web-repository and designed a teacher training program based on the use of such repository. In this activity we focused on the process of video analysis made in class, and then on the creation of a repository to be used in training courses aimed to promote FA in the practices of in-service Math teachers.

The videos collected show recordings of real classroom situations, where teachers use assessment techniques, such as the administration of a test or a task to students, the conduction of a written, oral or practical task; the reflection on the mistakes that were made in a test; the correction of an assigned task (in group, individual or in pairs); the teacher's formative feedback during the work on an individual exercise, and so on.

From the “long” videos, a number of short video-sequences were obtained that became the main training tool uploaded on the platform implemented for the training pilot course. These short videos have been analyzed through systematic observations, in order to detect the presence or absence of indicators of behavior which we defined in detail.

With the use of our grid for the video analysis we obtained a scheme that allowed a meta-dating of each sequence and so a system of annotating the videos that facilitated their storing in a web repository. These systematic processes had given an easy way to find specific materials in the repository, and also to integrate them into “pilot” training courses which were a guide to promote a correct use of FA as a tool to improve the teaching of Maths.

Such courses are aimed at acquiring specific skills in the use of formative assessment as an element that improves the quality of teaching. In these courses suggestions coming from the contemporary debate on teacher training will be integrated. It states that the observation by the teachers of their own practices would allow them to change their behavior by themselves and encourage processes of reconsideration on assessment and teaching.

Videos collected: some data

There are 126 videos in the web repository (total of videos). UNIBO has the highest number of videos, they recorded 90 videos, UCY has 16 videos, SUPSI has 11 and UCP has 9 videos recorded. InHolland could not place videos in the repository because of strict privacy laws in The Netherlands. Making and placing videos in a repository for use in research and training is not allowed without permission of all involved.

The analysis of videos (in the web repository) are all based on the common grid (developed by the consortium). The grid is grouped in 5 macro categories :

1. Mathematics Contents and capabilities (object of the teaching)
2. Time of assessment (before, during or after a learning activity)
3. Setting of Assessment (with the whole class or group or individual work)
4. Tools / strategies used to collect data on (written test, oral test, behavioral observations)
5. The different phases of the evaluation

1. The first part is about the ***contents*** of mathematics, which collects 4 areas:
   - Spaces and shapes : 49 videos
   - Relations and functions : 35 videos
   - Uncertainty and data : 11 videos
   - Numbers :15 videos

Summarizing the number of videos of all the partners according to *main capabilities,* we uploaded:

- Communication : 24 videos
- Mathematising : 24 videos
- Representation : 25 videos
- Reasoning and argumentation : 34 videos
- Devising strategies for solving problems : 20 videos
- Using symbolic, formal and technical language and operations : 31 videos
- Using mathematical tools : 9 videos

2. The second part deals with the **time of assessment** of all the partners’ videos :
   - Ex post : 40 videos
   - In itinere : 19 videos
   - Ex ante: 17 videos
3. The third part is about the **setting of assessment** :
   - Big class : 23 videos
   - Work group : 61 videos

- Individual assessment : 39 videos

4. The fourth part deals with the **tools/strategies** for data collection of students' skills, which is divided into 2 subparts : formal and informal

4.1. Formal

4.1.1 Objective test

- Multiple Choice : 6 videos
- True/False : 1 videos

4.1.2 written use of open or semi-structured strategies/tools of assessment (tasks:

b) Open task (argumentative texts, texts with a request to show the calculations, …) 51 videos

a) Semi-structured task (written problems solutions, short answer texts, ...) 34 videos

4.1.3 oral test/tasks with use of tool of systematic observation of student behavior

- Oral test/task 4 videos
- Discussion /questioning in the classroom 2 videos

4.2 Informal:

Oral tasks 17 videos

Observation of student's behavior during the activities 7 videos

Based on the analysis of the videos, the teachers set the FA after the learning.

You can find the synthesis of each country (according to the 5 parts) in the excel file (D3.3 ANNEX).

Then, based on the Excel file (of the web repository), the lessons of mathematics are more based on the shapes and spaces (49 videos), 34 videos (lessons) are about the reasoning and argumentation. The assessment is administered after the lesson (40 videos ex post) and the assessment is more a work group than an individual work. The assessment is more a written and formal assessment than an oral and formal assessment.

Most of the teachers share the correction and/or assessment criteria with the class (41 videos)

The videos deal with the formative feedback (most of them), 39 videos show that the teachers give back the results, the videos of SUPSI and UCP are about the Informal interaction.

3. The training teacher needs

As we noted, the theoretical framework highlights the importance of observational studies and surveys to understand analytically Mathematics teachers' beliefs and practices on assessment, in order to design effective interventions on teacher training.

Therefore, the main questions of the research were: how do math teachers think and act during assessment situations in the classroom? What are their strengths and weaknesses concerning the theory on assessment?

The goal was to analyse teachers' training needs through:

- the analysis of their beliefs on assessment
- the observation of assessment practices in the classroom.

Specifically, the aim of our research was to analyse how much and how these assessment practices deviate from the theoretical and methodological guidelines of educational research. Through video-analysis, using an observation grid, we highlighted how teachers gather information about students' learning process, correct errors and use feedback to support students' learning.

Many of the natural situations of Mathematics teaching in the classroom, analysed in the five countries through videos, point out a use of assessment with the following characteristics:

- it is specifically aimed at summative assessment, in order to give marks;
- it is not rigorous. The cases observed in natural environment show gaps in "measuring" learning and an incorrect use of feedback to the student (labelling);

- it is poor at recording analytically the learning difficulties of each student.

The first results, highlighted by the systematic observation of the videos, allowed us to understand the features of “bad” and “good” practices of formative assessment and to design specific interventions of teacher training.
In particular, the "bad practices" observed show weaknesses in the in-service teacher training and, at the same time, they can become an important tool to implement training paths. In fact, sharing systematic analysis of videos with teachers in training may solicit reflective and critical thinking in the teachers themselves and on their assessment practices. Therefore, this is an effective tool to foster their professional growth.

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