RICERCA - FORMAZIONE

R-F

Formative Assessment *for* mathematics teaching and learning

Teacher Professional Development Research by Videoanalysis Methodologies

Edited by
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R-F

Ricerca-Formazione

collana diretta da
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La Collana accoglie studi teorici ed empirico-sperimentali che indagano il rapporto tra ricerca e formazione degli insegnanti; essa nasce dalla comune volontà di un gruppo di studiosi e ricercatori di diverse università italiane interessati a questa tematica e con specifiche competenze di ricerca in ambito educativo.
I continui cambiamenti che attraversano il mondo della scuola e che coinvolgono direttamente coloro che operano al suo interno in qualità di insegnanti, dirigenti, educatori, necessitano di professionalità altamente specializzate e allo stesso tempo flessibili, in grado di interpretare le trasformazioni in atto e di gestire la complessità che oggi è presente nei contesti scolastici. Per questo è importante promuovere un rapporto sempre più stretto e sinergico tra la ricerca accademica e la scuola, affinché questa relazione possa essere letta in modo biunivoco e paritario.
La formazione iniziale e in servizio del personale scolastico, e degli insegnanti in particolare, rappresenta una leva decisiva per il miglioramento della qualità dell'offerta formativa, l'innalzamento dei risultati di apprendimento degli alunni e il funzionamento delle istituzioni scolastiche, in un'ottica di equità e di democrazia del sistema di istruzione. La ricerca educativa, con i suoi molteplici approcci teorici e metodologici, deve poter offrire nuovi ambiti di riflessione e strumenti d'intervento per formare competenze e sostenere lo sviluppo professionale degli insegnanti. La possibilità di progettare, realizzare e monitorare interventi e strategie efficaci, sul fronte sia della ricerca sia dell'educazione e dell'istruzione, nasce dalla capacità di far interagire competenze diverse e attivare processi didattici e organizzativi rispondenti ai bisogni di bambini, giovani e adulti. In tale prospettiva, si può parlare di metodologie orientate alla ricerca-formazione, da considerare soprattutto come una scelta metodologica per fare ricerca con gli insegnanti e per il loro sviluppo professionale e il miglioramento della scuola. Una scelta che caratterizza, accompagna e sostanzia (nelle sue finalità e procedure applicative) le specificità e il rigore dei vari approcci metodologici della ricerca empirica, nelle loro declinazioni di volta in volta quantitative, sperimentali, fenomenologiche e qualitative.
La ricerca-formazione pertanto, oltre a rappresentare un settore di studio interdisciplinare, che comprende molteplici apporti teorici ed epistemologici, viene considerata, all'interno della presente collana, soprattutto come un modo di fare ricerca insieme ai professionisti dell'insegnamento, inaugurando nuovi campi d'azione verso cui convogliare risorse e interessi comuni. In questo senso, la collana valorizzerà contributi capaci di evidenziare la contiguità tra insegnamento e ricerca, prestando particolare attenzione alle modalità di coinvolgimento degli insegnanti, al rigore procedurale, alla ricaduta formativa dei risultati raggiunti.
In particolare, gli aspetti presentati di seguito delineano l'idea di Ricerca-Formazione cui la collana si ispira; essi possono pertanto costituire un orientamento per gli autori.

Una Ricerca-Formazione, per essere tale, richiede:
1. una esplicitazione chiara della finalità della ricerca in termini di crescita e sviluppo della professionalità degli insegnanti direttamente coinvolti e un'attenzione a documentare e analizzare le ricadute in termini di cambiamento;
2. la creazione di un gruppo di R-F di cui facciano parte ricercatore/i e insegnanti, nel quale vengano chiariti i diversi ruoli dei partecipanti e in cui vengano negoziati e chiariti obiettivi e oggetti, scelte valoriali e metodologiche della R-F;

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3. la centratura sulle specificità dei contesti - istituzionali e non – in cui si svolge la R-F, che si concretizza in tutte le fasi della ricerca attraverso un'analisi dei vincoli e delle risorse in essi presenti;
4. un confronto continuo e sistematico fra i partecipanti alla ricerca sulla documentazione dei risultati e dei processi messi in atto nei contesti scolastici e in quelli della formazione;
5. l'attenzione alla effettiva ricaduta degli esiti nella scuola, sia per l'innovazione educativa e didattica, sia per la formazione degli insegnanti.

La collana intende accogliere contributi di studiosi italiani e di altri paesi, sotto forma di monografie, volumi collettanei, rapporti di ricerca e traduzioni relativi a studi e ricerche che realizzino una sinergia tra università e scuola, compresi volumi che documentino percorsi di Ricerca-Formazione realizzati nelle scuole.
Una particolare sezione della Collana accoglierà inoltre volumi relativi a risultati di ricerche empiriche che affrontino specificamente le questioni della formazione alla/della professionalità docente.

La collana è diretta da un gruppo di quattro studiosi di diverse università italiane che condividono finalità e scelte metodologiche del progetto editoriale e che mantengono un rapporto di confronto e di scambio costante con il Comitato scientifico.
Attraverso la collana, la Direzione e il Comitato scientifico intendono promuovere un ampio confronto tra ricercatori, studiosi, insegnanti, educatori e tutti coloro che a diverso titolo sono coinvolti nei processi di istruzione e formazione.

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Introduction

by *Giorgio Bolondi*, Ira Vannini*, Athanasios Gagatsis**, Laurent Jeannin***, Rob Velder*****

The main purpose of project of research LLP Comenius Project "FAMT&L – Formative Assessment in Mathematics *for* Teaching and Learning" was to encourage the use of formative assessment (FA) in the process of teaching-learning; in particular within the teaching practices of mathematics teachers at the middle level of school (students aged from 11 to 16).

The five member partners involved in the Project were the Alma Mater Studiorum Università di Bologna in Italy, the University of Applied Sciences and Arts of Southern Switzerland, the University of Cergy-Pontoise in France, the University of Cyprus, and the Netherlands' Hogeschool Inholland.

For three years, researchers from the five countries worked together with associate school teachers, forming groups geared to promote teacher skills in the FA. The purpose of the group was therefore to make a change in the teachers' beliefs and their assessment practices, both of the schools that participated in the project, and of other groups of teachers of broader contexts. The pathways have led the researchers to outline a specific training methodology in the FA field, with the development of specific techniques, tools and materials.

The Project took place in the years 2013 to 2016. The realization of the pathways has followed some specific phases: analysis of contexts and teacher training needs; identification of techniques and tools; production of video training materials for training; design of pilot training paths and their implementation and monitoring.

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This book aims to describe the pathways of the Project and its main achievements: our purpose is to contribute to the international debate on issues on teachers' professionalism in the school systems in Europe: specifically, the development of teachers' professional skills in the field of assessment practices and, in particular, the use of the FA in classroom. The book is structured in ten chapters.

The first chapter presents the scientific reasons for the adopted work methodology of "Teacher Professional Development Research" (Ricerca-Formazione, in Italian language). The principles of this approach and the resulting are discussed in the groups formed by university researchers and practicing teachers. Strengths and weaknesses are highlighted.

The second chapter analyses the concept of FA in math, starting from the debate on international literature until the definition of the FA construct used in the FAMT&L Group. In particular, the authors analyse the aspects of the effectiveness of the FA in student learning.

The third chapter presents in detail the FAMT&L Project and all the steps that have been taken for its implementation: from the analysis of the training needs to the implementation and monitoring of the pilot training course for teachers (based on the video analysis methodology).

The fourth chapter presents the survey that has been carried out on teachers' and students' beliefs regarding the FA. It describes the data collection system, the tools used, and the main results that have led to the identification of teacher training needs.

The fifth chapter deals with the methodologies of video analysis for the professionalism of teachers; the theoretical framework is presented and the basic techniques are described.

Chapter 6 describes the specific observation and video analysis method used within the FAMT&L Project. Web repository and grids for classroom assessment analysis are presented in their core aspects.

The seventh chapter deepens the training courses curriculum and it describes the design of the monitoring; for example, the results of the Italian experimentation. The synergies between researchers and teachers are highlighted.

The eighth chapter directly collects the voice of the teachers who participated in the Italian pilot course. Teachers describe their experiences and skills acquired, pointing out the strengths and weaknesses of experimentation.

Ninth and tenth chapters account for two fundamental aspects of the FAMT&L Project: the quality assurance procedures used and the exploitation strategies. These are two strictly technical chapters that help you get in the way of how the FAMT&L Group has consistently sought to evaluate, adjust the course and open up opportunities for further development.

Thanks to the Publishing House Franco Angeli of Milan, and in particular to Katiuska Bortolozzo, for having believed in this project. Giving voice to the processes and results of this project, we hope the book will be useful to the international debate and research on the development of teachers' professionalism.

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1. FAMT&L: a Teacher Professional Development Research

by *Giorgio Bolondi*, Ira Vannini***

1. Origins of the FAMT&L Project

The FAMT&L Project was born out of a firm belief and a key question. Firstly, the firm belief that *formative assessment* is a potentially revolutionary element for the educational and teaching function of the school systems, because it based on the idea of a democratic school (equity and quality together). Specifically, formative assessment is based on the bloomian belief (Bloom, 1972) that all students can learn basic skills in each topic and can do it excellently.

Later, the key question arises of how it is possible to accompany and support teachers in acquiring actual assessment skills; or rather: how to orient their practices towards formative assessment? This question involved a group of educational and mathematics researchers from five European countries (Cyprus, France, Italy, Holland and Switzerland), who have defined a research project that has involved, as protagonists, schools and teachers.

Within educational research, the research question on teachers' professionalism is accompanied by a broad and complex debate, which also calls on disciplinary experts and all those concerned with teachers training processes (pre-service and in-service). The key question is what are the most effective contexts and strategies to support the change of the teachers; a change towards:

- pedagogically founded and scientifically validated knowledge;
- skills and beliefs consistent with a school ideal of equity and the quality of learning outcomes of students.

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Chapter 1: Giorgio Bolondi; Chapters 2 and others: Ira Vannini.

In this sense, the international debate refers to the concept of *Teacher Change* (Floden, 2002; Guskey, 2002), a line of research devoted to exploring the processes of change (or resistance to change) that teachers put in practice during the teacher education or teacher training and staff development paths.

The FAMT&L research group shared the great importance of this theoretical framework and focused on the teachers change in the assessment skills; and specifically:

- What does it mean to support teachers in training processes oriented towards authentic practices of formative assessment in classroom?
- What are the most effective training strategies? What strategies allow a real change in the teachers' beliefs and in the teachers' practices?
- Which training tools allow to foster the teachers' reflective thinking (considered as a fundamental characteristic of teacher professionalism)?

These questions have become the central idea around which the group of researchers and teachers worked for three years; the partnership has been particularly profitable, especially because it has exploited the specific skills of:

- educational researchers, experts in the field of assessment and evaluation processes and empirical research on teachers;
- researchers in mathematics teaching, a field of advanced studies on the strategies of teacher training (D'Amore, 2009; English, Bartolini, *et al.* 2008), and which put the focus of attention on the urgency of teacher professionalism in mathematics teaching;
- school teachers associated with the Project, who had already considered and worked on the formative assessment in classroom and were available to give oneself a challenge in their teaching and assessment skills.

The research path has been structured in a complex way and (as will be described in the subsequent chapters) has followed several phases, each closely linked to the others:

- the analysis of the training needs of the teachers through sample surveys (in each of the five countries) on teacher' beliefs and through the video observation in classroom;
- the development of a specific observation tool for the videoanalysis of classroom assessment practices;
- the design, implementation and monitoring of pilot training courses for the use of formative assessment, supported by the videoanalysis technique.

During each design phase, the style of work was characterized by the comparison and collaboration between researchers and teachers; the group worked on the logic of sharing theoretical-value choices, objectives

and methodologies, complementarity of skills, professional growth of all actors.

In this perspective, the path can be considered a true "Teacher Professional Development Research" (in Italian language: Ricerca-Formazione, R-F).

2. An international path of "Teacher Professional Development Research" (R-F)

The term "Ricerca-Formazione (R-F)" is used in the Italian educational debate, although it has not acquired a shared definition among the various scientific currents. At international level, there is no real literal translation. The conceptual translation in English language could be "Teacher Professional Development Research".

The term R-F refers to a not well defined concept within the scientific debate in education; it can be traced back to different research traditions. First of all, the R-F refers its origin to the participating research (Mantovani, 1998) and to the more structured model of the Action-Research (Lewin, 1946), where the key elements are the sharing of researchers and actors and their commitment to change and social action. In the second instance, the concept of R-F was used in the current called Formative Educational Evaluation (Becchi, Bondioli, 1994; Bondioli, Ferrari, 2004) that considers the evaluation (of the contexts, curricula, programs) as an opportunity for self-assessment of actors actively involved in the processes and for their professional growth. Furthermore, in several cases, R-F is also considered as a process of individual professional growth (eg through autobiographical analysis tools).

Within the CRESPI Center (Center of educational research on teacher professionalism http://crespi.edu.unibo.it/) of the Alma Mater Studiorum Università di Bologna, a theoretical idea of R-F has been discussed and defined starting from empirical research experiences carried out by CRESPI researchers in the field of teacher professionalism. The path of the FAMT&L Project can be related to this idea of R-F.

CRESPI considers the R-F as a real empirical research that is carried out in the field of teacher professionalism in order to promote its development. It is a research that takes place within school institutions, strongly anchored to the context, where researchers and teachers share research itineraries but above all the goals of institutional change. Rather than a methodological choice (each R-F is careful to guarantee the validity and reliability of the collected data by adopting specific validation

procedures depending on the designs – qualitative, quantitative or mixed – that are applied) is a stance of researchers towards the school context and its teachers.

Those who engage in an R-F aim at effectively affecting the professional development of the teachers involved and, at the same time, of the school context. Research is carried out following deliberate decisions in the group: preferably an interdisciplinary community of researchers in collaboration with teachers, which discusses and clarifies the framework of educational and political-social values of reference.

«In the CRESPI Center (CRESPI Academic Group, 2016; http://crespi.edu.unibo.it/centro), the following methodological characteristics can be considered both as binding principles for researchers in the field of R-F and open questions in search of answers.

1. Render explicit the aims of the research in terms of the professional learning and development of the teachers involved together with the procedures for documentation and evaluation of the outcomes and impacts.
2. Define the composition of the TPDR group in terms of researcher/s and teachers, clarify their roles and negotiate and specify objects and objectives, values and methodological choices.
3. Delineate and maintain a clear focus on the specificity of the institutional and non-institutional contexts in which the research is carried out through constant analysis of the constraints and the resources present and which are crucial in all phases of the research.
4. Systematically discuss ways of experimenting and gathering data during the research, so as to enhance the development of a scientific approach to educational praxis on the part of teachers, and of evaluating and documenting products and processes within the specific contexts involved and the professional development promoted.
5. Maintain emphasis on the outcomes achieved by and for the school in terms of educational innovation, teaching praxis and professional development».

Below is discussed each R-F characteristic in function of how it was addressed within the FAMT&L Project.

2.1. *To clarify the aims of the research in terms of professional development, document and monitor them*

International framework of the FAMT&L Project has strongly contributed to the creation of a work style of sharing objectives, monitoring

and documentation. During the three-year of work, the R-F group had the purpose of promoting the development of teacher professionalism in the field of assessment practices. The main aim of the Project – after a phase of careful analysis of training needs and planning of tools and procedures – was to implement specific training pathways to change the beliefs and assessment practices of secondary school teachers by making them more and more adherent to the concept of Formative Assessment (see the Formative Assessment definition in FAMT&L group in the Chapter 2).

This goal has been the guiding principle of all phases of the Project, helping the R-F group to maintain common care on the development of teacher professionalism.

In addition, at each phase of the Project, the data collection was aimed at monitoring the processes in progress (analysis of teacher training needs through sample surveys, building and validation of tools for the observation and videoanalysis of practices, experimentation of training interventions by a pilot course in each country) and document – as transparently as possible – the results achieved. The purpose was to provide useful documentation not only to the R-F group, but as a point of reference to continue the research in other national and international contexts and to implement the pilot courses developed (training for Formative Assessment practices through methodologies of video analysis in classroom) on larger groups of teachers.

2.2. *Define the composition of the R-F group, clarify the roles and negotiate objectives, values and methodological choices*

As has been said, the R-F group was formed by the researchers together with a group of teachers from the five European countries participating in FAMT&L Project. The initial choices were elaborated and discussed in the academic group; from time to time, the goals and objects of the project were brought within the group of teachers to be deepened, rediscovered, further enriched. The ways of sharing within the group were different depending on the different work phases:

- during the initial phases of training needs analysis, teachers were involved in discussion on the results of surveys (regarding both teacher's beliefs data and practices observed in classroom). Within the several associated schools of the five European countries, and during meeting group, the researchers presented the beliefs and practices data to the teachers, and their first interpretations. Along with the

teachers' groups, critical data interpretation was further analysed in specific school contexts; the data from the observations were analysed together with the same teachers video-recorded and fostering their self-evaluation processes;

- in an explorative phase, the R-F group designed the videoanalysis tools and the curriculum of the pilot courses; in this time, the teachers have been actively involved. Initially, the grid for observing classroom practices was elaborated by the researchers from the Formation Assessment construct; subsequently this grid has been subjected to various try out in each country, through video analysis in the classrooms of the associated schools. Each country has suggested changes and improvements, up to the revision presented here which still constitutes a hypothesis tool open to further improvements (possibly through further discussions with teachers in new school contexts). The design of the pilot courses and the procedures to accompany the teacher's reflexivity has been different: in this case, the researchers group proceeded independently from reference literature and specific academic experiences in the field of teacher training;
- in the pilot phase, teachers were involved in a continuous process of monitoring and evaluating courses, both through systematic tools and through more qualitative procedures such as focus groups and interviews. These procedures have allowed teachers to take part as a protagonist in courses, to reflect critically on the knowledge and skills they were gaining and on the training methodologies adopted. During this time, also the video analysis grid was further subjected to the screening of teachers.

As it can be seen, the R-F group has not provided roles of parity between researchers and teachers, but of complementarity and constant exchange between academics and school actors: processes and results have been constantly analysed, questioned and re-designed between them. In roles negotiation, teachers were considered the earliest recipients of the project's results, the researchers were considered the first responsible for such results.

This negotiation was initially shared with the leaders of the associated schools of the countries involved.

2.3. *Analysing the institutional constraints and resources of the R-F contexts*

As mentioned in the previous point, the associated schools have been largely involved in all phases of the Project. This involvement has led,

from the very beginning of the Project, a commitment of researchers to enter within the institutional contexts of the associated schools of the five countries. In fact, each school context has brought with it important resources, but also constraints that each country has had to take into account in the various phases of the R-F.

At the beginning of the project, it was necessary to identify the teachers of each school and this required an early access by researchers into schools and a good negotiation with school leaders.

It is important to note that each school had already experience in the field of assessment teachers' skills and was therefore sensitive to the subject; however, in some schools the teachers were able to choose for them to participate in the project; in others the leader was instructed to indicate the teachers. This involved, in each of the five countries, an initial work for the constitution of the group and a progressive integration of the teachers within the R-F group. The care of relationships has been important in all five European countries, in the awareness that the socio-cultural context is a key element in order to carry out the effective R-F processes.

The most important institutional constraints have been met on the front of privacy, and at different levels.

First, during the surveys on teacher's beliefs and student's beliefs. In these two occasions, the schools in the various countries have proposed their specific regulations to allow data collection, both among teachers, but especially among students who are not yet of age.

Subsequently, the most important constraint was placed during class video-recording. On the one hand, classroom video tutorials involved collecting images related to students as well. In compliance with the national privacy laws, they have been signed with family liberators; however, in Holland – despite all the formal reassurances – it was not possible to enter in the classroom with a camcorder.

On the other hand, the video has created resistances in the same teachers involved in the R-F group, dictated by fears and lack of self-efficacy. It was therefore necessary to identify specific solutions within each institutional context: almost always the researchers increased the reflection meetings with the teachers in order to deepen the meaning of what was being done and to design together the assessment events to be filmed, while always guaranteeing the authenticity of the teachers' actions.

The analysis of constraints and institutional resources has been the subject of constant debate within the R-F group in order to identify the most sustainable solutions and to fully exploit all the theoretical and practical skills available within school contexts.

2.4. *Evaluating and documenting products and processes: a systematically dialogue on the gathering data in the R-F group*

Each phase of the project was developed through a specific research design: a survey of teachers' beliefs and a systematic observation survey during the early stages of the project; a qualitative-exploratory investigation for the development of video analysis tools; a pre- or quasi-experimental design to monitor the results achieved with the pilot courses. In each of these research moments, the R-F group has systematically documented the processes implemented: conversation and discussion among researchers, dialogue with teachers, decision-making, implementation of different procedures. This documentation has been facilitated by the fact that, within a European project, the research team is constantly urged to document using a variety of tools: minutes of meetings, e-mails between participants, drafting of reports in progress, to the specific documentation within the project's dedicated website (www.famt-l.eu/it/). This involves a constant dialogue within the group and a constant exchange of information.

The documentation of the results was achieved thanks both to research reports and to various publications in scientific journal that the researchers were writing during the project.

What is to be noted, as a weakness, is the lack of in-depth after-sales analysis on the produced documentation. Whether the choices on *what* and *how* to document were the result of shared analysis within the R-F group; they have missed moments to go back to the documents and reflect critically in a re-design perspective. This in-depth analysis was done only at the end of the Project, especially for the preparation of the final conference and, above all, in order to imagine possible exploitation phases of the research and the ways to maintain (after the end of the project) the tools (in particular, the web repository).

2.5. *Maintain emphasis on the outcomes achieved by and for the school in terms of educational innovation and professional development*

The FAMT&L project, since its starting as a Comenius Project proposal, has consistently been geared towards identifying hypotheses and solutions for teacher training and their growth in terms of professionalism. Specifically, as has been said, the Project has always been geared towards changing teachers' beliefs and formative assessment practices. As we

will see in the subsequent chapters, the R-F group's work was based on a key idea: student learning assessment is a major issue in school systems across Europe; teacher skills are often lacking and the assessment practices are often used for selective purposes rather than *for* learning. This is particularly true in secondary schools and, specifically, in those school levels for students aged 11 to 16 who are at the end of compulsory education. It is in these levels that the highest rates of school dispersion are recorded and a strong demotivation to students learning. International educational research, especially since the '90s (see references in the Chapter 2, shows that good formative assessment practices in classroom are largely effective to improve the students' learning, to stimulate their self-assessment and their motivation for learning. Formative assessment, at the same time, enables the implementation of different teaching methodologies and leads the teacher to self-evaluate and to reflect critically on his educational choices. Result is a growth of teacher professional skills: curriculum designing, using of good teaching methodologies, measuring and assessment, managing formative feedback.

From these considerations, the FAMT&L group has defined the main objective of the Project: to identify pathways and training arrangements to improve teachers' assessment skills. The relapse of the Project on the professionalism of teachers had to be tangible, both in terms of effective change in the beliefs and practices of teachers involved in the R-F group, as well as in modelling pathways and training methodologies to be reopened within wider contexts.

The results of the pilot courses, as can be seen in the following chapters, are encouraging: significant changes have been observed during pilot courses. Additionally, teachers in the 5 R-F groups are currently continuing to collaborate with university researchers and have been involved as trainers for new groups of teachers.

Curricula designed for pilot courses – their training structure, video analysis methodologies, video materials, and tools for teacher reflexivity – are also a major result in terms of innovation in the programs for in-service teacher training. Now, we have to continue the exploration of our research hypothesis in wider contexts.

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2. Why formative assessment in Mathematics?

by *Andrea Ciani*, Ira Vannini*, Federica Ferretti***

1. Introduction

Assessment in classroom has always been a key tool in order to promote, or to hinder, democratic values at school. An education system that does promote quality and equity for the learning achievements of its students, uses assessment as a key element to qualify the action of teaching in a democratic way, both at the beginning and during the process of teaching-learning; moreover it will consider the differences among the students and their possible learning difficulties as opportunities to make the teaching actions flexible in order to reach goals of quality for all (Vertecchi, 1976; Grandi, 1977; Weeden, Winter, Broadfoot, 2002).

As we can read in Crahay (2013), it has to be a kind of assessment which adheres to a principle of equality of achievements (Bloom, 1968; Black, William, 1998; Guskey, 2005), hence to an idea of "fairness" in teaching, by offering more to whom possesses less.

This need of fairness in achieving the competences for citizenship (OECD, 2015; Eurydice, 2012) is more evident in every education system when considering basic competences and at high and junior high school level, before the completion of the compulsory cycle of studies. In particular, relevant problems appear in the field of math teaching, with important gaps in the conduct of the specific teaching-learning processes.

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2. Formative Assessment: assessment for learning for all the students

Since its origins (Scriven, 1967; Vertecchi, 1976), the main function attributed to formative assessment (FA) is to be a regulator tool for teaching and learning.

Referring to the current international scientific debate on this issue, we can say that formative assessment is characterized specifically as an assessment for learning (Weeden *et al.*, 2002; Allal, Laveault, 2009). This means that it has to be an assessment which is functional to backing up and promoting learning; it is embedded in the teaching-learning process in a dynamic way, modifying the teaching actions by following the needs of the students. The aim will never be to just attribute marks, or to make a résumé on the abilities of a student; formative assessment helps a teacher to gather information to improve and to get her/his teaching action more effective.

Thus, when a teacher uses formative assessment, s/he is implementing two fundamental actions (Vertecchi, 1976):

- a diagnostic analysis of the achievements (knowledge, abilities) that the student is acquiring and of which meta-cognitive strategies the student is following;
- a reconstruction of the teaching path by following the student's needs and differentiating times and methods of the didactic process.

Thanks to this diagnostic function, formative assessment analyzes the learning situations and can give information in order to take coherent and effective decisions. It focuses on the "errors" of the student and of the teacher, by considering them as resources for designing and re-designing interventions in view of the teaching goals.

This kind of assessment requires a high professionalization of the teacher, which has to implement a continuous assessment attention during the teaching process, as a coach in the training of an athlete or a team (Bennet, 2010; 2015) who proposes activities and tasks to the trainees (as a trial for their abilities), detects and immediately corrects their errors (by discussing with the trainees about them), understands the specific needs and gives formative feedback.

As every assessment procedure (Gattullo, 1967), also FA is characterized by three steps (Gitomer, Zisk, 2015, p. 3):

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

Collecting evidence is an unavoidable phase (Ruiz-Primo, Furtak, 2004) inasmuch as it characterizes FA as a specifically evaluative action, both when it is formally or informally done (informally as in the course of a teacher's day-to-day activities) (Bell, Cowie, 2001; Duschl, 2003; Shavelson *et al.*, 2003). Without a willing gathering of evidence we would not be doing FA, but just a teaching activity.

The next step, data interpretation, is equally important. Doing summative assessment this step would end in the attribution of marks or of a judgment, doing FA any judgment is suspended. It is formative feedback that must take place in this moment, instead: the teacher's answer to the needs/requirements of the student. Researches show that feedback – together with FA – is the crucial element, which contributes, in a statistically significant way, to improve the results in the students' learning (Hattie, Timperley, 2007; Hattie, 2009; 2012; Huelser, Metcalfe, 2012).

For this reason the teacher's practices in class are particularly important, both in the moment when data about the students' achievements are gathered and analyzed, and when interpreting the data, elaborating hypotheses about the kind of mistakes the students do and implementing feedback actions to help them in the critical steps in their apprehension. All this is really fundamental in the teaching of mathematics.

The feedback activity is a complex set of actions by the teacher, not easily described by a set of rules or given operations; for this reason researches in this field are particularly relevant and compelling: it is necessary, in fact, to clear up, in detail, which are the most effective conducts that the teacher has to implement in classes activities when facing a "stumbling" student.

Via the feedback, the teacher should manage to make the student's errors explicit, and make them valuable as an asset in the learning process; in the meanwhile the teacher has to sustain the students' motivation to learn and to mobilize all their meta-cognitive strategies in order to overcome the obstacles. Here the didactic mediation is substantial; the teacher must use several and differentiated didactic tools, give additional explanations, sustain the students' aloud reasoning (Weeden, Winter, Broadfoot, 2002; Bennet, 2010; Doabler *et al.*, 2014).

Several researches about teachers' behavior highlight that they agree about the fundamental role of FA for the quality of teaching, nevertheless – in their practice – they follow more often summative assessment praxes. Also, in spite of the fact that they use FA in their ongoing activities, they may use superficial tests, propose mechanical answers, or give a feedback that is too generic (Looney, 2011, p. 10). In fact, they seem not to be prepared to interpret the evidence they have about their students' learning and often they attribute to external reasons the impossibility to

implement FA (too many students in their classes, too large curricula to teach, organizational difficulties in their schools) (OECD, 2005).

3. International debate: different views on the formative assessment

The formative assessment, as it has been outlined since its inception, has been conceived, imagined, designed to increase students' learning. Black & Wiliam studies and researches' have allowed to spread and share in the world an idea of FA and to support the efficacy of its practice. Although Black & Wiliam works' was referring to local contexts, data, considerations, it became a fundamental basis for the comparison and development of the international debate on the FA.

The international debate on the FA is based on additional interpretations or new approaches, without contradicting its initial conception even if the educational perspectives of application could be radically different (e.g. FA in behaviourist or in social-constructivist view).

In general, as Torrance (2012, p. 324) has documented, over the years the FA has defined more its meaning and the spectrum of related practices:

> from mastery learning and criterion-referenced graded assessment programmes in the 1970s and 1980s (Bloom, 1974; Popham, 1978; Pennycuick &Murphy, 1988); through systems approaches to feedback (Ramprasad, 1983; Sadler, 1989); to the variety of approaches to recording, reporting and profiling achievement which emerged in the 1980s and 1990s in the UK (Broadfoot, 1986; Torrance, 1991; Pole, 1993). Currents of formative assessment, also known as 'assessment for learning', are often linked to Black and Wiliam's (1998a) review of the literature, subsequent developments by the UK Assessment Reform Group (2002) and associated work by Black and colleagues.

If initially, in the U.S., early interest tended to revolve around mastery learning e and formative assessments' practices to develop programmes of 'measurement-driven instruction' (Popham, 1987; Airasian, 1988), over time a wider vision has been established, associating it with the assessment for learning.

Stiggins (2005), one the first promoters in North America of this vision, explains how assessment for learning is an approach to the formative assessment and defines its differences with a traditional view. In its traditional form, formative assessment has been thought of as providing teachers with more frequent evidence of students' mastery of standards to

help teachers make useful instructional decisions. In this way, formative assessment is intended to enhance student learning.

The purpose is using a lot of different evaluations methods to provide students teachers and parents with a continuous flow of tests of the student progress in mastering competences that support or guide to set the standards: during the learning, students are inside the assessment process, watching them grow, and feeling in control of their success. The most important difference between the traditional approach and assessment for learning is that the former intend to inform the teachers about student achievement, while the latter also wants to inform students about their own learning.

> Assessment FOR learning rests on the understanding that students are data-based instructional decision makers too, a perspective all but ignored in our assessment legacy and in previous approaches to school improvement. Another difference is that traditional formative thinking tends to want more frequent assessment of student mastery of the standards themselves, while assessment FOR learning focuses on day-to-day progress in learning as students climb the curricular scaffolding leading up to state standards (Stiggins, 2005, p. 328).

It is precisely on the guiding principles of assessment for learning that different ways of viewing the FA are born. In fact, in a similar way to what happens in the US, the initial conception of FA proposed by Bloom has been enlarged with other elements, in particularly

> In the enlarged perspective of formative assessment developed in French-language publications, the idea of remediation of learning difficulties (feedback + correction) is replaced by the broader concept of regulation of learning (feedback + adaptation). In an enlarged conception, external regulation (by the teacher, by the test, by remedial material) is redefined as scaffolding that assists students' development of self-regulation. […]This means fostering the active involvement of students in formative assessment through procedures of self-assessment, reciprocal peer-assessment, and joint teacher-student assessment (Allal, 2005, p. 245).

In the French FA enlarged perspectives, the learning regulation (interactive, retroactive and proactive) is fundamental. Allal writes that concept of regulation in the French-language literature about FA is linked to:

- the degree of active student involvement in these actions;
- the ways students make use of tools and resources present in the instructional environment to adapt or enrich their learning activity;
- the meaning the students and teachers give to the various aspects of assessment;
- the ways in which teachers and students negotiate assessment.

Thus, vision that emerges in the French pedagogical debate supports a socio-constructivist perspective of FA, close or almost superimposable to the approach of *assessment for learning.*

Although in Germany the FA in a Bloom/Black&Wiliam sense is not consolidated yet and there are few FA studies in comparison with UK, US and France, the alternative education has emphasized that teachers should be aware of how they provide feedback to students, as feedback indicating personal growth to students could foster their learning and motivational development (Köller, 2005).

In Italy, as in several other countries, the effort to promote a FA culture in schools following the Bloom perspective is quite substantial, above all in universities and in the world of educational research, but is also increasingly combined with the attention to the teaching, motivational and communicative processes. For this reason, in Italy people talk more and more of FA following the *assessment for learning* approach and the FAMT&L research has adopted this term to indicate a complete and upgraded view of FA.

4. Formative Assessment in Mathematics

The important role of the assessment is underlined in most National Curricula and it is entrusted to teachers, individual schools and ministerial institutions. The assessment is under the responsibility of the teacher in all the phases, both of the planning and of the operational process of teaching; for instance, in Italian National Curricula, the formative function of evaluation is clearly emphasized, as are its crucial role inside the learning process and its function as continuous stimulus for improvement.

Formative assessment for learning should indeed be essential part in all phases of the process of teaching and learning. From this perspective, its main function is regulative and its main objective is to help teachers and students to continuously adapt the teaching/learning process, especially if it is oriented to the individualisation of teaching procedures (Tornar, 2001). Specifically, formative and diagnostic function of evaluation is carried out, referring to a formative path, *ex ante* and *in itinere* with the aim of collecting detailed information both at initial stages and during the process of learning, whenever students are faced with difficulties, so to design educational targeted interventions and to have a constant and reciprocal feedback between teacher and pupil. Hence the purpose of formative assessment is essentially educational and its main aim is to provide feedback and information to the teachers, so that they can then do something to promote their students' learning. Formative assessment

is also characterized by the fact that it does not provide the explanation of a judgment or a vote, but is rather characterized by a significate enhancement of errors, considered as a resource to improve the quality of the educational path (Gagatsis & Christou, 1997; Gagatsis & Kyriakides, 2000, Zan, 2007). Some studies have allowed us to collect empirical evidence that could prove, for example, that the systematic use of the *in itinere* evaluation of the students' progress generates significant increases in their final performance. Moreover, the quality of the feedback, the active participation of the students in the evaluation process, some aspects of verbal interaction in the classroom and the effects of evaluation on self-confidence and motivation, have shown themselves to be crucial for the effectiveness of formative assessment to promote learning (Scallon, 1985; Black & William, 1998). From these studies a discussion at the international level has developed, getting to the conclusion that formative assessment is an "assessment for learning" (Weeden *et al.*, 2002).

5. Why formative assessment in Mathematics?

Teaching and learning processes concerning mathematics and sciences are a fundamental component of school activities, and they are preliminary to many of the skills that are significant in life and necessary for the citizenship formation. Mathematics paves the way for different ways of thinking and for applications that affect daily life, allowing critical interpretation and assessment of the huge amount of information produced in the modern learning society. Moreover, it also determines the practice of citizenship through logical reasoned and motivated decision-making processes about social issues.

Without adequate competence-building in mathematics (thinking, logical reasoning, etc.) it becomes virtually impossible to fully access the contemporary world made by information, communication and technology. This affects the opportunities for all to be involved in social and economic life. This idea is also stressed in the concept of "mathematical literacy", as defined in the OCSE Programme for International Student Assessment – PISA (OECD, 2013) as the capability to identify, understand and engage in mathematics, and to make well-founded judgements about the role that mathematics plays in an individual's current and future private life, occupational life, social life with peers and relatives, and life as a constructive, concerned and reflective citizen.

Despite researchers' and teachers' engagement, the crisis in mathematical education & learning is becoming very diffused and profound. Mathematics tends to be seen by young and adults as an uninteresting discipline.

According to recent international research (OECD, 2014; Eurydice, 2012), the main difficulties in mathematics learning are represented by:

- a severe lack of mathematical skills among students aged 15th in many European countries (OECD, 2005) based on problems in mathematical didactics starting from the 11-14/15 years age group;
- teaching methodologies and pedagogic lack in giving a broad "sense of number" and the ability to work with it (with figures, measures, statistics and probability);
- incorrect use of formative assessment and need to introduce strategies of teaching and learning individualization;
- in general, rising de-motivation for school learning, starting especially in the 11-14/15 years age;
- more specifically, de-motivation for learning mathematics.

The 11-14/15 years age group appears to be the one that requires innovative and adequate interventions to improve mathematical and – especially – numeracy skills, reclaiming both to mind for the lost ground in mathematical curiousness amongst youngsters as well to bring all students to obtain satisfactory results with a better and broader commitment to mathematical reasoning in any social-economic application.

It appears to be important to design innovative ways to invest in teacher training for mathematics, in particular through training paths that put teachers in collective planning situations and bring them to build plans, strategies and methodologies for teaching mathematics effectively. It goes without saying that this does not only means to investigate on the subject, but also on the pedagogical-didactical learning strategies, in particular in the field of assessment, stressing the value of formative assessment and individualized teaching strategies, planned to specifically respond to students' rhythm and learning styles.

For this reason, it was very important to investigate on mathematics teachers' beliefs and misconceptions about assessment in the classroom and to analyse learning activities in the classroom, investigating on teachers' rationales behind learning difficulties in mathematics in order to plan adequate interventions for remedial programming.

At the same time, we think that each teacher should acquire the necessary competences for reflecting on the content of mathematical education as well as on the pedagogical-didactical aspects. This implies to have an internal focus on mathematics itself and an external focus on the links of mathematics to other subjects. In both cases, it is important for teachers to learn, assess and diagnose students' learning needs and to give answer to them with adequate teaching methodologies.

During all project activities and implementations, the mathematics has been seen and validated as a multi-functional and multi-disciplinary

subject in school. One of the fundamental principles on which we are based is that the teachers need to be aware about their crucial position in school and about their need to reflect on difficulties and mistakes, to find the causes of them and to plan the interventions for remedial programming through efficacy strategies and tools of formative assessment.

In this perspective it is therefore necessary to train mathematic teachers not only in mathematics and didactics of mathematics, but also in the application of these disciplines in their own context. From this point of view, the solution lies mostly in the hands of teachers and teacher-trainers, more specifically in designing and giving them the instruments of educational planning and assessment.

6. FAMT&L view on the Formative Assessment

In 2008, Sattler has defined assessment as a way to understand a student, in order to make informed decisions related to classroom practices that involve him. In most theoretical frameworks for evaluation the first step of the evaluation process it is the diagnostic assessment, but it is quite of common knowledge that the evaluation process, and in particular the role of diagnostic and formative assessment, is often based on mechanical procedures influenced by implicit philosophies of each teacher, in particular in mathematics (Speranza, 1997).

Since the ’90s there has been a growing awareness about the need for significant changes in assessment practices of learning in mathematics and likely this is related to the fact that more and more mathematics has been identified as a key competence within the frame of life skills (Shepard, 1989; Webb & Coxford, 1993). The evaluation process is considered as an integral part of the learning process (Desforges, 1989) and the importance attached to the assessment in mathematics is reflected both by the impact of increasing disciplinary national and international standardized assessments (see, for example, OECD, 2015) and by the research work about the practices of classroom assessment (DES, 1987; NCTM, 1989).

In detail, as for learning mathematics, usually teachers assess knowledge, skills and abilities of students. In the school practice, assessment in mathematics is often divided and organized on the base of the content of teaching, although it is an increasingly shared notion that to properly assess cross components of learning is needed. In recent times especially there is an increasing interest on what competence in mathematics means and how it can be evaluated. FA is connected with a concept of learning according to which all students are able to acquire, at a adequate level, the basic skills of a discipline. Learning passes through the

use of teaching methodologies which can respond effectively to different learning time for each student, to different learning styles and to zones of proximal development.

Basing on these references and results, we adopt the following definition of *formative assessment:*

FA in the classroom is an assessment FOR teaching and learning.

It is part of the teaching-learning process and regulates it; it identifies, in an analytical way, the strengths and weaknesses of student's learning in order to allow teachers to reflect on it and maybe modify their own practices; it allows a formative feedback to establish a dialogue between teacher and student and to design educational interventions aimed to the recovery; it promote and foster the learning by all students through differentiated teaching that ensures each student different rhythms and different teaching and learning strategies; it *involves the students in the analysis of their own errors/weaknesses and their own ability to promote self- and peer-assessment and active participation in the teaching-learning process.*

It is intended to give information, feedback and feed forward – in and outside of the classroom – related to the development of mathematical life-skills. In particular:

- it addresses the different components and aspects of mathematical learning of the students (conceptual, procedural, communicative, semiotic);
- it is involved in analyzing problem posing and solving strategies, misconceptions, organization of mathematical experience, students' beliefs, students' image of mathematics and of specific segments of mathematics; students' behavior and classroom interaction when involved in different mathematical tasks;
- it is a critical issue to make clear what the outputs of teacher's choices are (transposition of mathematical contents, interface between contents and methods).

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3. THE LLP-Comenius FAMT&L Project

by *Federica Ferretti*, Athanasios Gagatsis***

1. Introduction

Teaching and learning processes concerning mathematics and sciences are a fundamental component of school activities, preliminary to most of the competences that are significant in life and necessary for the citizenship education. Nevertheless, despite researchers' and teachers' engagement, the crisis in mathematics learning is becoming very diffused and serious (OECD, 2015).

In order to contribute to the development of lifelong quality learning and to promote high performance, innovation and a European dimension in systems and practices in the field, the Comenius Project aims to:

- provide a methodological model and some valid materials for a quality proposal of mathematics teacher training in Europe-starting from an in-depth analysis of teachers' needs and on-going experiences in the different partner countries. In particular, the training proposal, within a lifelong learning perspective, is addressed to in-service mathematics teachers in order to significantly enhance their assessment competences.
- to promote in-service training of mathematics teachers through the design and implementation of a web repository of learning objects, such as video reporting significant classroom activities, assessment tools, etc. The repository will be an innovative product of the project, to be used in the future as an online resource for training activities addressed to mathematics teachers;
- to help young teachers (students and pre-service teachers) acquire the basic life-skills and competences necessary for their personal

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development, for future employment and for active European citizenship;
- to contribute to the improvement of in-service mathematics teachers' training through the design of specific on line support and the planning of pilot training courses, to be capitalized for the years ahead. The products of the project (repository and models training) aim to provide resources for the teachers training and staff development in Europe, adaptable to different contexts and always updated;
- to improve the quality of mathematics education in Europe and, therefore, to increase the level of basic skills in mathematics for secondary school students. Focusing on the relationship between teaching and formative assessment gives an opportunity to promote metacognitive and transversal skills (such as monitoring and self-control of learning from the students) in mathematics teaching processes.

The project, through some specific resources and actions for supporting in-service teachers training, aimed to improve mathematics teaching strategies for pupils aged 11-14/15. In particular, the focus on formative assessment methodologies in the classroom is crucial to make teachers really able to improve students' mathematics skills.

In details, the main goal of FAMT&L project consisted in realizing a training model (in blended modality) for middle school math teachers (that can be applied to in-service and pre-service training). This training model (or methodology) should improve teachers' competences:
- on educational planning and assessment (both formative and summative assessment; assessment for learning);
- on mathematics education.

As presented in chapter 6, teacher training goals are achieved.

2. The main topics of the Project

Teaching and learning processes concerning mathematics and sciences are a fundamental component of school activities, preliminary to many of the skills that are significant in life and necessary for the citizenship formation. Mathematics paves the way for different ways of thinking and applications that affect daily life allowing critical interpretation and assessment of the huge amount of information produced in the modern learning society. Moreover, it also determines the exercise of citizenship through logical reasoned and motivated decision-making on social issues.

Without adequate competence-building in mathematics (thinking, logical reasoning, etc.) it becomes virtually impossible to fully access this modern world made up by information, communication and technology.

This affects the opportunities for getting involved in social and economic life. This notion is also stressed in the concept of "mathematical literacy", as defined in the OCSE Programme for International Student Assessment – PISA (OECD, 2012) as the capability to identify, understand and engage in mathematics, and to make well-founded judgements about the role that mathematics plays in an individual's current and future private life, occupational life, social life with peers and relatives, and life as a constructive, concerned and reflective citizen.

Despite researchers' and teachers' engagement, the crisis in mathematical education and learning is becoming very diffused and profound. Mathematics tends to be seen by young and adults as an uninteresting discipline.

According to recent international research (OECD, 2012, Eurydice, 2012), the main difficulties in mathematics learning are represented by:

- a severe lack of mathematical skills among students aged 15th in many European countries (OECD, 2005) in relation to problems of the didactics of mathematics starting from the 11-14/15 years age group;
- teaching methodologies and pedagogic lack for almost all education sectors, a broad "sense of number" and the work with it, figures, measures, statistics and probability;
- incorrect use of formative assessment and need to introduce strategies of teaching and learning individualization;
- in general, rising de-motivation for school learning, starting especially in the 11-14/15 years age;
- more specifically, de-motivation for learning mathematics.

The 11-14/15 years age group appears to requests innovative and adequate interventions to improve their mathematical and – especially – numeracy skills, reclaiming both the lost ground in mathematical curiousness amongst youngsters, as well as bringing all students to obtain satisfactory results with a better and broader commitment to mathematical reasoning in any social-economic application.

Thus, designing innovative ways to invest in teachers' training for mathematics appears to be important, in particular through training paths that put teachers in collective planning situations and bring them building plans, strategies and methodologies for teaching mathematics effectively. Of course, this does not only mean to investigate on the subject, but also on the pedagogical-didactical learning strategies, in particular in the field of assessment, stressing on the value of formative assessment and individualized teaching strategies, planned to specifically respond to students' pace and learning styles.

For this reason, it was very important to trace mathematics teachers' beliefs and misconceptions about assessment in the classroom and to analyze learning activities in the classroom focusing on teachers' rationales

behind learning difficulties in mathematics, in order to design and plan adequate interventions for remedial programming.

At the same time, we think that each teacher should acquire the necessary competences for reflecting on the content of mathematical education as well as on the pedagogical-didactical aspects. This means an internal focus on mathematics itself and an external focus on the links of mathematics to other subjects. In both cases, it is important for teachers to learn, assess and diagnose students' learning needs and to give answers to them based on adequate teaching methodologies.

During all project activities and implementations, mathematics has been seen and validated as a multi-functional and multi-disciplinary subject at school. This is based on the fundamental principles that teachers need to be aware of their crucial position in school and their need to reflect on difficulties and mistakes, to trace their reasons and to plan the interventions for remedial programming, through efficacy strategies and tools of formative assessment.

In this perspective it was therefore necessary to train mathematic teachers not only in mathematics and didactics of mathematics, but also on the application of these disciplines in their own context. In this way, the solution lies in designing and giving instruments of educational planning and assessment to teachers and teacher trainers.

3. The partners of the project

Our project proposal was prepared capitalizing on some previous research experiences (and their achieved outcomes) conducted in many different countries and concerning the assessment of basic skills in the "junior high school", particularly in mathematics. Indeed, over the past 10 years, each partner of the project has conducting researches that allowed highlighting the important need for training mathematics teachers in the field of formative assessment.

The five Partner Members are all European University Institutions and have overall competence in pedagogy and didactics and mathematics.

In detail, the partners and respective research manager are the following:

- for Italy, Alma Mater Studiorum Università di Bologna (UNIBO), leader of the project with the Departments of Education Studies (Ira Vannini and Stefania Lovece) and Mathematics (Giorgio Bolondi, Federica Ferretti and Alessandro Gimigliano);
- for Cyprus University of Cyprus, UCY (Athanasios Gagatsis, Paraskevi Michael-Chrysanthou and Theodora Christodoulou);

- for Switzerland, University of Applied Sciences and Arts of Southern Switzerland – Department of Formation and Learning, SUPSI-DFA (Silvia Sbaragli and Miriam Salvisberg);
- for France, University of Cergy-Pontoise: UCP (Laurent Jeannin and Fathia Lograda);
- for Hogeschool Inholland/Netherlands' Hogeschool Inholland of Applied Sciences, Inholland (Rob Velder).

Each partner has contributed essentially and decisively to the project, providing their experience in various fields.

Members of Alma Mater Studiorum Università di Bologna were the leaders of the project. The Italian team consists of researchers, assistant and full professors of Mathematics, Mathematics Education and Education. The research team then provided the essential support at all phases of the project; especially in the construction of the shared definition of formative assessment in mathematics and of the FAMT&L grid of lesson analysis and in the design and implementation of the pilot courses. The research group, has been involved for many years in the professional development program of teachers at all levels of school both in didactics of mathematics in education and this experience has played a crucial role for the development of the project. The Alma Mater Studiorum Università di Bologna has also dealt with management; the team includes also present administrative and project managers of European projects and technicians, experts in usability and ergonomics in the web field.

The research team of the University of Cyprus is formed by professors of mathematics education, experienced researchers and PhD students in mathematics education. These experts have a strong experience and contributed significantly in data analysis, especially quantitative, using different statistical packages (ex. SPSS, Quest, EQS, Excel). Thus, the UCY team contributed to the analysis report, which includes the results of the survey on teachers' and students' beliefs and some directions for the pilot training courses aiming to improve the beliefs that emerged in the survey. Within the FAMT&L project the role of UCY was – apart from the tasks that are filled-in by all partners – focused on the educational/learning needs analysis, specifically towards the analysis of teachers' conceptions about teaching and assessment in mathematics. There was also a major role of UCY in the planning of the training pilot courses, together with SUPSI-DFA as WP co-leader. UCY provided also an important contribution for the realization of the project in its whole and, specifically in the process of dissemination, interacting with stakeholders at every phase of the project to the exploitation of the results.

Members of Netherlands' Hogeschool Inholland of Applied Sciences are researchers, project manager and ambassador; they are all experts

in Lifelong Learning and in Validation of Prior Learning Outcomes-systematics. The research team has been engaged for years in the design and in the development of one educational model based on competence based (lifelong) learning, implying that all teaching and learning activities concentrate on the professional competences to be acquired by students and maintained through life by them as professionals. This experience has been crucial for the validations and the monitoring of FAMT&L project.

The DFA – Departments of the University of Applied Sciences of Southern Switzerland SUPSI – research team is composed by teachers and researchers in mathematics education and in education. The SUPSI team provides initial teacher education to pre-service primary education teachers, a lot of pre-service secondary education teachers and continuing education to in-service teachers. All these programs combine theoretical modules, professional modules and research activities, in order to allow the development of scientific and professional skills. Applied research focuses in particular on the understanding and innovation of school systems, on teacher education and on education in general. This includes a clear focus on mathematics and science teaching and learning, which is researched by a pool of experienced researchers and teachers. This research team's experience played a crucial role in the design and implementation of the pilot course.

The University Institute of teachers training of Cergy-Pontoise University (UCP) was the biggest institute of France before the modifications of training programs. The institute is specialized in the education themes and have an important expertise in the development of the teaching and learning in distance Education and IT-Competences for teacher and learner. All UCP members who have collaborated on the project are experts in Educational/learning needs analysis, specifically towards the video analysis of mathematics teachers' practices. The contribution of the researchers' group was fundamental to the design and production of video and its video analysis.

Finally, a fundamental role is that they have associated schools at all different levels for collaboration within the project.

Each country has several "project-associated" schools with which the researchers cooperated during together during all phases of the project. Other schools were involved as well, although "not officially "associated", mostly in field of dissemination and exploitation. Teachers and students of the associated schools have played a key role in the different phases of the project. At the beginning of the project, both teachers and students, completed questionnaires that were used to outline the schools' educational needs regarding formative assessment in mathematics; some of them have also participated in interviews and the collaboration with them has

been crucial to deeply understand their needs within the school reality. Subsequently, research-training meetings were held where researchers and teachers discussed the results of the questionnaires, in order to understand and interpret them in a collaborative way. The researchers have thus led some professional development meeting about formative assessment in mathematics and in video-analysis tools and practices. Along with teachers, some key concepts that were then subject to video were outlined; partner staff went to the schools to produce videos of real classroom formative assessment situation in mathematics. Finally, in most of the partner countries, the teachers who participated in the various phases of the project were also participants of the pilot course that followed. The close and continuous collaboration with teachers and schools was crucial not only for teachers, but also for the development of the project.

4. The aims of FAMT&L Project

The Project aims to provide a methodological model and some valid materials for a quality proposal of mathematics teacher training in Europe, starting from an in-depth analysis of training teachers' needs and on-going experiences in the different partner countries. Subsequently, the project aimed to promote in-service training of mathematics teachers through the design and implementation of an online repository: an innovative product that we are using even now that the project is finished, as online resource for training activities addressed to mathematics teachers in the schools involved, and implementing each training teachers' national system. In particular, the FAMT&L training model has focused on changing the students' and teachers' beliefs on formative assessment of mathematics.

In particular, formative assessment, as a strategy to individualize teaching strategies and bring all students to achieve positive learning outcomes, is a key topic to affect change on mathematics teachers' "culture".

One of the major aims of our activities it is to be able to show the importance of formative assessment in order to make explicit to teacher that assessment:

- is not an instrument of power in their hands;
- cannot be used as extrinsic motivation for learning mathematics;
- is the key to make mathematics teaching adapted to the specific needs and students' learning styles.

Recapping, the FAMT&L project proposed an innovative path that, starting from an investigation of misconceptions and "bad" practices of mathematics teachers, got to design a virtual environment (a web

repository) for in-service teachers' training. This learning environment provides a variety of tools and objects (examples of learning contexts, video of situations of teaching mathematics, assessment tools, training' paths and their specific use in the teaching of mathematics), including a guideline to be used by in-service mathematics teachers that participate in training courses for secondary schools.

The main objective of this training methodology was to improve teachers' skills on the use of formative assessment in mathematics education in order to promote effective learning for all students.

5. The Phases of the Project

The methodological approach of FAMT&L project was based on achieving the above-mentioned objectives. It is focused on mutual decision making and regular exchange of information in order to ensure that all consortium members are involved in the network's progress. All partners committed themselves to share their knowledge and experience with the consortium, ranging from longstanding experience in: teaching and learning processes concerning mathematics, definition of training methodologies and strategies and assessment processes.

The project phases were the following:

1. The first part of the project has been dedicated to the analysis of teachers' learning needs through some specific qualitative and quantitative research methods (observations, interviews, questionnaires, survey, etc.).
2. In the second phase, the data collected from teachers and students were analyzed and the information that derived allowed to design an effective training model for teachers of mathematics.
3. In the third phase, the observation FAMT&L Grid for video analysis was designed and realized. All the videos were analyzed using the grid and have been then included into the web repository.
4. The fourth phase consisted of the design and development of the training model, realized as an action-training research, where teachers will be actively involved and trained to mathematics teaching and assessing competences as well as transversal competences such as:
   a) reflexive practice;
   b) self-assessment;
   c) planning and reporting methods;
   d) professional empowerment.

The support of video analysis tools and techniques was crucial for the effective implementation of the teachers training course.

During the various training courses implemented by each partner, questionnaires were provided to investigate the change in the teachers' beliefs and conceptions on formative assessment, and as described in chapter 6, there were actually positive results in this domain.

According to the planning of the project, the work was distributed to partners in Work Packages WP, as follows:

- Management (WP1);
- Elaboration of the Report on "teachers' and student's beliefs" about formative assessment in mathematics and hypothesis about teachers' learning needs (WP2);
- Elaboration of the Report on practices (or "bad practices") of the mathematics teachers and hypothesis about teachers' learning needs (WP3);
- Definition of the training model and realization of the pilot training courses (WP4);
- Design and implementation of the web repository for teacher training in mathematics (WP5);
- Analysis of the implementation of the pilot training courses in the associated schools partners (WP6);
- Dissemination and exploitation (WP7 and WP8).

Different partners were responsible of the processes aimed at reaching these milestones, under the overall guidance of the coordinator (UNIBO).

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4. Assessment in classroom: teachers' and students' beliefs

by *Paraskevi Michael-Chrysanthou*, Theodora Christodoulou*, Athanasios Gagatsis**

1. Introduction

In this chapter, the teachers' and students' beliefs about the purpose of formative assessment in mathematics in the five countries under study are analyzed and compared. Our focus is to study how students and teachers in each country perceive the purpose of formative assessment in mathematics and to explore whether the views between students and teachers resemble or differ between the five countries.

A questionnaire focused on the beliefs about formative assessment and assessment in mathematics in general was administrated to all participants. The participants were (Tab. 1) 308 Cypriot students, 460 Italian students, 340 Swiss students, 413 Dutch students and 128 French students filled the questionnaire. Respectively, 65 Cypriot teachers, 58 Italian teachers, 69 Swiss teachers, 51 Dutch teachers and 11 French teachers completed the questionnaire designed for the teachers.

In this chapter, we present the results about the students' and teachers' beliefs about the purpose of formative assessment in mathematics in the five countries participated in the project. Initially, a description and comparison of the participants' responses to the statements related to the purpose of formative assessment is conducted. Then, the results about the relations between these statements are presented, according to the hierarchical clustering of variables. For the particular analysis the computer software called CHIC was used (Gras, Régnier, Marinica & Guillet, 2013). This method of analysis determines the hierarchical similarity connections between the variables. The hierarchical clustering of variables is a classification method which aims to identify in a set V of

* University of Cyprus.

variables, sections of V, less and less subtle, established in an ascending manner. These sections are represented in a hierarchically constructed diagram using a similarity statistical criterion among the variables. The similarity stems from the intersection of the set V of variables with a set E of subjects (or objects). This kind of analysis allows the researcher to study and interpret clusters of variables in terms of typology and decreasing resemblance. The clusters are established in particular levels of the diagram and can be compared with others. This aggregation may be attributed to the conceptual character of every group of variables. In this study the similarity diagrams allowed for the arrangement of the statements into groups according to their homogeneity.

Tab. 1 - Participants of each Country

Students (N=1649)	**Cyprus (N=308)**	**Italy (N=460)**	**Switzerland (N=340)**	**Netherlands (N=413)**	**France (N=128)**
Grade 1	108	247	72	43	17
Grade 2	72	139	67	152	63
Grade 3	128	74	78 49	113	27
Grade 4	—	—	17 57	105	21
Teachers (N=201)	65	58	69	51	11

2. The questionnaires

A questionnaire for examining the teachers' beliefs regarding the purpose and use of formative assessment in mathematics was developed, based on an extensive literature review in mathematics education in relation to formative assessment and teachers' educational beliefs (Michael-Chrysanthou, Gagatsis & Vannini, 2014).

The questionnaire comprises of six parts. In the first part (Part A) the participants' demographics are asked. This part includes questions mainly about the participants' gender, age, education and teaching experience. In each of the rest five parts the participants mostly have to express their agreement or disagreement to different statements on a 4-point Likert scale (1=strongly disagree, 4=strongly agree). Negative statements are used as well, in order to increase the validity of the questionnaire. Specifically,

Part B includes 10 statements examining the first research axis, which is about the purpose of formative assessment. In Part C there are 21 statements about the use of different formative assessment techniques. In the next part (Part D) 7 statements are found, examining the participants' beliefs regarding the use of the results of formative assessment. Part E comprises of 12 statements for tracing the teachers' beliefs concerning mathematical errors. The last part (Part F) includes 16 issues of assessment on which the teachers' would like or not to be further trained on.

A questionnaire for examining students' beliefs for formative assessment was also developed (Michael-Chrysanthou & Gagatsis, 2015). Based on our literature review, various authors' opinions and research results were transformed to statements to be included in our questionnaire. Previous relevant research instruments were also traced, parts of which were taken as examples for forming some of our statements. The questionnaire comprises of two parts. In the first part (Part A) the participants' demographics (gender, age-class and school) are asked. Part B includes 44 statements for which students had to express their agreement or disagreement on a 4-point Likert scale (1=strongly disagree, 4=strongly agree). In fact, these statements reflected not only beliefs about formative assessment, but also about particular assessment practices used by the teacher or/and the students. This structure allows not only tracing the students' beliefs about formative assessment, but also to examine the relations between particular practices and the formation of positive or negative beliefs. The 44 statements were grouped according to four dimensions of formative assessment, as defined based on the results of our literature review. In fact, in the first group there were 10 statements about the purpose (P) of formative assessment. The second group included 8 statements about the use of different formative assessment techniques (T). In the next group there are 6 statements regarding the use of the results (R) of formative assessment, emphasizing on the use of students' mathematical errors. The last group includes 20 statements regarding the role of each stakeholder (S) in the formative assessment (students, teachers, parents). Representative examples of statements regarding the use of mathematical error are provided in the presentation of results.

3. Teachers' beliefs about the purpose of assessment in Mathematics

The table summarizes the teachers' beliefs regarding the purpose of formative assessment in the mathematics teaching and learning, as reflected by the 10 statements presented. Looking at the total score for

each statement, we can claim that the teachers' beliefs about the purpose of formative assessment are generally positive, as the average in the majority of the statements is above 3, which shows their (strong) agreement.

Tab. 2 - Mean of teachers' responses for the purpose of the assessment in the five countries

Variable	Statement	Cyprus	Italy	Switserland	Netherlands	France	Total
P1	Formative assessment establishes what students have learned in mathematics.	3.1	3	2.8	3.1	3.2	3
P2	Formative assessment identifies the students' strong and weak abilities in mathematics.	3.2	3.7	3.3	3.1	3.5	3.4
P3	Formative assessment identifies how students think in mathematics.	3	3.6	3	2.8	3.2	3.1
P4	Formative assessment should be based on the pupils' outcomes in math rather than on the process.	1.9	1.8	1.7	1.7	1.9	1.8
P5	Formative assessment should assess the students' ability to apply mathematics in unfamiliar everyday situations.	3.1	2.9	2.5	2.6	2.8	2.8
	The different assessment methods aim to assess the students'.	2.9	—	2.4	3.1	2.7	2.8
P6a	Knowledge (memorization): the ability to memorize rules, axioms, theorems and other mathematical information.	3.2	—	3.4	3	3.5	3.3
P6b	Comprehension (understanding): the ability to perceive mathematical meaning and to transform mathematical ideas from one form to another.	3.2	—	3.6	3.1	3.5	3.4
P6c	Analysis: the ability to analyze information and to arrive to mathematical conclusions.	3.1	-	3.3	3.1	3.2	3.2

Tab. 2 - continued

Variable	Statement	Cyprus	Italy	Switserland	Netherlands	France	Total
P6d	Synthesis: the ability to organize mathematical ideas altogether to form a complete image that has meaning.	3.2	—	3.3	3.2	3	3.2
P7	The purpose of formative assessment is to help students improve themselves in mathematics.	2.5	3.5	2.1	2.1	2.2	2.5
P8	Formative assessment is subjective while summative assessment is objective.	3.3	2.5	3.3	3	3.5	3.1
P9	According to the formative assessment results, I modify my instructional plan according to my students' needs.	3.1	3.5	3.1	2.9	3.3	3.2
P10	Assessing my students' is very useful for me, because it gives me a chance to verify the validity of my work.	2.9	3.7	2.8	3.1	3.2	3.1
	Total	3	3.1	2.9	2.9	3	

Looking at the total score for country, we also observe that the level of agreement in the different statements is slightly differentiated between the teachers from the five countries. In Cyprus, Switzerland and the Netherlands, teachers express their agreement in most of the statements, but not as strongly as the teachers from Italy and France for example, for whom we observe a stronger agreement in many of the statements. In fact the statements can be grouped into four categories.

In the first category there are six statements (P1 to P5 and P7) focusing on the role of formative assessment in the students' learning abilities and outcomes. Teachers from all countries mostly agree with the role of formative assessment in establishing what students have learned in mathematics, in identifying the students' strong and weak abilities in mathematics and the way students think in mathematics. This is why they express their disagreement to the fact that formative assessment should

be based on the pupils' outcomes in math rather than on the process. Thus, the teachers seem to realize that formative assessment focuses on identifying the students' reasoning and abilities, rather than measuring their performance. However, teachers' responses in the statement that *the purpose of formative assessment is to help students improve themselves in mathematics* are found in the middle of the scale. This result is in contradiction to the previous observation, which could be interpreted by the generality of the aforementioned statement, which probably inhibited teachers from expressing a strongly positive answer. Furthermore, the teachers rather agree that formative assessment should assess the students' ability to apply mathematics in unfamiliar everyday situations.

The second category reflects beliefs about assessing specific aspects of students' mathematical thinking (P6: a to d), such as Knowledge, Comprehension, Analysis and Synthesis. The teachers generally express positive beliefs in assessing these aspects of mathematical thinking, with the aspect of "Comprehension" to be the most important for them.

Two statements about the role of formative assessment in relation to the teachers (P9 and P10) form the third category. The teachers' agreement to these statements indicate that they recognize that formative assessment can have a positive impact on their planning and implementations, as it can work as a source for providing them feedback about the effectiveness of their teaching and a source of evidence about necessary future modifications for adjusting their teaching to their students' needs.

Finally, the last category includes the statement P8, which reflects the teachers' beliefs about the nature of formative assessment. Generally the teachers agree that formative assessment is subjective, compared to summative assessment, which is more objective. However, the power of this belief is not the same among the teachers from the five countries. Actually, the strongest agreement is observed in the French teachers, whereas the weakest is found in the Italian teachers.

In the similarity diagram for the Cypriot teachers' beliefs on the purpose of formative assessment (Fig. 1) three distinct similarity clusters are distinguished. In the first similarity cluster there are two statements referring to the students (S1 and S4), one statement about the teachers (P10), a statement about the nature of formative assessment (P8) and a statement about a specific aspect of students' mathematical thinking (P6a). In the first subgroup in this cluster the relation between the variables P1, P10 and P6d show that the teachers who believe that formative assessment establishes what students have learned in mathematics believe also that formative assessment is a source for verifying the validity of their work, and thus assessing students' knowledge (memorization) is important for them.

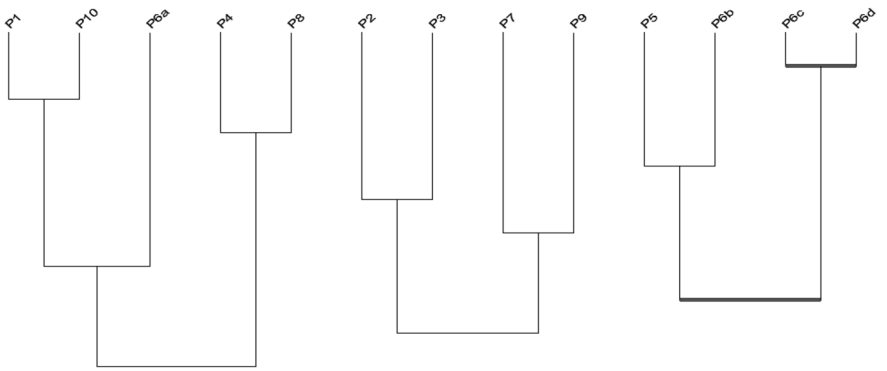

Fig. 1 - Similarity diagram of the Cypriot teachers' beliefs about the purpose of formative assessment

In the next cluster we observe coherence in the teachers' beliefs about formative assessment in relation to the students (P2, P3 and P7). This is why there are three statements about the students, which are related to a statement about the teachers (T9). The teachers have related beliefs about the benefits of formative assessment for the students' thinking, identification of their abilities and improvement in mathematics. These beliefs influence also their belief that their teaching should be modified in order to be adjusted to the students' needs. Thus, this cluster reveals that the Cypriot teachers seem to realize the positive effect of formative assessment on the students' mathematical thinking and that formative assessment can help them meet their students' needs and plan their next lesson in order to help their students as much as they need.

Four variables form the last similarity cluster of this diagram. One refers to the students (P5), whereas the rest three refer to specific aspects of students' mathematical thinking (P6b, P6c and P6d). Actually the teachers that consider important to assess the students' ability to apply mathematics in unfamiliar everyday situations, consider also essential to assess the students' comprehension, analysis and synthesis abilities. These dimensions of mathematical thinking are really important and directly related to applying mathematics in our lives.

The similarity diagram of the Italian teachers' beliefs (Fig. 2) is formed by three similarity clusters. In the first cluster we can distinguish two subgroups of variables.

In the first subgroup three statements regarding the purpose of formative assessment in relation to the students' learning are grouped

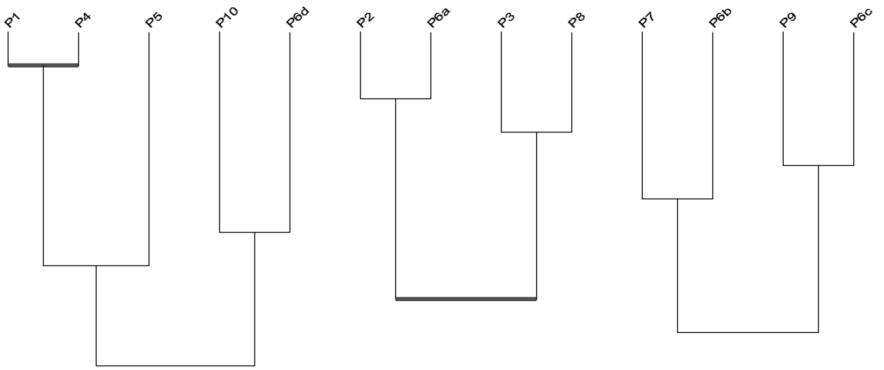

Fig. 2 - Similarity diagram of the Italian teachers' beliefs about the purpose of formative assessment

(P1, P4 and P5). In fact, a significant and strong relation is formed between the statements P1 and P4, indicating that the Italian teachers' belief that formative assessment establishes what students have learned in mathematics is strongly related to the belief that formative assessment should be based on the pupils' outcomes in math rather than on the process. In the second subgroup in this cluster we observe a relation between a statement that is related to the teachers (P10) and one statement related to a particular aspect of students' mathematical thinking (P6d). Particularly, the teachers' belief that assessing their students is a source for verifying the validity of their work is related to their belief that it is important to assess the students' Synthesis abilities. This is an indication that the Italian teachers focus a lot on the students' Synthesis abilities in order to verify the effectiveness of their teaching.

In the second similarity cluster four variables are significantly grouped. Two of these variables reflect statements about the purpose of formative assessment in relation to the students (P2 and P3), a statement about the nature of formative assessment (P9) and a statement about particular aspect of students' mathematical thinking (P6a). In fact the statements P2 and P6a form a first subgroup in this cluster, showing that the teachers' belief that formative assessment identifies the students' strong and weak abilities in mathematics is affected by the belief that it is important to assess the students' knowledge (memorization). Thus, for the Italian teachers assessing students' abilities to memorize rules, axioms, theorems and other mathematical information is important for tracing their strong points and weaknesses. The second subgroup in this cluster is formed by the statements P3 and P8. Therefore, the Italian teachers' belief that formative

assessment identifies how students think in mathematics affects their belief about the nature of formative assessment.

In the last similarity cluster two relations between four variables are formed. In fact, two statements about particular aspects of students' mathematical thinking (P6b and P6c), one statement about the teachers (P9) and one statement about the students (P7) are found. In the first relation the teachers' belief that the purpose of formative assessment is to help students improve themselves in mathematics is related to their belief about the importance of assessing the students' Comprehension (understanding). Thereafter, the Italian teachers appear the students' ability to perceive mathematical meaning and to transform mathematical ideas from one form to another as an aspect that shows their progress in mathematics. The next relation is about the belief that formative assessment can be used for helping the teachers modify their instructional plan according to the students' needs and the importance of assessing the students' Analysis abilities. Consequently, the Italian teachers consider important gathering evidence about the students' ability to analyze information and to arrive to mathematical conclusions for defining their students' needs and planning their future lessons according to them.

In the similarity diagram about the Swiss teachers' beliefs on the purpose of formative assessment three distinct similarity clusters are identified. In the first similarity cluster five variables are grouped, with three of them referring to assessing particular aspects of the students' mathematical thinking (P6a, P6c and P6d) and two of them referring to the students (P1 and P4). Specifically, students' Knowledge (memorization), Analysis and Synthesis abilities are important to be assessed for the Swiss teachers, in order to be able to establish what students have learned in mathematics and to focus on the pupils' outcomes in math rather than on the process.

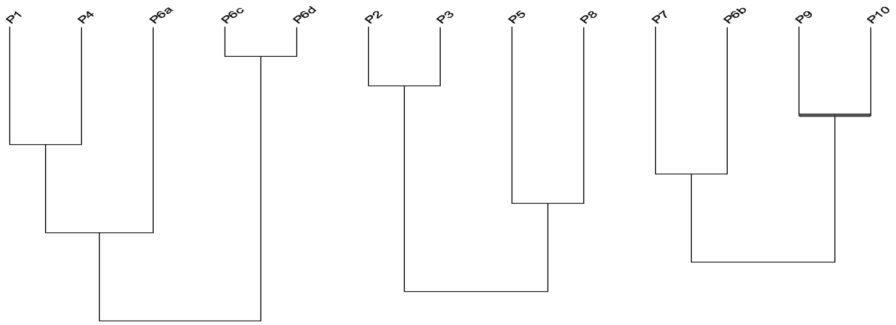

Fig. 3 - Similarity diagram of the Swiss teachers' beliefs about the purpose of formative assessment

In the next similarity cluster most of the statements regarding the purpose of formative assessment in relation to the students (P2, P3 and P5) are found together with the statement about the nature of formative assessment (P8). This cluster indicates the coherence in the Swiss teachers' beliefs about the effect of formative assessment in the students' learning and thinking. These teachers' beliefs that formative assessment aims at identifying the students' strong and weak abilities in mathematics, the way they think in mathematics and their ability to apply mathematics in unfamiliar everyday situations are coherent and influence their belief about the nature of formative assessment.

The last similarity cluster includes two relations between four variables. The first relation is formed between the belief that the purpose of formative assessment is to help students improve themselves in mathematics (P7) and about the importance of assessing the students' comprehension (understanding) (P6b). Therefore, the Swiss teachers consider the assessment of students' comprehension (understanding) as a way to help them get better in mathematics. The next relation is created between two statements about the purpose of formative assessment in relation to the teachers (P9 and P10). In fact, this is a strong and important relation, indicating coherence in this kind of beliefs. Actually, teachers recognize the important role of formative assessment in verifying the validity of their work and in modifying their next steps in relation to the students' needs.

The Dutch teachers' beliefs regarding the purpose of formative assessment are organized in three distinct similarity clusters, as shown in the Figure 4.

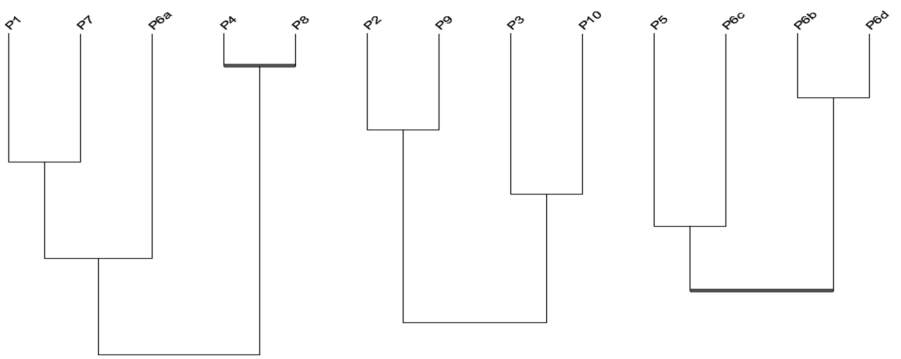

Fig. 4 - Similarity diagram of the Dutch teachers' beliefs about the purpose of formative assessment

In the first similarity cluster two subgroups of variables are distinguished. The first one is formed by the relation between two statements about the students (P1 and P7) and one statement about a specific aspect of mathematical thinking that should be assessed (P6a). This relation indicates that the teachers' beliefs that formative assessment has the potential to help students improve themselves in mathematics and that also establishes what students have learned in mathematics are interrelated. Those teachers' beliefs are related to the belief that students' Knowledge (memorization) is an important aspect of mathematical thinking to be assessed, as it is probably an indication for them about the students' learning and improvement. The second subgroup is formed by a significant relation between a variable about the students (P4) and a variable about the nature of formative assessment (P8). In fact, this relation shows that the teachers relate the fact that formative assessment should be based on the pupils' process in math rather than on the outcomes with that formative assessment is subjective while summative assessment is objective. Both those statements reflect the nature of formative assessment and thus this is probably why they are significantly related.

In the next similarity cluster four variables are related, two referring to the students (P2 and P3) and two referring to the teachers (P9 and P10). The first relation in this cluster reveals that the teachers realize the benefits of formative assessment in identifying the students' strong and weak abilities in mathematics (P2) and that this is important for them in order to modify their instructional plans according to their students' needs (P9). The second relation shows a similar realization, as the teachers' belief that formative assessment identifies how students think in mathematics (P3) is related to their belief that assessing their students is very useful for them as it help them verify the validity of their work (P10).

The last similarity cluster is formed by the significant relation between four variables. Three of them refer to particular aspects of the students' mathematical thinking (P6b, P6c and P6d), whereas the other refers to the students (P5). In particular, when the teachers believe that formative assessment should assess the students' ability to apply mathematics in unfamiliar everyday situations, they also consider important to assess students' Comprehension (understanding) and Analysis and Synthesis abilities. Thus, those dimensions of mathematical thinking are discriminated by the teachers as the most necessary for using mathematics in everyday life.

The relations between the French teachers' beliefs are illustrated in Figure 5. In this diagram the teachers' beliefs are organized into two similarity clusters, which are for the first time related significantly. Thus, this is the first time that coherence appears between the teachers' beliefs regarding the purpose of formative assessment.

In the first similarity cluster two subgroups are observed. In the first one five variables are significantly related. Specifically, one variable related to the students (P1) is related to four variables regarding specific aspects of students' mathematical thinking (P6a, P6b, P6c and P6d). In fact, this relation reveals that when teachers believe that formative assessment establishes what students have learned, they consider important to assess the students' Knowledge (memorization), Comprehension (understanding), Analysis and Synthesis abilities. The second subgroup consists of a relation between a variable related to the students (P4) and a variable about the nature of formative assessment (P8).

In fact, when the teachers consider that formative assessment should be based on the pupils' process in math rather than on the outcomes they also believe that formative assessment is subjective while summative assessment is objective. Actually, both statements refer to the nature of formative assessment and this can explain their significant relation.

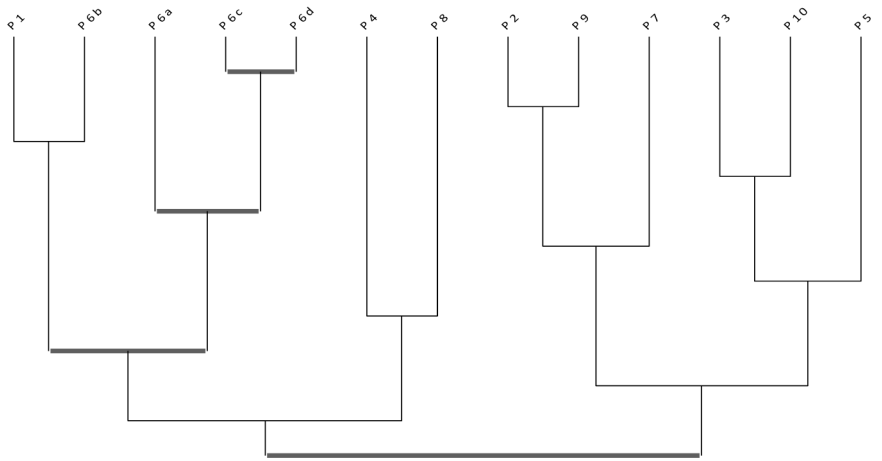

Fig. 5 - Similarity diagram of the French teachers' beliefs about the purpose of formative assessment

Similar to the first similarity cluster, the second one consists also of two subgroups. In the first subgroup, a relation is formed between two variables about the students (P2 and P7) and a variable about the teachers (P9). These relations indicate that for the teachers who believe that formative assessment can contribute in identifying the students' strong and weak abilities in mathematics (P2), formative assessment is a

source for providing them evidence in order to modify their instructional plans for satisfying their students' needs (P9). In relation to these, they also believe that among the purposes of formative assessment is to help students improve themselves in mathematics. Thus, the teachers recognize that the benefits of formative assessment are affected by the teacher-students interaction. The second subgroup includes the relation between two variables about the students (P3 and P5) and a variable about the teachers (P10). Actually, this relations show that the teachers' belief that formative assessment identifies how students think in mathematics (P3) is related to their belief that assessing their students is very useful for them as it help them verify the validity of their work (P10) and that formative assessment should assess the students' ability to apply mathematics in unfamiliar everyday situations (P5). Thereafter, this relation reveals once again the teachers' recognition that formative assessment can have positive effects both on the teachers and the students and that the interaction between them is an important aspect for the effective use of formative assessment.

4. Students' beliefs about the purpose of assessment in Mathematics

The following table (Tab. 3) summarizes the students' beliefs about the purpose of assessment in the mathematics teaching and learning, as reflected by the 10 statements presented. Looking at the total score for each statement, we can claim that the students' beliefs about the purpose of formative assessment are neutral, as the mean in the majority of the statements is between 2 and 3, which shows a relative agreement in the statements, but not strong. Looking at the total score for each country, we also observe that the level of agreement in the different statements is slightly differentiated between them. In Netherlands and France the students express less agreement in most of the statements, compared to the rest of the countries. In fact the statements can be grouped into two categories, according to the domain they refer to.

In particular, the first category consists of five statements (P1 to P5) focusing on the purpose of the formative assessment in the students' cognitive domain and in their understanding. Students from all countries mostly agree with the role of formative assessment in the identification of their good skills in mathematics. This statement (P1) has the highest mean, which shows that the students' realize more explicitly this purpose of assessment. The rest four statements included in the first category present a lower mean. This indicates that most of the students from all the

Tab. 3 - Mean of students' responses for the purpose of the assessment in the five countries

Variables	Statements	Cyprus	Italy	Switserland	Netherlands	France	Total
P1	Assessment helps me identifying my good skills in math.	2.8	3	2.9	2.9	2.6	2.8
P2	Assessment does not help me facing my difficulties on a mathematical subject.	2.8	2.9	2.1	2.5	2.6	2.6
P3	The grades that I receive on a math test cannot show if I have understood the mathematical subjects I have been taught.	2.6	2.2	2.5	2.5	2.6	2.5
P4	Some assessments serve to verify only what I have understood on a mathematical subject and not for our grade report.	2.5	2.8	2.7	1.8	2.6	2.5
P5	When feedback is continuous I feel I have a foundation that helps me to understand what I am learning in math.	2.6	2.6	2.6	2.5	2.5	2.6
P6	Assessment in math provokes me anxiety.	2.2	2.7	2.5	2.1	2.5	2.4
P7	I feel more confidence about myself when I have more frequent feedback about my progress in a mathematic subject.	2.9	2.9	2.7	2.3	2.4	2.6
P8	Assessment information motivates me to set new goals in learning math.	2.6	3.2	3	2.3	2.6	2.7
P9	When I am not satisfied about the grades that I have received for my working in math, I have to try harder.	3.2	3.4	3.2	2.9	2.4	3
P10	The grades and the reports in math do not force me to work when I don't want to do.	2.7	2.1	2.6	2	2.4	2.4
	Total	2.7	2.8	2.7	2.4	2.5	

countries agree less with these statements and thus their beliefs about them are more neutral. It is noteworthy that the students' beliefs about the statement P4 are very different between Netherlands and the rest countries under study. In particular, the Swiss students disagree with this statement, while most of the students in the other countries agree that "*some assessments serve to verify only what they have understood on a mathematical subject and not for our grade report*". Generally, most of the students seem to have positive beliefs regarding the role of assessment in their cognitive domain, because the average in all the statements is higher than two.

The second category includes the statements P6 to P10, which refer to the role of assessment in the students' affective domain (e.g. anxiety, satisfaction, motivation). At a first glance, we observe that students in Cyprus, Italy and Swiss are more positive than those in Netherlands and France in these five statements. In general, most of the statements indicate the neutral beliefs of the students in all countries. A differentiation appears in the statement P9, which presents the biggest agreement by the students from all countries except France. The results of the statements in this category bring us to the conclusion that assessment does not have such a large impact on the students' affective domain.

In the first similarity diagram (Fig. 6) about the Cypriot students' beliefs, two similarity groups are formed, which are not connected. This is an indication that the Cypriot students do not have a coherent view about the purpose of assessment in mathematics.

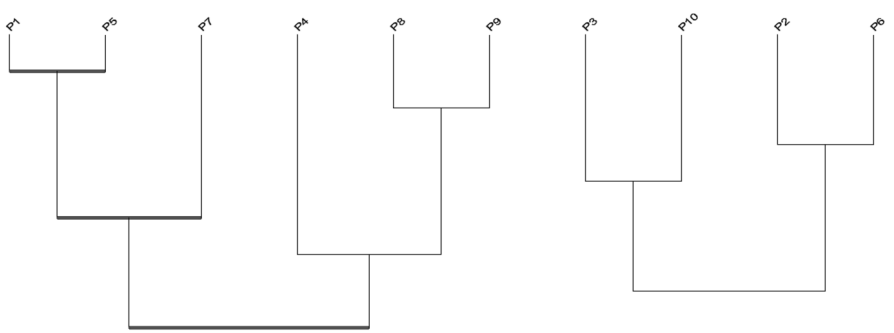

Fig. 6 - Similarity Diagram about the Cypriot Students' Beliefs about the Purpose of the Assessment in Mathematics

The first similarity group comprises of six variables that are divided into two subgroups. The first subgroup includes the variables P1, P5 and P7,

which are significantly related. Among these three variables, the strongest and significant similarity relationship is identified between the variables P1 and P5, which refers to the students' cognitive domain. In particular, they refer to the possibility that assessment provides to the students for identifying their strengths and verifying their understanding in mathematics. These two variables are linked with the variable P7. The second subgroup consists of three variables (P4, P8, P9), which are connected because they refer to the students' motives for assessment and their affective domain in general. Specifically, the strongest similarity relationship is observed between variables P8 and P9, which are related with the students' motives and how these are affected after an assessment. Among all the variables that form the first similarity group a weak, but significant similarity relationship is observed. This probably occurs because the variables that form this similarity group refer to the positive dimension of assessment, especially to the students' cognitive and affective domain.

The second similarity group includes two pairs of variables, which are grouped because they highlight the negative aspect of assessment in both the cognitive and the affective domain of the students. In particular, we observe that the strongest similarity relationship lies between the variables P2 and P6. According to these two variables, the assessment does not help students to overcome their difficulties in mathematics and this causes anxiety to the students. The variables P3 and P10 are also strongly related and they refer to the negative influence of grading on the students' understanding of mathematical concept and their effort to overcome their difficulties.

In the similarity diagram (Fig. 7) for the Italian students we observe that two similarity groups are formed, which are not connected. This is an indication that the Italian students do not have a general view about the purpose of assessment in mathematics, but they isolate some of its aspects.

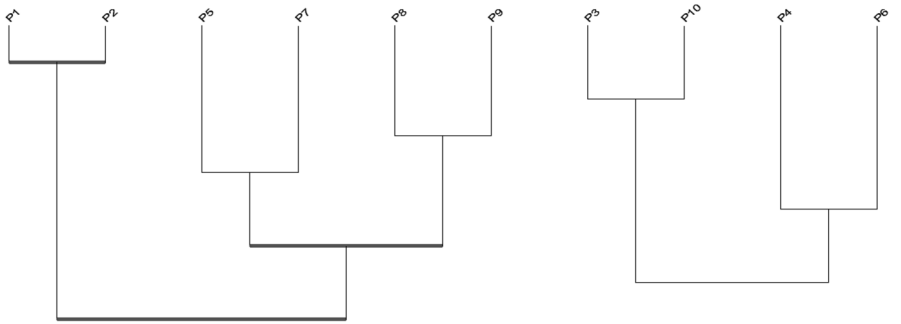

Fig. 7 - Similarity Diagram about the Italian Students' Beliefs about the Purpose of the Assessment in Mathematics

Analyzing each similarity group separately, we observe that the first similarity group comprises of six variables that are divided into two subgroups, which are significantly related. The strongest and significant similarity relationship lies in the first subgroup and links the variables P1 and P2. The grouping of these variables has probably emerged due to the fact that they refer to the students' strengths and difficulties in mathematics. However, the relations in the two pairs of variables that form the second similarity subgroup appear less strong but still significant. These variables are connected because they are related with the students' affective domain. In particular, in the second subgroup, the strongest similarity relationship is observed between the variables P8 and P9, which mainly refers to the students' motives and how these may be affected by an assessment. The pair of variables P5 and P7 also forms a strong similarity relation. These variables refer to the students' affective domain, which it seems to affect their learning in mathematics.

The second similarity group includes two pairs of variables which are grouped because they refer to the negative aspect of assessment on the students' cognitive and affective domain. In particular, we observe that the strongest similarity relationship in this similarity group is identified in the pair of variables P3 and P10, which are related to the negative influence of grades on the students' mathematical understanding and their effort to overcome their difficulties. The variables P4 and P6 have a less strong relation, but according to them, some assessments may be conducted in order to verify the students' understanding and not exactly for the purpose of the grade in the progress report. However, these kinds of assessment cause anxiety to the students.

In the following similarity diagram (Fig. 8) about the students from Swiss two similarity groups are formed, which are not connected. This is an indication that the Swiss students' beliefs are compartmentalized.

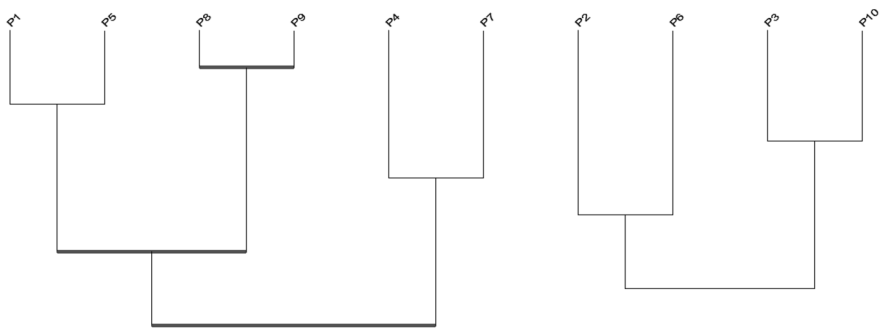

Fig. 8 - Similarity Diagram about the Swiss Students' Beliefs about the Purpose of the Assessment in Mathematics

Analyzing each similarity group separately, we observe that the first similarity group consists of six variables that are divided into two subgroups. The first subgroup connects the variables P1, P5, P8 and P9, which are significantly linked. The variables that form the first similarity subgroup refer to the positive dimension of assessment, especially to the students' cognitive and affective domain. In particular, the strongest and significant similarity relationship is identified between the variables P8 and P9, which are related with the students' motives and how these are affected after an assessment. The pair of the variables P1 and P5 also appears with a very strong similarity relation between the two variables, which refer to the students' cognitive domain. In particular, they refer to the possibility that assessment provides students the possibility to identify their strengths and verify their understanding in mathematics. The second similarity subgroup consists of the variables P4 and P7, which refer to the students' understanding and their progress in mathematics. In general, among all the variables in the first similarity group, we observe a weak, but significant similarity relation. This probably occurs because the variables that form this similarity group refer to the positive dimension of assessment and especially to the students' cognitive and affective domain.

The second similarity group is formed by two pairs of variables which appear a relatively weak similarity relation, but they are grouped because they are related with the negative aspect of assessment, in both the cognitive and the affective domain of the students. In particular, we observe that the strongest similarity relationship in this similarity group is identified in the pair of the variables P3 and P10. These variables are related with the negative influence of the grade on the students' understanding of mathematical concept and their effort to overcome their difficulties. The similarity relation between the variables P2 and P6 is quite strong and according to these variables, the assessment does not help students to overcome their difficulties in mathematics, so this stresses them.

In the next similarity diagram (Fig. 9) for the Dutch students we observe that two similarity groups are formed, which are not connected. This is an indication that the Dutch students' beliefs about the purpose of assessment in mathematics are not comprehensive.

The first similarity group comprises of six variables which are divided into two subgroups. The first subgroup connects the variables P1, P5, P7 and P8, which appear a relatively weak, but significant similarity relation. However, the variables that form the first similarity subgroup refer to the positive dimension of assessment, especially to the students' cognitive and affective domain. In particular, the strongest and significant similarity relationship is observed between the variables P7 and P8. These variables are related with the students' confidence and motives and how

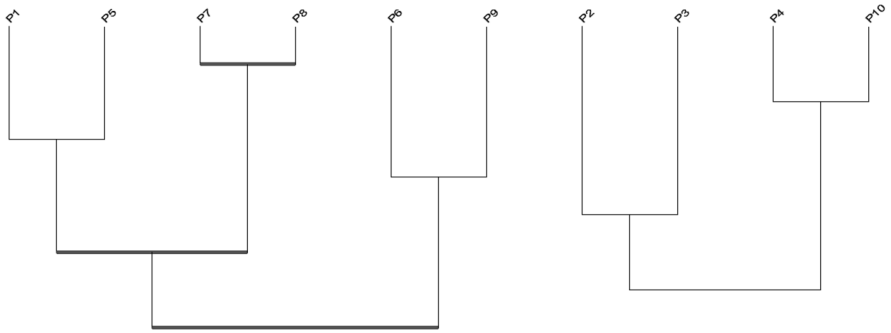

Fig. 9 - Similarity Diagram about the Dutch Students' Beliefs about the Purpose of the Assessment in Mathematics

they are affected by an assessment. The pair of the variables P1 and P5 also appears with a strong similarity and it refers to the students' cognitive domain. In particular, they refer to the possibility that assessment allow students to identify their strengths and verify their understanding in mathematics. The second similarity subgroup consists of the variables P6 and P9, which appear a strong similarity relation and refer to the impact of assessment on the students' affective domain. In general, among all the variables of the first similarity group, a weak but significant similarity relationship is observed. However, the similarity relation between these variables is very weak so that, the grouping of two subgroups of the variables cannot be precisely interpreted. However, we could say that the first similarity group is composed of two groups of variables that link the two dimensions of assessment; the positive one in the first subset and the negative one in the second subgroup. Also, most of the variables in both subgroups mainly refer to the students' affective domain and how it is affected (positively or negatively) by assessment.

The second similarity group consists of two pairs of variables which appear very weak similarity relations. However, these variables are grouped because they are related with the understanding of mathematical concept and the general impact of assessment in students' cognitive domain. In this similarity group, the strongest similarity relationship is found in the pair of the variables P4 and P10, which refers to the grade of the assessment and its effect on the effort of the students in order to overcome their difficulties. The similarity relation between the variables P2 and P3 is quite strong and according to these variables, the assessment does not help students overcome their difficulties in mathematics, nor gives information about students' understanding for the mathematical concept.

In the last similarity diagram (Figure 10) about the French students' beliefs we observe that two similarity groups are formed, which are not connected. This is an indication that the French students do not have coherent beliefs about the purpose of assessment in mathematics.

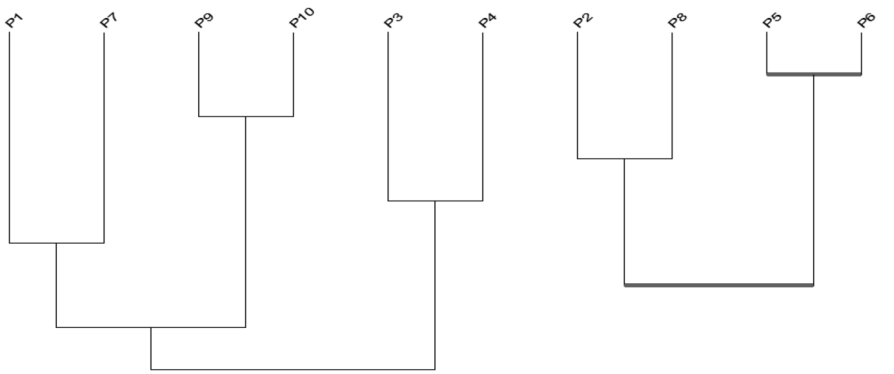

Fig. 10 - Similarity Diagram about the French Students' Beliefs about the Purpose of the Assessment in Mathematics

The first similarity group comprises of six variables which are divided into three pairs. The strongest and significant similarity relationship links the variables P9 and P10, which refer to the students' affective domain and to the grades that result from assessment. Less strong similarity relationship is presented by the variables P3 and P4, which are related to the students' understanding of the mathematical content and how the assessment helps them verify if they understood the content taught. A weaker similarity relation is found between the variables P1 and P7, which are not related to each other. A very weak similarity relation is observed connecting all the variables of the first similarity group. However, they are grouped because most of them refer to the grade and the information given by assessment about the students' understanding of the mathematical content taught.

The second similarity group consists of two pairs of variables which are related with a very weak but significant relation. However, they are grouped because they represent statements that mostly refer to the impact of assessment on the students' affective domain. In particular, we observe that the strongest and significant similarity relationship in this similarity group is found in the pair of variables P5 and P6, which refers to the students' affective domain and how it is influenced either positively or negatively by the assessment. The variables P2 and P8 form a less strong

similarity relation and they refer to the role of assessment in addressing students' difficulties in a mathematical content and setting new goals in learning of mathematics.

5. Conclusions

The teachers from all the countries have positive beliefs about the purpose of formative assessment in their teaching and the students' learning. They realize that formative assessment can have a positive impact on their teaching, as it helps them recognize their students' thinking, understanding and level of abilities and thus can use this information for adjusting their next lessons in relation to the students' needs. Students are also improved by this process, as their needs, abilities, conceptions and misconceptions are identified and proper actions are designed according to them. The only point that the teachers' beliefs are slightly differentiated regards the nature of formative assessment, either as subjective or objective, in contrast also to the summative assessment. However, they seem to consider summative assessment as more objective in relation to formative assessment.

The students from Cyprus, Italy and Switzerland have most positive beliefs about the purpose of the assessment both in the cognitive and affective domain. The biggest agreement between the students from all the countries appears in the view that "*when they are not satisfied about the grades that they have received for their working in math, they have to try harder*". However, in fact, the students' beliefs from all the countries are not clearly positive towards the role of the assessment in mathematics, but we could claim that they are mainly neutral. Thus, the impact of the assessment in students' understanding about mathematics or their feelings about mathematics is not very large.

Generally, the students' conception about assessment possesses some formative characteristics, but they do not consider assessment generally as formative. On the other hand, they tend to link assessment with grading, thus summative assessment is more grounded in the students' beliefs. This can be explained in relation to the students' learning and teaching experiences, which seem to apply assessment in a more summative form. However, their teachers seem to give a more formative character to assessment, as they agree with the benefits of formative assessment on the students' learning and on the improvement of their own practices. This brings us to the conclusion that there is a contradiction between the teachers' beliefs about the characteristics of formative assessment and their actual assessment practices in classroom.

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5. Theoretical framework of video-analysis methodology

by *Laurent Jeannin**

1. Introduction

In research, there is a question which is not insignificant: collecting and using the data. The FAMT&L project has two objectives. The first is to have a state of representations of a category of teachers, on the notion of formative assessment, in a particular discipline, here mathematics at a given level of education: secondary. On the basis of these results, it is then proposed to set up a training program for novice teachers (beginners) based on video excerpts. Three issues emerge from the two above-mentioned objectives, namely, whether the video data in question should enable:

- to compare the «declarative representations» of teachers and their actual or non-actual implementation in real situations?
- to provide training support and thus to present all the characteristics necessary for the exercise of training of type autoscopy?[1]
- to be both?

In order to work on this point of view, the project consortium first took note of the history of video data in social sciences and humanities research and then decided and applied a method of collecting, processing, cutting and use in training sequences. This chapter therefore aims to take the different stages worked during the project around the notion of video data.

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1. Autoscopy is a concept of video training: autoscopy is literally a self-focused look through the image. Through autoscopy, we can analyse his professional practice.

2. Point of view of history/representations of the uses of the videos in researches

There are two contradictions in research in Arts, Humanities and Social Sciences: (1) distrust of the visual and (2) the explosion of technology and mass consumption of images, which have consequences:

- Theoretical and methodological construction of the visual appeal;
- Data analysis methodology to implement;
- Archiving, metadata.

The researchers use different ways of video data, which you can find some examples below:

- Anthropology and Sociology: photo and documentary film;
- Visual Cultural Studies: Visual Culture, receipt and consumption of public images, media;
- Mass Media studies;
- Women/Feminist Studies: Critical to the use of images of the female body (Cartwright);
- Studies of social interaction in sociology/linguistics analysis of the organization of action, social practices, analysis of the uses of language located, Corpus audio from the 60s to today, video;
- Study gestures (psychology, linguistics, etc.);
- Ergonomics, workplace studies; study of work situations;
- Study of Sign Language;
- Science education, for example: Observation and Research Centre on the teaching of mathematics and Michelet Schools Talence: COREM, TIMSS, CLASS…

In summary of this non-exhaustive list of research applications in the Arts, Humanities and Social Sciences, we can easily realize that the collect of video data and its use do not have the same objectives involving different methods: situation called "authentic" "to be a reflection of a culture at a specific moment, or to allow the collect of a trace of a social or cultural phenomenon before its extinction, the researcher who positions himself as the one who films or even orchestrates a situation "In the laboratory" to have all the characteristics that are necessary.

2.1. *Point of view of Historical References*

- Late nineteenth century, Haddon uses the movie to fix the population costume of Strait Toress.

Fig. 1 - Malu-Bomai Ceremony at Kiam – Torres Strait Islander Ceremony Documentary, Anthropological Footage, Travelogue). Haddon, Alfred Cort. (non-indigenous director/anthropologist), 1898

The researchers did use films between the two wars: eg documentary film by Grierson. The visual anthropology explicitly begins with Mr. Mead and Bateson in the case of the study of Balinese culture: a film to exceed the limits of verbal language and to tell/show "etos the" eg "the intangible aspects of culture".

In the interdisciplinary project The natural history of an interview (1955), there are a multi-disciplinary analysis of a film documenting the psychiatric consultation Bateson with Doris patient and a participation of Birdwhistell, which is developing a system of transcription and precise kinetic annotation video data:

- *Our primary data are the multitudinous details of vocal and bodily action recorded on this film. We call our treatment of such data a "natural history" because a minimum of theory guided the collection of the data. The cameraman inevitably made some selection in his shooting; and "Doris", the subject of the interview, was selected for study not only because she and her husband were willing to be studied in this way but also because this family suffered from inter-personal difficulties which had led them to seek special psychiatric aid.*
- McQuown, 1971, The Natural History of an Interview. University of Chicago Library Microfilm Collection of Manuscripts in Cultural Anthropology, series 15, Nos, 95-98.

The pioneers of the Video are Kendon and Goodwin, Adam Kendon who is a pioneer in the study of gestures in a natural situation: movies from the 60s and Charles Goodwin who is the global standard for multimodal interaction study: movies from the early 70s.

2.2. *Point of view of diversified uses*

The diversified uses of video in research in Humanities and Social Sciences are listed in the following non exhaustive list:

- Dissemination of content: a viewer to read:
  - video results as restoring means or used for communication;
  - cutting by chapter or streaming.
- Elicitation of speech organized by researchers:
  - video-elicitation (Krebs, 1975 Balinese dance in a quasi-experimental perspective Asch 1980 trance in Bali, in a phenomenological perspective);
  - self-confrontation in ergonomics (Theureau), clinical psychology (Clot).
- Documentation of events, activities, social practices to an analytical reading:
  - active viewing, selection of extracts, navigation in the video;
  - video as material given corpus (Kendon Goodwin).
- Referential reading versus praxeological reading:
  - referential reading emphasizes content, like video memorial and informational support;
  - praxeological reading favors the organization of the action video as making available a phenomenon to be analyzed in its temporality and dynamism (in game process). fundamental importance of time: both the overall time for action and time details of a movement, an adjustment to the other.

In conclusion, first developed in the United States, research on teacher practice resulted in many works. They have long been enrolled in a paradigm of "process-product" by identifying variable categories (Durand, 1996; Anderson, 1983; Brophy, 1983; Doyle, 1983, 1986; Crahay, 1989) that influence student learning but reducing the study of the teaching process only to observable behavior of the teacher. These studies were designed to determine the "effectiveness" of education (Walberg & Fowler, 1991) and are still present today with a consideration of the "performance" of pupils (TIMSS, 1995 and 1999).

Secondly, researchers have developed the cognitive models "thinking of teachers" (Shalvelson, 1981; Tochon, 1993) who studied the cognitive

nature of education: preparations, planning and decision making affecting practices.

Thirdly, the "ecological" models have rehabilitated the importance of the "situation" (Bronfenbrenner, 1986) or the instructional. Finally, in last decade, interactionist and plural models (Robert, 1999; Rogalsky, 1999) have developed. They articulate several types of variables: the teacher, the learner and the "situation".

According to Beillerot (1998) "*the practice, although they included the idea of the application, do not immediately return to how and gestures, but the methods to do. The practice is at once the rule action (technical, moral, religious) and the exercise or its implementation. This is the double dimension of the concept of practice that makes it valuable: on one hand, gestures, behaviors, languages; the other, through the rules, these are the objectives, strategies, ideologies which are invoked*".

In order to treat teachers' practices, researchers have usually two methods: taking open notes (written notes, schemes, drawings) or the use of a coding grid, sometimes supplemented by copies of documents or a collection of objects created or used (Barron, 2007). The problem is the number of constraints that occur during their use: the accuracy of the human eye, write speed when taking notes, the necessity of a long immersion in a population, reproducibility of data, elaboration of observation grids before observation and determination of categories.

3. Methods for recording video in the classroom

Since the development of digital technologies and the extension of the video in the educational research field, different methodological practices to collect and to analyze data from video recordings have emerged.

3.1. *Video recording equipment in classroom settings*

The primary concern before starting to record practices on the classroom should be the choice of the video camera(s) and the positioning of the camera(s).

Before questioning the technical protocol, it is necessary to define, based on the theoretical framework, the types of data required. For example, access the contents of knowledge exchange between students need to have a quality recording, but whose? a student dyad, but then how to choose? how will they be representative of the entire class, an entire age? to have simultaneously the teacher, class and several pairs or groups

of students? Each of the protocols we have just stated affects the sound acquisition device and therefore the effect of the record.

Recording a group of students need to have a strong and clear sound for each student in the group, so at least two devices are possible:

- an area microphone in the group center, on a table in height (10 to 15 cm) to avoid taking the sounds of objects against the table and good distances mouths. One micro manage, but also risks to not hear a student who moves too far or not actually in front of the microphone;
- a wireless microphone per student and thus we have a high-quality sound reproduction for every student. Depending on the number of students in the group, it can be complicated to manage multiple frequencies, multiple batteries for the microphones, multiple receivers, a mixer to combine all sources on a single recording track.

Regarding the teacher, two methods are possible:

- with a unidirectional microphone gun manipulated by an external operator to the teaching sequence. A sound of a high quality without battery problem, but someone outside the class that always drives a shotgun microphone in the direction of the teacher;
- with a wireless microphone, without the pressure of the shotgun microphone but with risks of tapping the microphone to have a battery concern, or a reception problem between the microphone and the receiver.

Then, as the analysis will focus on the articulation between the various resources: teacher talk, room ambience, issue of students in class, groups… so it will be necessary to have synchronization all sound sources.

Two devices are also possible:

- Like in the movies, with a "clap" start, which is present on each sound recording and then allows it to declare clap as the zero time on what is called the time code?
- Merge all sources into a single source.

In the same perspective as the sound recording, the video recording situations must meet several requirements for researchers to exploit. First, the record must be very good, so the image should not be underexposed or overexposed, it must include all the information related to the sound capture. For example, it can be detrimental for analysis to have the sound and not the picture or vice versa. Several cameras are sometimes necessary, when data need to be the teacher, class and several groups of students.

Veillard (2013) analyze some research works in order to make the statement of video data collection methods. The characteristics of the situations studied (lessons in the classroom, lectures, practical work, interviews with teachers and/or students, or preparatory meetings between teachers) limit the variety of devices. He lists and describes just four

types of video-recording devices developed by researchers to film teaching situations.

The first technical solution (for recording the entire class) supposes two cameras (a first camera equipped with a wide-angle lens on a tripod in a top-class area, with a wide static shot of the students and a second camera on a tripod in a corner in the back of the class with a static shot of the area around the table), a wireless lapel microphone worn by the teacher, one or more wireless lapel microphones worn by students to capture verbalizations in class (see the Figure 2).

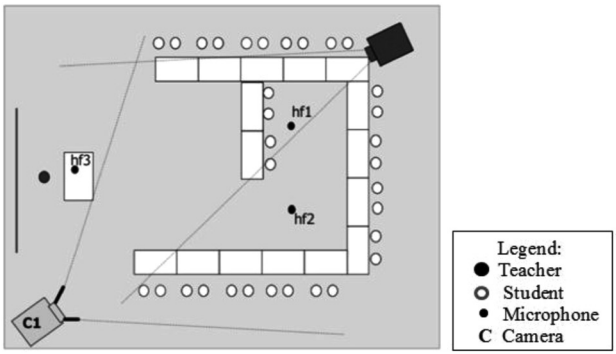

Fig. 2 - Video device for recording the whole class

One version of this solution is presented in TIMSS project. The main idea in this project is to keep one static camera (on a tripod) and to use a second moving camera in two ways:

- On the tripod but by allowing framing changes during recording (for example: track the movements of the teacher, or some students.
- On the shoulder which allow to follow certain actors or certain artifacts
- A second solution is a binomial device. The equipment necessary in this case is composed by a camera on a tripod, with a static shot of the pair or small group of students studying with, in the background, depth of field on the immediate environment of the group; one or more wireless microphones to the students in this group; a wireless microphone on the teacher (see the Figure 3).

Another technical solution listed by Veillard (2013) is a mobile device for video recording adapted for kindergarten classes (as in French kindergarten classes) which are often divided into several areas where students are temporarily divided by type of activity. Because children are moving much from one to another zone, a camera up with wide static

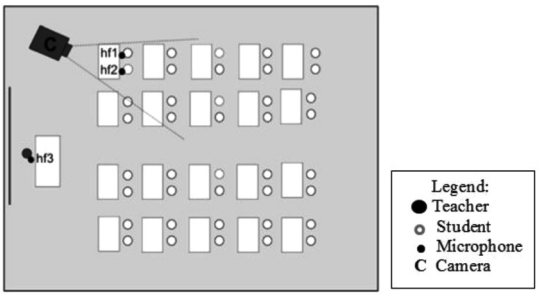

Fig. 3 - Binomial video device

shot is usually not precise enough to capture what is happening in a given area. In this case, a second camera mobile, shoulder, will allow following the movements of children, including outside the class if the educational activity considered the leads to it (see Figure 4).

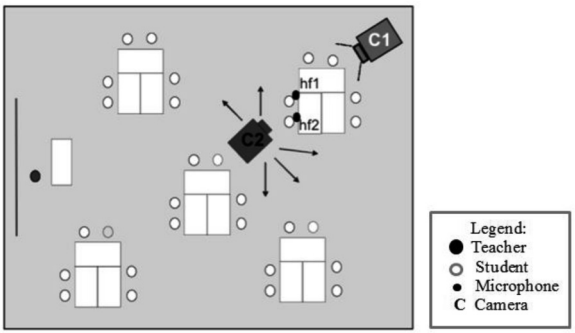

Fig. 4 - Mobil video device

The last video recording device described by Veillard (2013) is a technical solution adopted for meetings or interviews (see Figure 5). The equipment is smaller and much easier to dispose in the room. It is

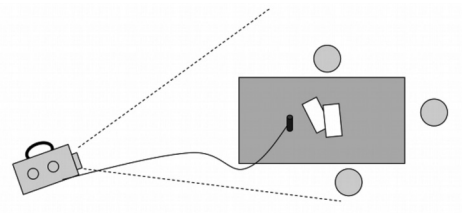

Fig. 5 - Video device for meeting/interviews

important to have a camera on a tripod, with a still shot of the players present at the table; a microphone wired room on the table or lapel microphones for actors. An additional camera can be installed above the vertical to film the materials used, handling and registration.

To synthetize, there are four modes to use the camera (see Table 1):

- camera positioned on the tripod in static shot (no action on the camera which means no zoom, no movements) or in dynamic shoot (allowing zoom and movements in horizontal or vertical axis);
- handheld camera (on the shoulder) without movements, zoom or with movements and zoom.

Tab. 1 - Camera positions' mode

	Static shot	**Dynamic shot**
Camera on tripod	No action No movements	Zoom Movements on horizontal and vertical axis
Camera on shoulder	No movements No zoom	Movements Zoom

Kilburn (2014) presents three methods for producing video recording within classroom settings depending on needs to capture or not more than one camera angle, to have or not the video available for immediate play-back, to have or not mobile equipment.

A single camera recording is necessary if we not wish to capture more than one camera angle. In this case, Kilburn (2014) advise to place at the back of the classroom a HD digital camera with a wide lens angle for learners or an optical zoom for teacher. The teacher is the primary "subject" for the video recording. The camera may be positioned in front of the classroom to record students. In this situation, the teacher will be left out of the shot.

Another alternative is to use a multi-camera recording for editing later (see also Veillard, 2013) or a live capture from multiple cameras.

Advances in digital video technology will allow new methodological approaches or developments. The wireless connectivity allows video to be transferred or 'streamed' to a nearby device using a wireless ('Wi-Fi') network connection, reducing for example the need for obtrusive wires to be trailed around the classroom when undertaking a live capture recording.

Smartphones and tablets are not only able to record video, but can also take advantage of the same sorts of wireless network connectivity discussed above to transfer video to other devices. In fact, software

developed for Apple devices even allows multi-camera recording from Smartphones or tablets connected to each other wirelessly.

Wearable cameras, with ongoing improvements in the video quality, usability, and cost of ultra-compact wearable cameras, are bound to see more widespread use in the classroom.

3.2. *Advantages and disadvantages of camera's types*

The camera on the shoulder is undoubtedly the one that allows the most opportunities: static shot throughout the registration or change of plan, zoom and camera movement, ability to remain static or change its position to better access certain events or follow the actors. However, it is technically difficult to implement because it requires knowing precisely what we try to decide at any time to his position, framing and plan changes, relevance to zoom in on an item. In addition, it requires significant expertise in handling the camera for good quality images (stabilization of the camera, taking account of the light sources, anticipating noise conditions, etc.).

Hall (2007) is considering that "the job of a person operating a follow camera is to stay with the proxemics shape of the interacting group (i.e., bodies in relation to each other and things), ideally keeping everybody in that group within the visual frame as they move around. For example, a follow camera operator can attempt to have speaker and listeners in view as a speaker is making some point primarily with words. The reason for wanting to have the participants' faces and bodies in view as much as is possible is that analysts will want to determine what people orient to in conversation (where gaze is allocated, how bodies are coordinated with media, etc.). But when the speaker begins to open a document to point out what he or she is talking about, or begins writing on a white board or sheet of paper, the follow camera operator can begin alternating between zooming in close to get the artifact-level details and zooming back out to get speakers and listeners. As a way to capture aspects of context that are (presumably) available to study participants, zooming in and out of the scene is preferable to panning across speakers and media" (Hall, 2007, pp. 9-10).

The camera on tripod is probably more secure, especially when it remains fixed during the entire recording. Registering the class in a static shot wide and makes the open video for further analysis by other researchers. It is however not without drawbacks, especially if a player leaves the field, or if important information for the analysis remain inconspicuous (eg enrollments table).

Anyway, as we have seen in the types presented above devices, usually researchers combine several of them, using multiple cameras. This allows multiple viewing angles on the same object and the combination of a large and fixed plan and a more local and mobile plan. This is essential when the researcher wants to be able to capture many local scenes that take place in parallel: for example, a discussion of the teacher with a small group of students while other exchanges occur farther between, on the other students.

4. Data organization

Leblanc, Ria and Veyrunes (2013) propose the construction of an interactively "electronic corpus" to organize data, heterogeneous and often very large, using a spreadsheet and hyperlinks to the direct opening of various documents. The digitization of video recordings on the computer can then be used to fix the collected data (such cuts that appear on the tapes), to hid parts of the image (blur faces or silhouettes if it lacks permissions to shoot some people), to mix different records (if two or more cameras are used, a record can be embedded in another) (Veillard and Coppé 2009), to move scenes or images.

4.1. *Data Compression*

Because of their size, original video files cannot be kept in this form on computers (for reasons of space on device storage and facilities to handle them). Compression operations are needed to reduce this size. The multiplicity of formats (.avi file type, .mov, wmw, etc.), of video encoders (Sorenson codec type, mpeg1, mpeg2, mpeg4), of audio (mpeg3, AAC, etc.) and of multiple adjustable parameters (flow rate, image size, etc.) do not facilitate this operation. A compromise must be found between the quality of picture and sound required for analysis, the smallest possible size of the video to allow manipulation and easier transfers.

Here are many free or payable video converting applications (for example: Adapter, Compressor, Episode, Handbrake, Media Converter, MPEG Streamclip, etc).

4.2. *Methods of video-recordings analyze (Data Reduction)*

Veillard (2013) mention four methodological strategies used to perform the reduction of video data:

1. Observation strategy and systematic coding video recordings
   TIMSS Video Science (Roth *et al.*, 2006) is an example of one type of methodology for the analysis of video recordings based primarily on coding categories. The objective of this project is to compare teaching practices in different countries (5 different countries: United States, Australia, Czech Republic, Japan and the Netherlands) and study their effects on learning. To ensure the solidity of this device in all national contexts where it was to be used, the researchers first looked for a strong consensus among the participants of these countries which was given by the use of the same codes.
   "Descriptions for each code were developed collaboratively as the group watched and discussed video examples together. Science Code Development Team members then independently applied the proposed definitions to a new lesson(s). Afterwards, the group compared their independent coding decisions and used differences in opinion as a strategy for clarifying the written definitions and for reviewing the effectiveness of the proposed codes in capturing the desired lesson feature. This process of independent review of lessons followed by group review and consensus building continued until 85 percent or higher inter-rater agreement was reached by the Science Code Development Team members or until a decision was made to drop, revise, or create new codes" (Roth *et al.*, 2006, p. 7).
   The data reduction is performed by reference to conceptual categories developed by researchers. It consists, for coders, in searching the information flows, certain defined events or objects, which are indicators of the presence or manifestation of these categories, definition of the work of these indices and their application link with categories have already been created by the designers of the encoding device. The following analysis is quantitative and operates through statistical processing (descriptive statistics and cross-tabulations mainly).
2. Crossing strategies for various types of descriptions
   Recently, many studies in comparative didactics (Schubauer-Leoni *et al.*, 2007; Sensevy, 2007; Sensevy & Mercier, 2007; Tiberghien *et al.*, 2007) postulate the interest of articulating several types of descriptions of the video recordings.
   On example is the thesis of Marlot (2008), based on the theory of joint action in didactics. The author favors a work by contrasted case studies. Two class sessions are filmed and analyzed. Video recordings are complemented by primary data associated: questionnaires and interviews with two teachers, pre- and post-test questionnaires for students. The data analysis process is operated in several successive

stages which mobilize different modes of description video recordings under different registers or genres of discourse (narrative, synoptic, categorical).

3. Progressive refinement strategy assumptions
   The methodology introduced by Engle, Conant and Greeno (2007) to study the role of discourse in conceptual learning is based on a method of data reduction operated by so-called progressive refinement strategy assumptions. This methodology is characterized by an intense use of video recordings at all stages of the analysis.
   It is successively used for:
   - select relevant passages for the object of study related to the research mentioned by a specific discussion topic;
   - characterize the phenomena by which manifests the object studied;
   - transcribe more finely selected passages;
   - code these passages with conceptual categories; search for factors explaining the phenomena highlighted and construct theoretical assumptions;
   - test and refine these assumptions on other types of discussions.

   This methodology needs an efficient indexation system:
   - "Searching for episodes of this topic was feasible because we had made content logs of the video-tapes in our collection" (Jordan *et al.*, 1995).
   - "A content-log is written by someone watching a tape with only minimal reviewing in order to provide a time-indexed list of topics being discussed" (Engle *et al.*, 2007).
4. A collaborative strategy researcher/actor observed
   As part of the action current, the theoretical point of view is to account for the asymmetrical relationship of an actor with his environment: he built his own world in the course of the action by selecting its environmental elements. The researcher is primarily interested in the pre-reflective consciousness, that is to say what makes a sign to the actor in the situation, his concerns, and that on which he focuses during the action. The data reduction work is strongly guided by the views on the action and is based on a methodological protocol where class video data is only an insufficient step to access this object. The researcher must rebuild the own world of the actor which it is not direct accessible for him. The researcher does not operate alone data reduction but in cooperation with one or more actors.

5. Procedures and tools dedicated to the analysis

The TIMSS video project is dominated by an explanatory logic: the aim is to highlight the relations of statistical correlations between on the one hand, class configurations, shapes and teaching content and secondly, learning opportunities, with efforts to develop a common and uniform coding system for all countries and to ensure the highest possible reproducibility of video encoding process, regardless of the cultural context.

Research conducted within the course of action is highly dominated by the understanding and focus on one or a few cases: it is about to focus on the perspective of the actor, on the meaning of the situation for him, on his own meanings.

Engel and colleagues highlight a real dialectic between comprehensive phases (search for video segments with a subject-specific discussion) and explanatory phases (analytical and comparative approach, using criteria and encodings, distribution speaking turns, quantification of overlapping, types and number of outdoor activities in the discussion).

Marlot uses the narrative register that refers to the idea of articulating interpretations and intentions of those events with more goals in the course of joint action. It also relies on a more explanatory language type analysis.

Some researchers follow the idea theorized by Lemke (2000) that the didactic or educational processes are located in complex systems that require multilevel analysis of temporal extension. This is of course the case of research that mobilizes type analysis scales as macro, meso, micro (Marlot, Tiberghien and Malkoun). Other research, however, do not distinguish between different levels of analysis (this is the case of Engle, as well as the TIMSS project).

6. Data reduction tool: macro analysis for indexing an event from video corpus

It is a complete set of data that is aggregated for this project:

- a questionnaire to assess the performances of in-service teachers on the concept of formative assessment;
- responses of teacher's questionnaire in each participating country;
- sound recordings and videos of authentic teaching situations;
- an indexing grid of sound and video recordings;
- indexed sequences;
- analysis analyzes of output files;
- a method of selecting sequences of training for novice teachers;

- training course for new teachers;
- pathways analysis.

This paragraph presents the method for indexing an event from a video corpus. To ensure the reproducibility of the method, we conduct a four-part analysis:

1. macro-analysis of all of the recorded footage to help identify formative assessment passages.

Example: Video France, formative assessment phase
Macro-Video-1 Analysis – Teacher, Daguerre College Shooting 14 September 2015, 6th, Teaching hours: 8 am to 9:05

Tab. 2 - Macro place of classroom activity

Time	Content	Comment
00 : 00 => 00 : 02	Instructions: students take their notebook exercises, recalling the exercises numbers, recalling the name of the software to read a pdf, which student goes to the blackboard? Students raise their hands, one designated student, one student goes to the blackboard and corrects the exercise, teacher asks the class if they agree, the teacher asks who wants to go to the blackboard following the exercise.	They use the video-projector to do the correction
00 : 02 => 00 : 04	Teacher sends a student to the blackboard while this teacher walks in the class ranks, he looks at the books of students, one student corrects the exercice in the blackboard, the teacher asks the class if they agree, the teacher asks who wants to go to the blackboard to correct the following exercises, the teacher sends a student to the blackboard, teacher holds the graduated ruler because the segment or line tracing has its first high point on the board, the teacher asks the students to raise their hands, the teachers calls on one student, “student gives an answer, teacher asks «why», the sudent gives justification, the teacher asks the student questions” any difference between a straight line	

Tab. 2 - continued

Time	Content	Comment
	and a segment, students in the class raise their hands.	
00 : 04 => 00 : 06	Teacher recalls “the last time we said that,” the students raise their hands, the teacher gives some definition, the teacher asks some questions at the blackboard, he gives the correct answer, the correction continues, the students raise hand, the teacher asks who wants to go to the blackboard to correct the following exercises, the teacher sends a student to blackboard, the teacher holds the garduated ruler for tracing the segment or line (because of its first high point on the board), the teacher asks the class if they agree with the student’s answer, the student gives an answer, teacher asks a question, students raise their hands, student gives an answer, teacher raises their hands, a student answers, and other students raised their hands.	
00 : 06 => 00 : 08	The teacher asks another student, the student gives the right answer, the teacher valids, the teacher teaches the lesson. Next exercice, the teacher reads the instruction, one student raises his hand, teacher sends the student to do te correction of the exercice, from the student’s answer,the teacher gives the right answer , and he asks the class if they are all agreed.	
00 : 08 => 00 : 10	Teacher asks a student to do the correction of the next exercice, the teacher asks questions to the student at the blackboard. Teacher refers a student for the last two exercices, the teacher talks with the student about the rignt answer at the blackboard, the teacher asks the student to show him a segment, the student then corrects the exercice, a new request from the teacher about the straight line.	

Tab. 2 - continued

Time	Content	Comment
00 : 10 => 00 : 12	Teacher asks the class if they are all agreed. Oral Question, few raised hands, the teacher asks a student, a student gives an answer, teacher resumes the set, teacher gives the answer, teacher designates another student, student gives an answer, teacher gives the correction, last oral waiting matter, teacher asks a student, student gives an answer, the teacher valids the teacher asks a question, teacher takes over again and wrote on the board the right answer, another question for the student.	
00 : 12 => 00 : 14	The student gives an answer, teacher asks a question, student gives an answer, teacher asks another question, continuous interaction between teacher and student, validation request to the class, not back, question to the class, student gives an answer, the class validation request, 1 yes question to the class, student gives an answer, teacher designates another student, another student gives the correct answer, teacher resumes, he asks a new question, a student gives the correct answer, the teacher request validation of the class, teacher resumes and shows.	
00 : 14 => 00 : 16	Back to the lesson notebook.	End of FAMTL

To select a sequence, we recall the definition of the project (Black & William, 1998; Sadler, 1998; Gagatsis, 2000; Nicol & Macfarlane-Dick, 2004; Black & Wiliam, 2006; Hattie, 2009; Looney, 2011; Cauley & McMillan, 2010):

- the FA is an integral part of the teaching and learning process that contributes to its regulation;
- allows teachers to identify weaknesses and strengths of each student, in order to reflect on their practices and adapt them to match better with the final goal of student learning;

- establishes a dialogue between the teacher and student, with positive fallen on educational.

From a macro point of view, we observe a calibrated organization that evolves over time.

Assumptions of this evolution:
- exercises that present more and more troubles, no good answers from the students at the first time, need for reminder by teacher;
- Time management (7 : 30 min => the issue of time management);
- Organizational Management (ditto => 7 : 30 min => issue of time management);
- observation of the number of hands raised => understanding indicator;
- validation by the class.

Confirmation/invalidation of these assumptions by micro analysis:
- Time spent in the actions must evolve based on implicit or explicit criteria with respect to the teaching practice;
- Repeat these characteristics at other times to become a characteristic of the teaching practice and gifts of teaching style (PISA).

Oral interactions:
- 0mn to 07mn30: Teacher routine (who wants to correct the exercise at the blackboard, he sends a student to the blackboard (alternating girl/boy kept during the sessions), the student brings a correction, validation by the teacher who asks the class if class is ok with him, then if the class does not agree, he can either ask the student to make a new correction or he asks the class) => co-Construction of enunciation of the effective knowledge correction;
- from 7mn30s to the end of the video: teacher gives his own correction, because the majority of students sent to the blackboard have difficulties. He keeps the same structure, i.e. it is not the teacher who corrects directly, but it's him who makes the final correction and institutionalizing knowledge. => Apparent co-construction, even share structure, but not the same relationship to knowledge;

indicators:
- number of raised hands;
- quality of interactions with the student on the board;
- quality of interaction with the class.

Knowledge:
- devolution => correction by the students on the blackboard with behaviors which change over correction;
- institutionalization => always made by the teacher with the class validation;

- didactic contract: very established: hands raised, correction on the blackboard, alternately girl/boy, classroom organization.
  Teacher observation:
- in the first 2 minutes of the correction step, the teacher goes into the ranks and looks at the student booklets;
- second passage, with indexing TIME OF ASSESSMENT, TOOLS/ STRATEGIES PHASES and to make a micro-analysis and confirm or refute the hypotheses constructed from macro-analysis;
- third passage for indexing content with mathematics. The third passage is to frame the mathematical content with actions and the application context. This passage can check also the first encoding;
- fourth crossing. This passage is made by someone other than the one who conducted the other three passages to compare the two micro-analysis.

7. Using video in a training program: example of France

Concerning the French case, it was decided from the outset that the training program would be short, available at a large number and at a distance. It is in this perspective that an MOOC type device has been set up. The two main reasons for the implementation of this type of device were:

- the training models and therefore the program is national. It is therefore not possible to modify a training module to introduce a distinctive training theme, at the risk of not offering the same training between two teachers in training;
- as part of a national program to increase the digital competence of the population, several devices are put online in a volume of 3h, 6h or 9h. It is a question of being able to deal with a particular point of the program or a pedagogical practice in the given time and in a type of training of a professional type.

1. Presentation of the platform and its contents:
   The platform used to operate the training videos in MOOC mode is OpenEdx®. It offers a structure allowing easy reading of contents. A vertical menu offers all the training modules and a horizontal menu offers the content backed up by each module. Two modules have been created, namely:

- formative assessment;
- links to research.
- The content of the module focusing on formative assessment is composed of:

– a positioning test allowing each learner to measure its proximity between its representation and the definitions proposed by the consortium;
– knowledge text proposed by the consortium;
– videos to understand the topic;
– videos to show authentic class situations;
– a knowledge base that provides a synthesis in 4 pages. Its role is to set the necessary scientific resources for the learners;
– a knowledge test, the questions of which are drawn from the questionnaire drawn up by the consortium.

The module whose title is links to research, aims to offer learners complementary links from the research, the link of the website of the project and a survey of satisfaction of the device put online.

2. Analysis of the device

Given the main theme of this chapter, namely video, we will give here some details on the videos present in the online platform. Regarding the section, videos to understand, there were 4 videos available free on the Internet which presents a point of view on the formative assessment:

- the first is proposed by Marc-André Lalande, consultant, Canadian expert teacher;
- the second proposes an adapted iconography of some rules of formative evaluation;
- the third describes the types of feedback the teacher can do to his or her students;
- the fourth objective is to present the speech of a researcher, former rector, Jean-Marc Monteil, who talks about the victims of the assessment.
- The second section proposes to show authentic situations:
  – the first video features an explanatory animation;
  – the second video proposes a no-grades approach, without quantitative assessment;
  – the third video presents a participatory approach.

The third video is a video from our data. This video was selected because it reflects a point of difficulty for learner teachers. We describe here the process of selecting this video data.

Firstly, the consortium has established a questionnaire to reflect the difficulties and representations of novice teachers in training «beginners». After analysis, several difficulties and conceptions were identified by the researchers. It was then decided to record using a background camera with a wide angle and a microphone on or in the direction of the teacher. The goal is to have a comprehensive view of the classroom and to hear very clearly what the teacher could say. A macro analysis was carried out,

making it possible to select extracts with particularities either with respect to the formative assessment or with regard to the difficulties identified by the initial questionnaire.

In our case, a major difficulty is the management of time and interactions in a phase of putting students to work and evaluation in a formative assessment process.

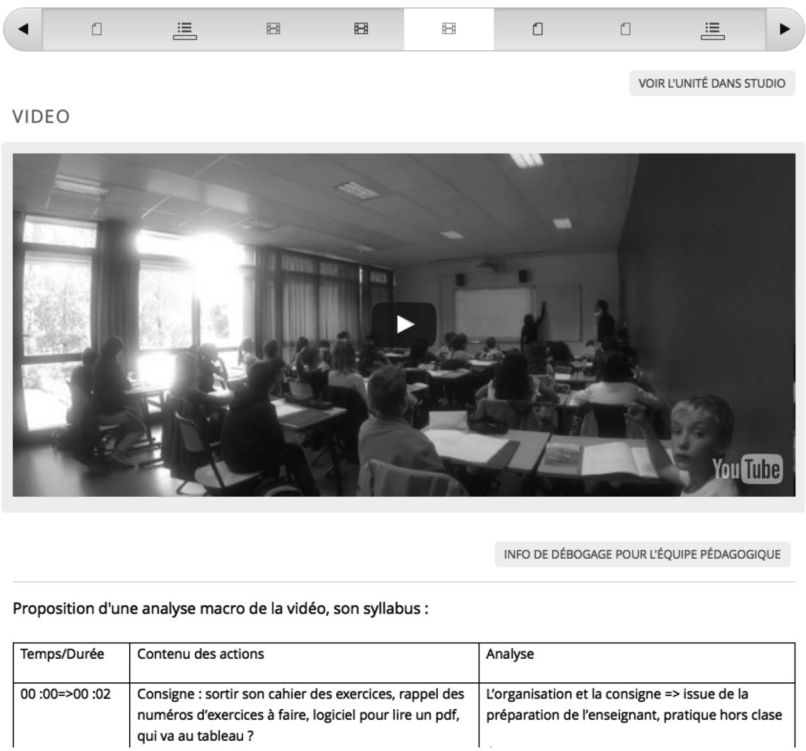

Fig. 5 - A video to understand the management of the regulation of interaction during a formative assessment process

About 125 participants (teachers at the middle school and at the high school) to the pilot training course were asked to fill out electronically the initial questionnaire (test de positionnement-premier test du dispositive de formation) about their beliefs on formative assessment. We use the software of survey, Sphinx® and the Platform, OpenEdx®. The duration of the training is 6 hours online. The teachers could debate before and after the pilot course through the forum (in the platform). And there is also a

chat online (live) so the teachers could express themselves and debate and talk with each other and also with the trainers (the designer of the pilot course).

The meaning of the formative evaluation for the teachers is well known and recognized. 4 categories of answers are obvious:

- Category 1: assess student achievement, identify objectives, allow students to have a description of their difficulties, give teachers a chance to check the validity of their work, give teachers a chance to understand the changes to be made for teaching methods. This category never totally disagrees with the assertions.
- Category 2: assess students' abilities to use mathematics in everyday situations, authorize and apply comparison of student outcomes (strongly disagree); Permits to write a classification of the students according to their performances. This category covers the whole spectrum of opinions with a strong disagreement on the assertions: allows and compares students' results.
- Category 3: Based on the work process of students more than on the results in mathematics, provides feedback that enhances motivation and leads to improved knowledge and abilities very strong majority strongly agree.
- Category 4: Allows you to write a classification of students according to their performance. Very little disagreement.

These 4 categories provide information on the representations of MOOC participants who responded to the questionnaires. First of all, they have at least basic knowledge on what characterizes formative assessment, namely Cat 3: initiate a process of assessment of the process of constructing meaning and provide feedback to students enabling them to remain motivated and thus encourage the scientific approach by a set of games-error-successes. It is more difficult for these teachers who responded to have clues as to what this formative assessment gives them, namely Cat 1: level of student acquisition, identification of objectives… The sample is here more divided, the majority that are agreed with the assertions, but there is also a set that rather disagrees with these principles. Symmetric of Cat 3 on an assertion, there is strong disagreement with the assertion that permits and applies a comparison between student outcomes.

In conclusion, in-service teachers who participated in the MOOC and who responded are sensitive to the question, are aware of the interest of the approach but do not necessarily have all the indicators that this assessment approach can bring them in the management of students' meaning construction.

However, the teachers do not feel competent enough to submit activity where students realize a peer assessment but they do feel competent when

they talk to students one by one and explain them the instructions to follow. By contrast, the teachers do not feel competent enough to identify and make the students identify their own abilities and weakness. They are more facilities to teach to the whole class than a peer group (or a small group of students).

By combining these first two analyzes, we come to a first outline of the categories of knowledge and skills of the teachers (responses). They have knowledge on the subject, are able to identify what this can bring them as well as to the students, but with an uncertainty as to their ability to understand and use the indices that are provided by this method. This second point is precise here where it is a question of implementing an activity in which the metacognitive skills of assessment of the other or even autoscopy for purposes of personal construction and meaning, here in mathematics. They seem comfortable to help overcome an obstacle to students by bringing the solution themselves, or exercises. This seems more difficult for them when it comes to implementing an approach that allows the introspection of the difficulty so that the student develops strategies on his own to 1) analyze the reasons for success or failure strategies and 2) enabling them to re-engage in other situations and thus consolidate the notion of scientific approach.

They also follow a pattern: prepare, implement, observe and analyze. The teachers also replied that the formative evaluation allows the students to know the points on which they have to rework and the teacher to know in which area/competence to help the student. Before doing the questionnaire, the teachers wrote that they teach by using the students' mistakes. The teachers preferred the group work (students work together). The teachers also used oral assessment through a quiz and the students have to answer according to the answer given by the other.

Before the administration of FA: the teachers checked that the students understood well the goals of the FA (ask questions to the students). The teachers chose to teach some lesson and examples that will be present in the FA. The teachers were very careful to the behavior of the students and the process used by the students. They always corrected the work done by the students, and administer some feedback.

In general, teachers use all the activities mentioned to implement a formative assessment. The only case where it is ever recorded is when students set up a mathematical problem starting from the text.

In summary, we can make some assumptions about the representations of the French teachers who made the MOOC and who replied:

- theoretical knowledge of the concept of formative evaluation: from the point of view of the definition and the contexts with which it can be implemented;

- difficulties for teachers to learn from the evidence provided by the process;
- difficulties for teachers to implement meta-cognitive skills that allow students to assess their difficulties and successes and implement strategies to accomplish the task;
- the causes of students' difficulties are well identified and some are discarded: such as the limited abilities of the students or the knowledge taught previously.

Therefore, we can retain that the teachers who did the MOOC and answered the questionnaire has competences on the topic but have difficulties with the indices of construction of meaning that can bring the method.

In the training process, the tool used, here a MOOC, is above all a revealer of the representations and conceptions of teachers in training and in service. It is like the questionnaire, namely a declarative tool. We used two types of videos:

- videos to understand;
- videos to show.

The structure of the MOOC and the particularity of the videos had only one aim:

- the positioning test: to question the learner, explain to him/her at the beginning of the training the specific topic on which he/she was going to work, namely here the management of time and interactions in a training assessment process;
- videos: to make concrete, to have a real representation of what was evoked in the positioning test. The two types of videos aimed at making the link between theory and reality of an authentic situation. Here, we place ourselves in a modeling activity: a modeling activity with a distinction between theory and events and learning is mainly in the relationship between the two (Tiberghien, Vygotski);
- a knowledge base as a scientific text, a theoretical reference which is intended to be sufficient for itself to enable the learner to evolve these representations. Here again, the principle of modeling activity resides with a process of the type: appropriation of the theoretical model, understanding of the reality of the event by manipulation of the theoretical model and learning when it is easy for the learner to do of going back and forth between these two worlds: theory/reality;
- a final test to allow the learner to measure the evolution of his or her conceptions and also the gap that may still exist between conception and theory;
- in the perspective described above, it is therefore necessary to have a strong epistemology regarding video data: what will be recorded, will serve in what purpose (why) and when?

8. Conclusions

We have worked on this chapter following three approaches. The first aimed at taking stock of the notion of video data, the second proposed a state of the art in the use of this type of data in research in the arts, humanities and humanities fields, exemplify the method and use of data in the project.

From the first two approaches, it follows that there is no unification of practices with this type of data. Starting from various works, including TIMSS-Video (1999), the consortium worked on the harmonization of a practice, namely that of data acquisition, micro analysis, and hence indexing in the Web directory and the fine analysis allowing each one to make the link between conceptions of the teachers and objectives of the training set up.

Despite the Dublin Core standard descriptors, there is still some work to be done in harmonizing to allow countries to use videos other than the one they have produced themselves. Due to time constraints, it was not possible to carry out cross-analyses of the type: 1 video produced by country X is analysed by country Y, then coding of the two analyses is carried out, and a comparison, with the consequence that if and only if a small difference is found, then the corpus and its analysis can be exploited by the whole community. At this stage of the project, each country exploited, according to their identified needs, the videos they have produced, analysed and selected. Several prospects for continuing work can be envisaged, namely:

- Have the same objective of training, videos from different countries and to take cultural differences or not? What impact will they have on education? And on formative assessment?
- From the point of view of the training system, the impact of face-to-face and distance training? Regardless of the country?
- From the point of view of data collecting, each teacher can use a smartphone to record, publish and work with others, how is this modality taken into account in training?
- From autoscopy to experience sharing, using video tools and shared with digital tools, how to create a catalog of professional gestures, guaranteeing a diversity of practices and also of an era?

The last point on which we want to react here is the very notion of video in training, already extensively dealt with, but in a different format, renewed by the MOOCs. It turns out that 90% of the participants in the MOOC appreciated the format with claimed autonomy of learning, a kind of "tutorial of existing practices", which answers a very precise question for France: how teachers regulate interactions and time in a formative

assessment phase. It is not a question of working on the whole idea, but of looking at a specific point of the problem. The video as a surgical descriptor of a practice?

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6. From beliefs to practices: the video-analysis methodologies to observe the formative assessment in classroom

by *Stefania Lovece*, Ira Vannini**

1. In classroom practices and teachers' reflective thinking

OCSE-Pisa international data from the last 15 years – but recently also the Talis survey (OECD Talis, 2014; Vieluf, 2012) – have shown how the use of more or less innovative teaching and coherent formative assessing practices is mostly determined by the teacher variable, more than by the geographic or organizational variables of the school.

This is especially true for Italy, where both the analysis of the students' learning outcomes and the statements made by the teachers themselves, show considerable differences within a same schools (between different classes and, then, different teachers).

This tendency to individualism and self-centeredness of the teachers is often accompanied by strong deficiencies in collective and democratic work among teachers.

In this perspective acting on system variables that aim at changing the culture of school evaluation is still extremely important, both in Italy and abroad. At the same time it is as much essential that we focus on the teachers' practices in the classroom.

Ever since the 80s and 90s, studies on *teacher change* have highlighted how changing educational practices is a key factor in changing the beliefs teachers have. On the other hand, teacher training paths that aim at changing practices by only working on beliefs often appears to be counterproductive (Guskey, 2002).

Therefore, in order to encourage the teachers' reflective thinking, their capacity for self-assessment and critical analysis, it is necessary to start from their individual practices.

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It is a question of encouraging teachers to commit to change, to exercise their reflective thinking (Dewey, 1910) and to evaluate (and if necessary modify) their actions as they would evaluate a scientific hypothesis.

2. Observing practices as a fundamental tool

From this theoretical-methodological perspective, the observation is a fundamental tool to help in-training teachers to 'start from practice' (Danielson, 2007). Observation draws attention to empirical data made of 'actions and behaviour' in an actual framework. In this way teachers are able to compare the beliefs they have with empirical data and use them to formulate and reformulate new beliefs.

Data that emerges from systematic observation has the potential to allow the observed subjects to distance themselves from their actions and to be able to think critically about them. Data, if it is collected diachronically, also allows subjects to take note of the progress made in time and to make a diagnosis, serving as a starting-point for projects for change.

Obviously, knowing the observations' objects and criteria is a fundamental condition to get teachers to be actively involved in a virtuous training cycle. We speak for a training cycle in which the teachers themselves can analyse their own practices and the practices of others teachers, changing their point of view and modifying their 'routinely practices'.

In terms of changing beliefs, observation becomes even more significant when it puts teachers in a participative position (Danielson, 2012). This happens, for instance, in peer observation: teachers take turns in being the observer and the observed (Bell, Mladenovic, 2008), watching themselves from the outside and watching from the outside the practices of others. The goal is to activate their reflective thinking, their ability for collective discussion and for making democratic decisions (House, Howe, 2003) that aim at planning better ways to act in a teaching-learning environment.

3. Video analysis to enhance the classroom observation

The use of video-analysis for teacher training (Ferretti & Vannini, 2017) goes hand in hand with in classroom systematic observation and with the observation of teacher behaviour especially.

Many studies still show the effectiveness of the *microteaching* (Calvani *et al.*, 2011) and, more generally, of the teacher observation with consequent video-analysis to promote change and improving of teachers'

professionalism (Rossi *et al.*, 2015), namely with math teachers (Casabianca *et al.*, 2013; Walkowiak *et al.*, 2014).

These strategies create a strong connection between theory and practice and they allow in-training teachers to change their point of view and to observe themselves in video sequences (Altet, Charlier, Paquay, Perrenoud, 2006).

These methodologies that enhance our observational skills through the use of video are currently largely used abroad: the American and the British research (Guernsey, Ochshorn, 2011) highlight the need to use observation to make teachers more and more aware of their actions when teaching. Other experiences have been made by some American professional associations (such as the New Teacher Project, the New America Foundation and Teach Stone) which are developing systematic tools to observe the behaviour of teachers in classroom.

More specifically, Santagata's studies (Santagata, 2010; Santagata *et al.* 2010; 2011) regarding the use of video-analysis are a very important reference for teacher training. For teachers, the careful observation of students during their learning process and of how teachers behave in relation to that, are key elements to exercise their analytical skills and reflective thinking.

Moving in the direction of creating opportunities for shared analysis and discussion about specific events that happen in the classroom are the American 'Video Clubs' (van Es & Sherin, 2010) and 'Lesson Studies' (Lewis &Takahashi, 2013) which are the result of Japanese studies and work towards using observational data collected during classes to discuss and collectively re-plan – between observed and observer – the teaching-learning processes.

The research carried out in French speaking countries is also of great interest. This research mainly focuses on the teachers' self-assessment processes (cf.. Laveault *et al.*, 2009; Paquay *et al.*, 2010), on studies about teaching practices (Altet, 2003; 2006; 2012) and, more specifically, on "action analysis" (Durand, Filliettaz, 2009).

It is qualitative research that analyses "activated" teaching (Iobbi, Magnoler, 2015) in order to identify its key elements and draw from them opportunities for teachers to use their reflective thinking and enhance the self-evaluation and critical skills of teachers. In all of this, videos are a tool of great value to foster the teacher in his thinking about the action through different methodological approaches (Theureau, 2006; Vinatier, 2009).

The connecting suggestion of these different strands of research – research stemmed from different cultural backgrounds and different theoretical and methodological framework – is to encourage the

development of teacher professionalism helping teachers themselves to use their analytical thinking on their practices and the practices of others.

Focusing on the details, paying attention to what one is doing inside the classroom (a place that is traditionally not open to outside observers, whether they are human observers or video cameras) is what allows teachers in training to really notice what they are doing, rethink about it and distance themselves from it so that they can then be able to criticise it.

In summary, the research on video-analysis (in classroom) highlights how this methodology – if it is integral part of intentional training pathways:

- promotes the reflective thinking of teachers and better responds to their training needs (Meyer, 2012; Ertmer, Conklin, Lewandowski, 2002; Plakhotnik, 2001; Mottet, 1997);
- allows teachers to identify strategies for self-improvement (more than what the analysis of the students' learning outcomes itself does) (Meyer, 2012; Ertmer, Conklin, Lewandowski, 2002; Plakhotnik, 2001; Mottet, 1997).

4. Video analysis and Formative Assessment

Concerning classroom assessment practices, international research (Harbor *et al.*, 2015) highlights the importance of analysing teacher attitudes in the use of formative assessment.

Video analysis urges teachers to "see" what is happening in the classroom, and in particular to focus on teacher assessment behaviours that have a positive impact on learning outcomes. Specifically, three types of core teacher behaviour related to *formative assessment* and teaching individualization are highlighted: how it involves students, using questions that create opportunities for students to intervene and respond (Kern & Clemens, 2007); how to use the modelling behaviour; how it communicates formative feedback.

In this sense, video analysis follows a very similar method to that the one used in the research experience FAMT&L: the aim is to draw the in training teachers' attention to the details of those behaviours that are more related to educational effectiveness.

Being able to describe these behaviours, to see the details and to re-think them in an improved way, are very valuable training opportunities for teachers. Research carried out by Kane *et al.* (2011) has attempted to explore the connections between teaching practices and student performance. It is precisely from these studies that emerges the need for specific observational procedures to focus on the actions that teachers take

in the classroom, in particular on assessment practices. This is important both in the early phase of collecting information on students' learning, and in the specific phase in which the teacher is engaged in giving *formative feedback* to the students.

Observation in the classroom aims to detect the assessment strategies used by teachers during the teaching-learning process:

- how to communicate assessment objectives and criteria to the students;
- how to present and deliver assessment tests;
- how to collect information about the students' achievements in the classroom;
- how to correct assessment tests and errors;
- how to communicate feedback to the students.

The experience in the schools shows that FA is not a natural habit of the teachers and there is a need to improve the teacher practices on FA. To do this, it is essential to have in-depth knowledge of what happens in the classes during the assessment moments in order to identify "good" and "bad" practices and thus design effective teacher training and staff development courses. Therefore, the FAMT&L Project has acted in this perspective: the analysis of the specifics of teacher assessment behaviours and the use of video recording in the classroom have been the key tool for designing professional development pathways and to produce a real change teacher.

5. Pilot course for FAMT&L project: a common training model for all Countries

In line with the theoretical and methodological studies briefly described so far, in the FAMT&L project one of the main goals achieved was the design of a model course for mathematics teachers in which the use of video and observations in the classroom could be the main method to promote reflective activity that could generate change in teaching practices.

A model course that could adapt to the different designs of the partner countries – differences dictated by different timings, different trainees' selection modes, different certifications, etc. – did not prevent the specific courses to be characterized by some common features.

It has thereby been possible both to preserve each country's specificities, and to have a similar architecture for monitoring the training programs using common survey tools in order to allow evaluation and comparison. The main characteristic of these courses was the use of video in the training sessions for teachers in service, following guidelines from the scientific and theoretical framework. In particular, the use of video has

been incorporated as an opportunity for reflection and discussion on the construction of beliefs and on formative assessment practices.

A further important aspect is the traceability of the change in these beliefs and practices in the perspective of improving teaching in an innovative way.

Regarding the content of the course, the training program provides general knowledge on teaching design and assessment and more specific knowledge of mathematics teaching with particular attention to summative and formative assessment and therefore to "for" learning assessment. This is because we thought that a correct use of FA methods and techniques is a key element to make teaching math more effective and innovative.

To develop a training course that could enhance the reflective activity of teachers as a potential key to change in future teaching practices, some learning activities have been suggested trying to combine theoretical content and teaching methods based on experiences geared towards elaborative and reflective action supported by the competent intervention of university teachers, supervisors, tutors or critical friends (experienced teachers and already partially trained on the subject who participated in the course). The suggested activities of communication, analysis, discussion and reflection centred on issues related to the design of assessment practices, the development of data collection tools, the provision of concrete experiences and practices, the documentation of the path, have been tested through a number of stimuli and reflections/discussions shared in presence and at a distance with the tools and materials on an e-learning platform.

Some of these activities are described below.

- In-depth study of the themes presented in class, in which the main theoretical and methodological references on the assessment and teaching of mathematics have been discussed, investigating in particular the theme of methodologies and tools to be used.
- Observation activities during which videos from the web repository that have previously been analysed are shown or short videos are systematically analysed using the shared observation grid (or selected parts of the grid) previously used for analysing the collected videos.
- Reflection on one's own evaluation practices in the direction of planning a new evaluation strategy in which, after dealing with the issues and the various evaluation models, teachers participating in the course are required to plan the activity they will eventually lead in future.
- Sharing of the analysis and the activities planned in order to collectively reflect and gain greater awareness through the feedback and reflection of others.

By themselves, all these activities, however, are not sufficient to give life to the experience of change in the evaluation practices of the teachers concerned and therefore it is particularly important that they are accompanied and supported by instruments and trainer serving as guidance and orientation. Recent research has shown the critical role of tutoring or mentoring to stimulate learning *from* experience and *in* the experience highlighting how professional performance improves when teachers are listened by a mentor that gives them the ability to create connection points with their own experience (Filliettaz, 2014).

In this sense it is also important to emphasize the use of strategies and methods drawn from research experiences that show how the video recording of educational practices becomes even more incisive if intertwined with opportunities for reflection and dialogue urged by questions-stimulus introduced by a researcher/facilitator or by tools such as drills and tasks with questions stimulation or learning diaries that guide the subject to a metacognitive level (Santagata, Zannoni, Stigler, 2007).

6. The use of video for teacher training between theory and practice

The methodological and operational implications for teacher training have allowed us to better identify ways to use videos on assessment practices in the training paths we have proposed and in particular to use videos as stimuli to conceptualize and reflect on the teachers' own practices. Additionally, we have found especially important to use video sequencing to allow us to identify more accurately the actions put into practice by teachers during their classroom lessons.

The videos used were obtained the phase of the project in which we investigated teachers' beliefs and assessment practices (see chapter 4).

The correlation between the research on conceptions of teachers' beliefs and the first phase of observational research has allowed us to understand what types of wrong beliefs teachers had on formative assessment in the classroom. What has emerged is a common tendency to use traditional practices of summative assessment and difficulties in perceiving formative assessment as a useful tool for improving teaching and learning.

Difficulties to understand the effectiveness of formative assessment were also found during a first analysis of the first videos examined. Many of the natural situations of math teaching in the classroom confirmed the results of the first phase of research (the questionnaires), as they have

highlighted the use of evaluation mainly aimed at "measuring" learning and assessing them in a summative way by using not-rigorous methods of collecting information about learning and not accompanied by a correct use of feedback.

Clearly, to get more detailed information for our research, we had to build a tool for the observation and analysis that we could use both to analyse recorded videos in the classroom and to categorize and store video sequences to be used in future training courses. The tool has been defined with reference to guidelines derived from international literature and experiences of in-service training. This tool has been useful in gathering several indicators on good and bad mathematics teacher training practices (e.g. their habits in gathering information on student learning; the error correction process and the use of feedback to support learning) (Lovece, Michael-Chrysanthou *et al*., 2016).

First of all, we started to consider what the literature on docimology defines as the classic phases of a proper evaluation process. This is merely to refer to specific technical and procedural guidelines which, if they refer more specifically to the summary (objective and most scientific) assessment procedures, can also be considered valid for the practice of formative assessment. The stages of this process we refer in particular are (Gattullo, 1967):

1. the *definition of the object*, as the pupil performance manifest following the teaching action, described and identified in terms of indicators "capable of providing detectable data on learning and its outcomes" (Tornar, 2001, p. 147);
2. *measurement*, that is the assessment, detection of data capable of providing information on the level of learning achieved by a pupil. This phase must necessarily have the *validity* requirements (when the object identifies with what is actually measured) and *reliability* (when the information it provides is responsive to the actual status of the measured object and therefore the measurement is repeatable remotely time or other subjects with constant results);
3. the *assessment*, that is the expression of a judgment on data and information obtained through a particular language and on the basis of a specific.

They are also taken into account the theoretical and methodological guidelines for measurement practices in a way more properly formative as, for example, the systematic use of the on-going evaluation of the progress of the students, the communication of the training feedback, the error analysis, etc.

6.1. *The grid: a tool for video analysis*

The tool created starting from these theoretical-methodological references has therefore been used to provide each video with metadata that allowed categorization and sequential descriptive analysis (to observe correlations) that helped to define the classroom assessment practice profiles.

Therefore, the grid used has been structured on different levels. On the first level we find the data that "identify" the video files which allow for first storage: the video identification code; Nation; Language; Type: audio/video (length, format); Creation date; Author; Class and school level; Number of students in class.

On the next level, we have used categories which have allowed us to better study the qualitative analysis as we considered the many variables in play in such a specific and complex process as assessment.

From an environmental perspective (Bronfenbrenner, 1979) this observation grid allowed us to collect several indicators on the evaluation practices of math teachers and to group them into five macro-categories:

1. math content (content and skills that are the subject of teaching);
2. assessment time (before, during or after a specific learning activity);
3. assessment setting (with all the students in classroom, with student groups or with each single student);
4. type of tools used to collect data on student skills (written tests, oral exams, behavioural observation, …);
5. stage of formative assessment (presentation of the assessment activity, information gathering, error correction, feedback).

In the first category we consider the information about the mathematical content that is the subject of each lesson/situation. Taking into account the complexity of the teaching-learning process, the activities in this category obviously cannot be considered only as content in mathematical knowledge (mathematical objects) but we had to expand our horizon to take into account the skills and competences the students bring to the learning process. So we adopted a two-dimensional content/capacity schema based on the OECD-Pisa approach (OECD-Pisa, 2013) as shown in Table 3.1.

Other categories have been elaborated starting from the consideration that, as has been said, a good assessment strategy must necessarily refer to an equally rigorous measurement phase. Only in this way, the assessment can be defined strictly scientifically, and flexibly adaptable to the operational choices that the teacher adopts for a successful process of teaching/learning.

Tab. 1 - OECD-Pisa Approach/Capacity Schema (OECD-Pisa, 2013)

Contents	**Skills**
Numbers	Communication
Spaces and shape	Mathematization
Uncertainty and data	Representation
Relationships and Functions	Reasoning and argumentation
	To devise strategies for solving problems
	Use symbolic, formal and technical language and operations
	Use math tools

In particular, thanks to the collaboration with the teachers, we considered the importance of implementing choices that would ensure the widest and most adequate framework of reliable and accurate information on achieving specific learning objectives.

In the grid, the second category (*time*) was set to identify the moment the formative evaluation activities are carried out over the time of the whole lesson (for example before, during or after a teacher's explanation).

The *setting* category (third) considers the context of training evaluation. This is necessary since categories, time and space/context (which also take into account the predisposition of the class group) are variables that can affect the teaching process and, if pedagogically planned and suitably adapted to the specific teaching-learning situation, they can play a very positive role in facilitating the process.

The next category, the one that considers *tools*, is equally important. It is also through the use of appropriate tools and techniques for detecting, processing and analysing the information that can be obtained, which can best integrate evaluation practices into strategies and didactic paths promoted (Domenici, 2003, pp. 34-37). This involves a strong focus on the validity and reliability of the information to be taken into consideration, as the teacher should be able to express a reasoned and documented assessment of the pupils' performance (Tornar, 2001, p. 161).

Docimology studies have produced several classifications of test and assessment techniques that can be used in the different contexts and moments of a training path. There are also numerous studies demonstrating the validity and limitations of the most commonly used tests in teaching practice (Vertecchi, 2003).

The variety of tests available is very wide and often the choice of the tool and its construction is very difficult for the teacher. This also because it is very much dependent on the purpose for which an instrument

is used and from the moment when an assessment is made. In the grid, instruments have been classified into types of tests, distinguishing between scripts and oral, individual or group, and structured or not. All those situations in which a teacher implements an assessment process, even though this practice does not follow the formal process, is based on spontaneous or unexpected observations with non-systematic or informal interactions.

Finally, the last category of the grid is the most interesting and most characteristic because it collects a wide range of behaviours and actions that can be considered as indicators to be observed in the various *phases of the assessment practice.* It is also the most complex category, because it collects actions and behaviours (predominantly of teachers) implemented at different moments of the assessment phase.

For this category, reference was also made to the methodological indications from docimology studies, foreseeing phases of which should be a good assessment practice. For a systematic and rigorous assessment methodology, it is necessary to follow a series of indications to try to reduce the risk of subjectivity. At the same time, it is necessary to ensure, as much as possible "formative" assessment that ensure a useful feedback to adapt teaching and learning strategies with their aim. A proper "way" to activate a correct evaluation is the one that distinguishes the phases of (Domenici, 2003; Vannini, 2009):

- presentation of the test, in particular by sharing with the class of correction and/or assessment criteria;
- the administration of the test, which requires special arrangements depending on the type of test used, for example written or oral;
- feedback, that is, returning the results obtained by the student.

For each of these phases, therefore, in grid construction, we tried to identify all observable actions that could be considered as indicators of good or bad assessment practices. For example, at the stage of the presentation of the test, the teacher should clearly communicate when the pupils will go and share the goals, the contents, the methods of testing, the criteria for correcting it and assessing it.

In the administration phase, however, actions may differ according to the type of test used. For example, particular attention should be paid to the distribution of a written test, providing explanations on how to run the test or compilation of the distributed module and strategies used to ensure that there is no interference in individual work (for example, to avoid some copied from class mates). In the case of oral tests, the operating instructions are different, depending on whether they are individual, group or paired, and depending on the mode and timing for example to answer a question.

In the recording phase, the detectable and observable activities are few and differ according to the type of test performed. For example, if the teacher decides to assess a student through direct observation, he or she can decide whether to use more or less structured grids or a freer and narrative recording mode.

The feedback phase is also quite articulated and includes all the actions through which the teacher can give information on the result achieved and aimed at allowing each pupil to be aware, for example, of the type of error committed. Even at this phase, actions may also be differentiated depending on whether it is a written test or an oral test or even a test involving peer evaluation.

In this chapter, unfortunately it is not possible to describe in detail all the actions that can be detected by observing the videos recorded in the class. To see the indicators, refer to the overview of the analysis grid in the appendix.

Here we limit ourselves to specifying that for each phase of a valuation practice, the grid has created subcategories containing the individual indicators. For example, during the administration and feedback phases the actions were grouped into subcategories referring to the use of different types of tests (written and oral). Researchers, moreover, have never considered the grid as "complete" and "definitive" as observable and measurable actions as indicators of an assessment practice may be much more numerous.

It should be noted that grid construction work was perhaps one of the longest and most complex of the research carried out by the researchers throughout the FAMT & L project. Much support at this phase was given by teachers who actively collaborated on research. They helped us during different training and sharing moments that allowed us to observe the teaching practices more closely.

Using the analysis grid tool, the research team was able to conduct a systematic observation study on a large sample of video sequences of teachers gathered in the five partner countries involved.

The collected videos consist of real classroom situations recorded while implementing assessment practices such as giving a test or a task to students; conducting a written, oral or practical test; reflecting on the mistakes that have been made in a test; correcting an assigned task (in a group, individually or in pairs); the teacher's answers during work on an individual exercise, and so on.

From "long" videos, some short video sequences have been obtained that have become the main training tool for the pilot course.

7. Collecting videos in a web repository

The videos collected and analysed using the grid we described also required the researchers to design and build a virtual environment so that they could be stored and categorized. For this reason, a web repository has been designed, according to the common model described (see paragraphs 3 and 5 and chapter 7) to be used during the teacher training paths.

Using the video analysis grid has therefore allowed a meta-dating of every short video sequence and a video recording system that facilitated their archiving. This archiving system has also been designed in a way that finding specific materials in the repository would be easy so that they could be integrated into "pilot" courses aimed at promoting the correct use of FA as a tool to improve math teaching.

In the design phase of the repository, the partners had thought of a virtual environment that could contain many useful teaching objects and tools and have some specific characteristics. The repository needed to:

- contain various types of teaching tools and research tools used and produced during the project;
- have at least one tool that could be used for exchanges of information and communication (e.g. a blog);
- be administered by all partners; for this reason English has been chosen as the official language, but it is possible to upload materials and content in all the languages of the different partners;
- be organized in different sections based on criteria defined together by the partners (e.g. nationality, topics, age, etc.).

Lastly, all the materials had to be easily accessible, usable (e.g. to facilitate searching for different materials) and had to remain available (e.g. for teachers from different countries) beyond the end of the project.

To design and implement this kind of environment, researchers have looked at different solutions and followed different stages of product development, which in the final version has taken on features slightly different from the ones initially planned.

First of all, many different digital materials and training assessment tools designed and used as a methodological resource for planning and conducting teacher training courses have been uploaded to a specific e-learning platform made available by French partners (e-Space Platform). This platform has become the support for partner courses that they wanted to adopt and is available for the courses that will be implemented in the future. The materials that can be uploaded are several: training content, assessment tools (such as charts, schemas, etc.), videos (educational situations recordings), movie extracts with text comments or related activities, specific tools for formative assessment, learning objects created

and used for teacher training, reference bibliographies, link lists and web sites, glossaries, project documentation file (draft, reports, alerts, meeting records, articles etc.).

Instead, the videos analysed were uploaded to the web repository that has features and functions described in the next section.

The FAMT&L web repository: features and functions

The main language is English but the website is organized in 5 sections, one for each partner's language: Italian (for UNIBO and SUPSI), French (for UCP), Dutch (for Netherlands' Hogeschool Inholland) and Greek (for UCY).

FAMT&L web repository hosts two different type of contents: Training and Context Unit.

The *Training Unit* is a set of information related to a video analysed with the analysis grid. It shows a situation in classroom and the related analysis.

It also displays a set of further data: last modified data, related video, documents that explain and expand the situation.

Training unit are searchable in home page through facets system that allow to select a number of filter like partner or abilities and so on.

A group of training unit that describes a more complex problem or situation are grouped in a Context unit.

Context Unit is the second form of content type. It spokes about context in which one or more training unit are developed, group them together and show more data about it.

Some example of data is: short description of the media, creation date, school level target, training unit collected, language and country.

Context unit are listed in Context unit page.

Over the core (training unit and context unit), web repository exposes some static page in which the whole project in presented and explained.

The repository is divided in a *front office*, in which everyone registered to the site can explore, search and navigate units, contents, page and a back office in which certain role can manage units and contents. The *back office* allows adding, editing and removing every type of content through dedicated forms.

On the top of the web site there is an edit menu from which each partner can manage its contents but it is necessary to have an administration role that permits to edit all the contents without property limitations (in the repo are defined, at the moment, the follow roles: register user, editor and administrator, each of which has specific permission and abilities to read/write certain type of content).

All the repositories are translated into four languages: English, Dutch, Italian, Greek, and French. So each type content is submitted in one or more of these languages.

Regarding the site interface, the home page contains a brief introduction to FAMT&L project and some link to search video:

- by Context or Training Unit (tab under the logo);
- by the 5 languages in which partners had uploaded files;
- by author of the uploading (the 5 Partners);
- by some section of the analysis grid (Contents, capabilities, time of assessment, tools or tasks to assess the students).

In the first page it's also possible explore directly among the list of video uploaded.

The screen of the single unit (see Figure 3), however, is characterized by having, at the top, the video's identification name (named according to the shared criteria that allows immediately to understand provenance, grade, school, recording year).

In the left part of the screen is the video frame and below a brief description of what it contains. In some cases you can also find materials used by the teacher for the assessment (correction grids, forms to be filled, observation grid).

On the right side of the screen there are all indicators of the analysis grid observable in the video: the individual actions that the teacher and the pupils do at different stages of an assessment process.

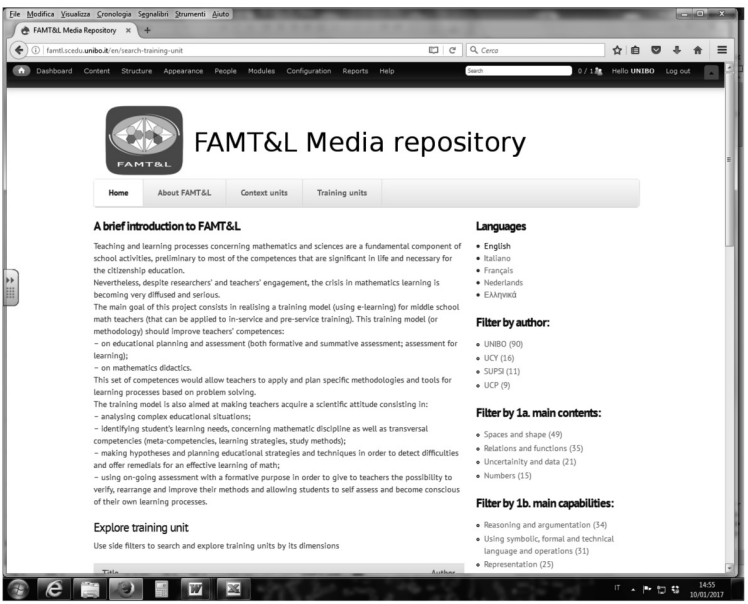

Fig. 1 - Homepage screenshot

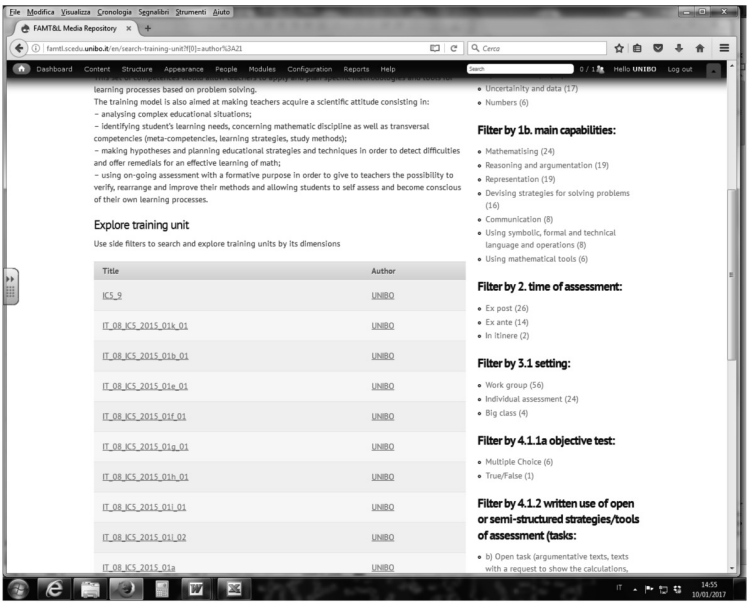

Fig. 2 - Homepage (second part) screenshot

Fig. 3 - Screenshot of a Training unit

Following there are also other information grid that allow to understand what content and what skills are object of the specific assessment practice.

The important repository functionality is the possibility to select through the individual voices of the grid all Training Units that contain videos in which the same indicators were identified. This, for example, is useful for searching, by a teacher, starting from the mathematical content or skill to be assessed.

8. How to use of videos collected during teacher training

In our research project we considered the international scientific debate (Perrenoud, 2002; Anderson, 2004; Darling-Hammond & Bransford, 2007; Koster & Dengerink, 2008) on teachers' professionalism. In particular we know that teacher training has to be considered a strategic factor to improve the national educational systems (see Mumby *et al*., 2002; Richardson & Placier, 2002; Darling-Hammond, 2006; Darling-Hammond *et al*., 2007; Coggi, 2014).

A good part of the scientific debate about teachers' formation activities seems to focus on the relationship between theory and praxis, between knowledge and competences, i.e. by the research of how to form the teachers in such a way to get that the information they gain will really develop into new behaviours and competences that will enter into play in their everyday teaching practices.

In this line of thought, it is particularly relevant the concept of *recurrence* between theory and praxis, meaning an alternation between distinct (but at the same time interrelated) steps in a specific learning process (Atelet, 2003) which are able to translate theoretic knowledge and methodology into an *action* and also, at the same time, reflection on the action itself, a reflection that, in turn, becomes new knowledge, and so forth. There are several different contributes to this debate, based on interdisciplinary studies (in Pedagogy, Psychology, in Neuroscience).

Many of those studies seem to validate the idea that a fundamental step for the professionalization of teachers is the identification of the most suitable ways to *conceptualize* their explicit practices in teaching (Rossi, 2014) by means of recursive processes, integrated and interdependent among them (Seidel & Stürmer, 2014), as are observation, comprehension, anticipation or prediction (Rivoltella, 2014) of what happens and can happen after a specific action.

From here several indications stem about the most effective methodologies to promote the co-presence of theory and praxis in the formation of teachers (both in-service or pre-service). Among these, there

are many techniques that can be based on the use of specific support tools, as, in particular, the videos.

Usually the formative activities which are based on the use of videos are defined "*video education*", an expression which covers an ample range of teaching experiences, starting with the first movies in the last century, to the use of television and analogue supports (VHS) and then to digital (CD/DVD) and ICT ones (PC and multimedia) to end up with the Internet and the so-called Web 2.0 (O'Reilly, 2005).

The presence of videos in formation activities for teachers is more and more common, with several modalities in there use (Masats & Dooly, 2011):

- as both an object and a tool for observation and analysis, to show a subject to the teachers (we speak of *video-viewing*, in this case);
- as an example or display, when the video shows the practices and the behaviour of experienced teachers in specific situations (*video modelling*);
- as a record of the teachers themselves, which is shared with the others, making it an occasion of comparison and debate with colleagues or with a trainer (*video coaching*).

These modalities yield several implications. The videos' content can be quite different: a teacher record her/him-self, use recording of colleagues or other experts, focus on specific didactic practices or behaviours, attitudes, interactions. Moreover, the videos can be presented as an example of everyday teaching activity (Carbonneau and Hétu, 2006; Clarke *et al.*, 2008), or as a "best practice" which rarely could be directly observed (Seago, 2004), or as a specific experience or experimentation (Santagata & Guarino, 2011). Also the length of the proposed video sequences can vary, from very short excerpts to longer and complex sequences.

Several studies, anyway, confirm the effectiveness of video-based interventions in the training of teachers: videos become a tool which is able to integrate and support, via the visual activity, the direct observation and the learning of good teaching practices of which, otherwise, there could only be a description, oral or written (Santagata, Zannoni, Stigler, 2007).

In the last years the didactic technique of *microteaching* has gained much credit; actually it is a technique that dates back to the experiences in the '60-'70's by K. Romney and D. Allen at Stanford University. Allen himself defines (1975) microteaching as a technique which consists mainly in having the trainee teacher to present to a small group of students a short time teaching session, focused on a specific subject. The short session is monitored from trainers which use video recording as main tool. This will allow the supervisors of the microteaching session to show to the trainees, via the analysis of the teaching sequence, which abilities will help them to solve the problem in their teaching practice end the errors they can do

in their activities. Such an analysis can promote and facilitate a reflexion on what is done in the class, which contributes to an improvement of the teaching practices. This attention to the reflexivity as an attitude of the teachers to analyse and think over about their own practices, is essential to get an educational success (Dewey, 1961), and is what allows us to speak of the teachers as *reflexive professionals* (Schön, 2006; Damiano, 2007), and of a professional knowledge of their own (Calvani, Bonaiuti, Andreocci, 2011).

Thus it is impossible not to see how effective the use of videos can be in the formation of teachers, but it is also important that this use take place within a well-structured formation proposal, characterized by:

- a clear and thought over choice of the learning objectives that one wants to achieve with the trainees teachers (Blomberg *et al.*, 2013; Seidel *et al.*, 2011; Rossi, 2015);
- the production or selection of the videos best suited to the defined objectives;
- a good support and guide to the vision, comprehension and analysis of the video;
- elaborating suitable tools for evaluation, appropriate to the objectives (Calvani *et al.*, 2014).

Following these ideas, the FAMT&L project elaborated a pilot model of a course for mathematics teachers that integrated and use the analysis of videos made in class with teachers involved in the project with different modalities, but all oriented to the achievement of specific formative targets.

As we have already said, the idea that guided the recording-analysis of the videos was to be able to use the analysed video-sequences as part of training courses for in service teachers that can acquire specific skills in the use of formative assessment as an element that improves the quality of teaching.

In line with the debate on teacher training, the observation of teaching practices by themselves would allow changes in their behaviour and encourage processes of reconsideration on assessment and teaching.

In fact, the pilot course that has been developed was centred to use the video sequences analysed in order to promote critical thinking of teachers in training.

The model of the course had been tested and its efficiency verified with small group of mathematics teachers in the several partner countries, so that it can be proposed as a model to be adopted also in other activities, both for in-service or pre-service teachers.

In the following chapter we can see the more detailed description of these course and the main results we obtained.

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7. Teacher training through the video-analysis: a model for five pilot courses. Mathematics Teachers Change in FA: monitoring of the pilot courses

by *Giorgio Bolondi, Federica Ferretti**

1. Introduction: the frame and the objectives of the pilot courses

The central phase of the project consisted in the design of the pilot course, which was framed on the theoretical framework shared by all the partners, and has been designed relying on the results obtained in the questionnaires administered to teachers and students at the beginning of the project.

The theoretical-methodological shared framework used for the design of the pilot course defines the key points of formative assessment in mathematics and the pilot course was intended to answer to the teachers´ formative needs pointed out by the questionnaires. The main purpose was to focus on the basic elements of the observation of classroom practices and, in particular, assessment practices, in order to capture those peculiar aspects that have to do with its formative function in mathematics.

In according to our FAMT&L theoretical framework we started from the premise of considering assessment as assessment *for* learning and not assessment *of* learning and assuming that the implementation of formative assessment leads to higher learning quality (Wiliam, Lee, Harrison & Black, 2004).

The main purpose of the course was to build good assessment skills for math teachers of secondary schools (grade 6 to 10), trying to significantly affect their knowledge, skills, by working also on metacognitive aspects.

The objective of improving assessment skills, in the direction of specific and consolidated knowledge, skills and beliefs of teachers, made the frame of each activity carried out during the training course. In

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particular, the work done in classroom about the beliefs of each trainer was crucial, both in large group discussions and in small group activities, with the aim of developing a shared learning culture of assessment *for* learning in mathematics.

From a methodological point of view, the central idea was to implement video analysis techniques, as a key tool for teacher training. Therefore, the web repository constituted the central tool of the entire path, based on recursive processes of video analysis, individual reflection, discussions in large and small group. As we shall see in the next paragraph, the importance of video analysis in the field of teacher training is now shared at the international level; video analysis in fact plays a fundamental role to act as teachers' analytical skills and the consequent development of their reflective thinking (Santagata and Angelici, 2010; Santagata and Guarino, 2011).

2. The importance of formative assessment in mathematics in teacher's professional development

We recall here some theoretical aspects that have guided and served as the frame of reference for all research activities: the role of formative assessment in mathematics.

Looking for a generic (and etymological) definition of the term *evaluation*, we could first say that it consists in "attributing value to something or someone". To attribute this value, those who have an assessment responsibility should follow coherently a well-defined assessment-related model, and rely on rigorously designed techniques and tools. Following the latest assessment theories, the role of evaluation can thus be essential to ensure a quality education and training system with respect to the level of skills of pupils (Vannini, 2009). In a peculiar way, the role that the evaluation should have is the *formative* function (the term being originally coined by Scriven, 1967).

Formative assessment should in fact be an indispensable part at all stages of the teaching-learning process. In this regard, its main function is regulatory as it aims to modulate and adapt the training process continuously, especially if this is oriented to the individualization of teaching-learning steps (Tornar, 2001). We can then define the assessment as collecting evidence and information about the teaching-learning process, thus leading to a change of perspective also in mathematics teaching, from the assessment *of* learning to assessment *for* learning. In this framework, therefore, the concept of formative assessment in mathematics becomes ever more important. In school practice, assessment in mathematics is

often structured and organized according to the *mathematical content*, but the education mathematics community is increasingly questioning if this is the optimal way, in a formative perspective. We can found a great support in this direction in Martha Isabel Fandiño Pinilla's research results, in which the different components of mathematics learning are analyzed in depth. The frame there constructed is very useful for defining a dimension, other than the content one, for assessment (Fandiño Pinilla, 2008). As we read in the author's words, mathematics is one and learning mathematics is a unitary fact; it is however useful to distinguish several components of it, which are:

- conceptual learning;
- algorithmic learning;
- strategic learning;
- semiotic learning;
- communicative learning.

These reflections have a strong impact on the assessment, because in order to carry out a detailed analysis of the learning, to be used for intervening on the learning process, it is necessary to treat these components both independently and in their interplay. The overall study of components of math learning is so useful in investigating what works and what does not work throughout the math teaching-learning process. This theoretical-methodological framework, moreover, helps to investigate the causes of student errors, a fundamental process in a formative assessment. It is precisely with reference to the above mentioned theoretical framework that the pilot course has been developed.

3. The design and the methodology of the pilot courses

The core of the pilot courses consisted in activities aimed at explicating teachers' beliefs, by sharing of beliefs and opinions about formative assessment in a small and large group. As we know, this initial shift from the analysis of personal beliefs to the building of a "useful learning" collective idea is strongly influenced by the complex social interactions that come into being within social groups (Hoyles, 1992). Particular attention was paid to these moments, in particular by stimulating the comparison between teachers 'analysis of the video proposed in the web repository. For the design of the pilot courses, we worked on a collaborative approach classroom situation and on the idea of individualization, diversifying classroom interventions also in according to individual teachers' needs. At all phases of the course, however, we have tried to pursue – for all the participants – some fundamental objectives:

- to identify and recognize, among other things, situations of formative assessment in the classroom;
- to analyze the details, and identify non-functional evaluation practices;
- to reflect on their own way of evaluating in the classroom and identifying what analogies and differences with the situations being analyzed.

From the point of view of the didactic methodologies adopted during the course, we adopted a constant collaborative work approach between participants and researchers (Morissette & Desgané, 2009); we have therefore tried to make the participants active during each classroom sessions, to achieve a shared knowledge building. Participants have been considered as competent actors who have the resources to act, reflect and theorize on their actions. Discussions with experts and group comparisons were the strategies with which the acquisition of knowledge and abilities and the change of individual beliefs were promoted most, starting from the need to analyze and then internalize what is gradually was shared.

4. The structure of pilot course

Pilot training models have been personalized by each partner country, based on individual resources and learning needs. However, there have been points in common both as regards the definition of aims, objectives and content, as well as the methodologies and assessment practices.

The training model will then be used to define training paths that promote the correct use of formative assessment in mathematics training assessment by encouraging critical and reflective thinking of participants by analyzing effective/ineffective strategies through video analysis tools and techniques.

The aim was therefore to create a training model on which to build training paths, both in presence and in blended learning mode. In Annex 1, we show the structure and the organization of model training; the following table (Tab. 1) shows the structure and dates of each partner country's pilot courses (FAMT&L – Final Report WP4).

Tab. 1 - The structures and the organizations of models training

	Italy	Switzerlan	Cyprus	Holland	France
When	5 meetings 7 october 2016 (5 hour) 14 october 2016 (5 hour) 15 october 2016 (8 hours) 28 october 2016 (5 hours) 29 october 2016 (7 hours)	2 meetings each 6 hours 7 march 2016 18 april 2016	**Two courses** 3 meetings each 4 hours 7, 8, 9 June 2016 3 meetings each 4 hours 4, 5, 6 July 2016	4 meetings each 1,5 hours 10 June 2016 24 June 2016 Next school year: 4 September 2016 9 October 2016 Afterwards periodic meetings in Professional Learning Community (every 6 weeks, each 1 hour) until end of year. This means training will continue after FAMT&L has ended.	6 hours of training course begin 10 october (via the E-space and OpenEdx platform).
Number of trainers	5	4	3	2	This is a Mooc online (via the platforms so there will be no trainers).
Function of trainers	• Two trainers with expertise on the subject of evaluation and three teachers of mathematics education. • Preparation of material. • Organizing and coordinating the meetings with teachers.	• Two trainers with expertise on the subject of evaluation and two teachers of mathematics education. • Preparation of material. • Organizing and coordinating the meetings with teachers.	• Preparation of material. • Organizing and coordinating the meetings with teachers.	• Mathematics (didactics) specialist and specialist in formative assessment • Pedagogy trainer, specialist in assessment	The Mooc is created by a teacher of Maths.

Tab. 1 - continued

	Italy	Switzerlan	Cyprus	Holland	France
Number of teacher	15-20	18-24	**Group 1:** 16 post-graduate teachers (kindergarten/ primary/ secondary). **Group 2:** 10 secondary mathematics teachers.	18	This Mooc will be opened to the whole education institute (ESPE), every students (teachers part time and also full time) could participate at this Mooc 3500 students of ESPE of Versailles.
Which kind of teacher	Mainly High and Low Secondary Teachers.	Teachers in training who teach part time as teachers in a class of middle school.	Two possibilities: 1. Post-graduate teachers (master students in Mathematics Education). 2. In service mathematics teachers.	In-service teachers Training is validated by nationwide registry www.registerleraar.nl (validation number wpZs7owYcw). Teachers will receive certificate to prove their participation (mandatory in-service training which is registered for every teacher).	Teachers in training who teach part time and full time as teachers in a class of middle school.
Number of hours	30 hours	2 meetings of 3 h	**12 hours:** 3 meetings of 4h	In total 12 in course, thereafter 6 hours in PLG-meetings.	6 hours
Use the e-space	Use of platform mainly for uploading/ using material.	We will not use the e-space platform, but we do face-to-face lessons. We will use the repository and the questionnaire on-line start and end.	We will not use the e-space platform. We use the web-repository for watching the videos We mainly work face to face.	We will use videos available on internet (teaching channel.org). E-space platform not used. Training is done face-to-face (6hours) and “at home” (6hours).	(Via the E-space and OpenEdx platform).

As we see in the table above, the pilot course implementation modes were different in each country, but the common structure nevertheless allowed a constructive comparison. As we read in Annex 1, certain steps are foreseen for each modality of realization of course, so that all courses are consistent with the planned design in line with the theoretical framework. For instance, some countries, like France, have been the course completely online on E-space environment, while others, such as Switzerland and the Netherlands, have not used the E-space; this difference in achievement has allowed highlighting the strengths and weaknesses of each modality of course implementation. As we will see in the next paragraph, the web repository and the FAMT&L grid have been a common video analysis tools for all pilot courses and they have been fundamentals for delivering common goals.

4.1. *The crucial roles of the FAMT&L Grid and of the Web repository within the pilot courses*

The Web repository of the project consists of recorded videos containing formative assessment situations in the mathematical classroom, carried out by associated partner schools of the project itself. With videos collected and analyzed, FAMT&L researchers have created a web-repository that contains all the videos, hundreds of microsequences and their video analyzes. In particular each country has produced "long videos" in which there is a total recorded lesson and from every long video has been obtained some microsequences that portray training assessment situations; within the web repository it is possible to trace each microsequence on long video.

These videos have been analyzed and indexed according to a structured grid, the *FAMT&L Grid* (Annex 1), designed to analyze mathematics formative assessment practices. As we can see in Chapter 4, the FAMT&L Grid was developed in line with the formative assessment theoretical framework shared and, starting from it, quality indicators for formative assessment mathematics teachers' practices were described. The indicators (validated by the researchers after several trials within each country) were assembled by different categories, related to the specific phases of the formative assessment: e.g., sharing of assessment criteria, the administration of assessment (write or oral), the formative use of the error, the self and peer assessment and the formative feedback. Each set of indicators behaves like a specific check list, to be used in Web repository to label the "class scene" that is taking place on

the video. The indicators were placed within a largest scheme that includes further and fundamental macro-variables: the description of the class setting, the timing of the evaluation practice, the mathematical knowledge and skills involved (based on the theoretical framework OECD-Pisa, 2013).

The indicators were used in the pilot courses for recovering situations to compare, for opposing behaviors, for outlining categories.

Every long video has been meta-dated in the following categories; moreover each Country conducts a micro-analysis of each short episode, with the following macro-categories (as we can see in Chapter 4).

The web repository has been a fundamental tool in all pilot training courses; in each country all coursers have been provided with a temporary password, thus having the opportunity to watching videos freely and getting in touch with the video analysis FAMT&L grid. The video analysis grid played a key role in these training paths, having objected, at first, to a free exploration by the participants and then – gradually during the training courses – of systematic use to focus on the details of the various videos, both in the classroom (in large and in small group) and individually.

5. First results of training model courses

As we have seen, critical and reflective analysis datasheet, individual or on group, have been compiled throughout the course, and each trainee has consistently compiled a personal "diary on board". The research tried to analyse some "changes" in the skills of teachers at the end of the pilot course; indicators of acquired knowledge, practical skills and metacognitive aspects have been identified and investigated. Regarding the knowledge of assessment and, specifically, formative assessment in mathematics, it was chosen to analyse the learning perceptions by the participants, that is, they monitored as they progressed through the training course. In particular, it was attempted to investigate how their knowledge of the theoretical reference framework, their ability to recognize and analyse classroom assessment situations, to argue the effectiveness of this formative function.

In general, by analysing the documents compiled by the trainees throughout all the course implemented within the project, one can conclude that there has been an increase in awareness of both the theoretical framework of mathematical formative assessment and in the ability to analyse (and self-analyse) the classroom situations.

5.1. *The Italian research*

For instance, the Italian research group carried out a pre-experimental design to investigate the above-mentioned aspects. In details, during the Italian pilot course, three main detection tools were used (almost all the questionnaires are the same of the questionnaires administered in the other countries pilot course):

- a questionnaire on "learning perceptions", which has highlighted the perception of knowledge and skills of the participant;
- a questionnaire on educational beliefs, structured with two item batteries with 4-level of agreement, from "a lot" to "nothing". The first battery concerns a Likert scale on the "school idea" (see Vannini, 2009) that contains a sub-scale on the ideology of "students' natural skills" and, on the other hand, another sub-scale on teachers' confidence in the potential of teaching in terms of learning opportunities. The second battery concerns the beliefs on the formative function of the evaluation, in line with FAMT&L shared definition;
- finally, the Norwegian Teacher Self-Efficacy Scale (NTSES, Skaalvik & Skaalvik, 2009) validated in the Italian context (Avanzi *et al.*, 2013), composed of 24 items divided into 6 dimensions, to which the teacher must respond by declaring "if you feel able to…" implement specific behaviors in defined school situations, with a gradation form "nothing" to "totally" responses).

As we can read in Ferretti & Vannini (2017), research has brought good results in almost every direction; below we show the most relevant results.

Learning – Knowledge and Abilities perception

In the questionnaire on learning perceptions, participants were asked to score a score from 1 to 5 (low to high) on their perception of competence compared to each of the following indicators:

- "knowledge of the theoretical framework on formative assessment";
- "explain the reason why formative assessment is a high rate of effectiveness";
- "being able to analyse a classroom assessment situation with predetermined indicators";
- "know how to organize in the classroom a situation where the formative assessment is integrated in the didactic design".

The questionnaire was administered at the beginning, during and at the end of course.

With reference to all indicators, there is an increase in the average scores of responses provided at the end of the training course compared

to the intermediate and initial training. The trend is increasing in all four cases; there is no inversion and no constant trend. The T-test for paired samples shows that all differences are significant at 0.0001.

Although there is a significant increase in perception of competence and this represents an important indicator of the effectiveness of intervention, perceptions do not show real mastery of skills, knowledge and more generally of competences. Particularly relevant data is the almost linear increase in the scores with respect to the indicator "To be able to analyse a classroom situation with predetermined indicators", indicating a significant increase in the perceptions of the participants of their ability to analyse video situations. It is shared internationally that the reflexive skill of teachers grows as they refine their ability to analyse details in videos and to think and discuss about video situations. The increase in critical reflexive skills and in analytical thinking of the teachers was also perceived during the working group. Another one interesting information is the increase in the scores obtained in the indicator that refers to the perception of one's own skills of "Know how to organize a classroom where the formative assessment is integrated in the didactic design". The average referring the scores obtained has increased by 1.5 points, indicating how the pilot course had a positive impact on the perceptions of the trainees on their "practical" assessment skills.

These results, although entirely "exploratory" and exclusively linked to self-perceptions of competence, are particularly relevant as the expectation of *teacher practices change* is the most important goal to be pursued.

Self-Efficacy Scale

Regarding the Self-Efficacy questionnaire, we have process aggregate data for the 5 sub-scales, comparing the answers provided by participants at the beginning and at the end of the pilot course. The scores of almost all sub-scales have increased significantly and the related T-test for paired samples gave results of significance below 0.05. This sensible increase in sense of Self-Efficacy in almost all dimensions investigated is totally in line with the perception of improving the ability of the teachers to put into practices and techniques of formative assessment and with various international studies that hypothesizes the positive correlation between the use of formative assessment in class and the Self-Efficacy of the teacher.

6. Conclusions

The analysed results of the Italian group's research are in line with the results obtained in other countries' pilot courses (some of which are still

being analysed). The results are of particular utility for the development of more clear hypotheses on the teachers' professional development courses and on the use of video analysis methodology.

The research team has verify that video analysis seems to reveal its potential only if it is integrated into a well-structured teacher training proposal. One of the objectives of the FAMT&L research group is to carefully analyse all the data obtained in the various pilot courses, compare and study them.

An in-depth analysis of all the results will enable the development of well-structured pilot courses in terms of:

- a clear and reasoned choice of learning objectives to be achieved with the group of teachers in training;
- the production or selection of videos that best fit the goals to be achieved;
- the elaboration of appropriate reflexive and self-evaluation tools, also aligned with the objectives.

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8. The voice of the teachers: their experience in FAMT&L

by *Andrea Maffia*, Federica Recchiuti*, Camilla Spagnolo**

1. Introduction

Pre-service teachers' education usually consists in a theoretical part, then followed by some kind of practice in school. In our experience, it is quite common to hear about the discrepancy between what is taught in universities and what is put in practice. If you are the new young teacher of your school, doing things differently than your more experienced and more estimated colleagues can make you feeling uncomfortably. In this kind of situation two different paths are walkable: you adjust your practices to those of others, or you try to strengthen your own beliefs about teaching. Participating to FAMT&L has been for us the chance to follow the second way. Attending further teacher education, comparing our practices with those of other teachers and observing ourselves were opportunities to criticize what we do as teacher and so to acquire new awareness on our job.

In this chapter we highlight how FAMT&L involved us – in different ways – as mathematics teachers and how it triggered a process of pondering on our formative assessment practices. Each one of the following sections concerns a particular aspect of the involvement of each one of us. In particular, the first section is written by the first author, the second section is by the third author and the last section by the second one.

2. Cameras in the maths class: videotaping your own teaching

One of the main features of the FAMT&L project is the video database for formative assessment practices. Obviously, the realization of such a repository involved mathematics teachers and their classes.

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Videotaping of a lesson does not seem so difficult for a teacher: you just should do what you usually do while someone stays there behind a camera. There is nothing more. However, when you are really asked to be videotaped, several worries come out. The origin of those worries may be the idea of someone else looking at that video while thinking that you are a good teacher or a bad one. All the mistakes you do during the recorded class will be permanently impressed in the film (or better a digital memory) and the others will be able to see them.

Usually, what you do and say in your own class remains between you and your students. The idea of someone watching at you while you are working brings you back to the feeling of being judged (or maybe assessed, or evaluated?). In the exact moment in which you realize it, a process of rethinking on how you evaluate your students' work begins. Videos are used in FAMT&L to discuss and to rethink formative assessment practices. This means that watching at those videos will not result in a judgment of the involved teacher but in a formative process of development of practices. This means that if any assessment is made through those videos, it is formative assessment.

Feeling part of a formative assessment process (rather than a summative one) is definitely less stressing: Isn't it the same for students? Even if, as a teacher, you are alone while the video operator is filming you, is quite better when you also know that you are part of a project. In the project, there are some other teachers that are videotaped as you are. In some sense, you become part of a potential community of practice, in the sense of Wenger (1998). Finally, it seems a bit less risky.

Once I accepted to be videotaped, then I informed students' parents and colleagues about the event of a video operator coming to school. One of the most common question that I got back was "how can it be spontaneous?". The main concerns were about the fact that pupils could be scared or inattentive; colleagues asked about my teaching: would it be the same without a camera recording? The experience within FAMT&L gives me an anecdotic knowledge to give some possible answers to these questions.

When the red light of the camera is turned on, some students notice it. It is easy to realize it both during the class, both watching the video: their gazes are taken by the camera. Then the class starts, it is time for doing mathematics, their attention is suddenly oriented to the tasks. They do some peer-to-peer work, the teacher walks around the room to hear what is happening and it is easy to see that the dynamics are the same as always. Apparently, nothing is different from the student's viewpoint.

What about the teacher? Thinking back to the moment of videotaping, I can assure that there was not a moment in which the main concern was the camera or the video operator. When the class is going on there are continuous stimuli by pupils. There is not enough time to consider both the camera and the lesson. If we just give a look to the video, it seems that also from the teacher viewpoint everything is as it has always been. But, to be honest, it is not exactly the case: the main difference is not visible in the classroom because it was exploited before.

As a matter of fact, being somehow evaluated prompts to put a considerable attention in the designing of the videotaped class. You try to make as clear as possible your aims for that lesson; you chose carefully the tasks and the way of presenting them; you ponder on the groups of students working together; you redesign your assessment rubric. Going back to former readings (books, university notes, papers, …) to see if you considered everything you were taught, you begin a process of critique to the didactical tools you already use in your classes and you rethink them and their use. Finally, the implemented class is not the same as it would be without the camera, but it is not because of the video operator in the room; the difference depends on a reflection that took place before.

When the camera is turned off, it is not still done. Before everybody can see that video, you want to give it a watch. As far as you put a strong effort in designing the lesson, you can see clearly everything that is not as it was in the plans. Watching the video several questions come out: questions about how things went and why they went that way. The powerful opportunity given by the video is to watch it a second time – maybe a third – to try to understand it. A process of *self-confrontation* (Fuller & Manning, 1973) begins.

Videos in FAMT&L repository have also been subtitled and so a new opportunity rises. Reading back the dialogues allows putting attention to the words that were used, both by the teacher and the students. So far, most of the rethinking was about teacher's practices: a slow reading of what students said switch the focus on their learning. Why did they use those words? Why were they so secure on some topics? What is the source of a particular difficulty I can notice?

Even if it is thought as a tool for other teachers' training, the video itself becomes for the teacher a tool for formative assessment of his students (Ferretti & Maffia, 2017). The richness in thinking and reflection that can be evidenced along all this process made me feel the necessity of videotaping some other classes in the future; it can be useful for others, it is very fruitful for me.

3. The experience of the pilot training course: learning from videos

The assessment in mathematics has a strong impact on students and teachers alike. Moreover, many researches have shown the fact that the assessment is the most important factor in determining the positive or negative behaviour of students when approaching maths. For this reason, a problem of crucial importance is how the teachers evaluate their students' learning.

This problem has always been there for a teacher, but it rises even earlier when you are studying to become a teacher. The first approach that I had with the FAMT&L project was during my graduation, while I was writing my thesis (Spagnolo, 2016). I will later describe my experience as a teacher in training.

During our course of study, we often asked ourselves if what we learn from the textbooks or in the classes is enough to safely step into the classroom. Will we be able to deal with the variables that show up in class during an explanation, a work group or an open discussion? The web repository that was implemented during the realization of the FAMT&L project includes a grand total of 126 videos of situations that actually took place in the classroom, that allow teachers still in training to perceive the life of the classroom without having experienced it first-hand, and to observe with a critical eye every detail within the context of the class. Of these 126 videos, 91 are in Italian and they record the work of 58 teachers from Italy and 69 from the Canton Ticino (Switzerland). It is also possible to watch videos in every language, thanks to the subtitles that each country provided both in their mother tongue and in English. The collaboration among the project partners allowed developing a grid of punctual indicators for each phase of the formative assessment. This grid was used during the training course to analyse in detail some of the video sequences of classroom situations.

This research project focuses on training the teachers on formative assessment. The objective is to help the teachers to learn how to use formative assessment in mathematics (Ferretti & Lovece, 2015). The tool of working on videos about real classroom situations shapes an innovative way to promote a correct use of formative assessment in teaching-learning situations. It is not the first time that videos are used as a tool for training. In fact, the same tool can be found in tutorials or in videos representing significant moments of a class, created ad hoc, sometimes even with the help of actors. The real innovation is not in the use itself of the videos for training, but rather in the fact that they display moments of a classroom's real life.

The pilot training course was structured in remote and presence activities, as well as small groups or individual activities. The workload was distributed during the whole course, and it allowed everyone to participate to the proposed activities. The remote activities consisted in both an individual study and the development of group activities by using the course platform (where many different kinds of educational material were available, such as learning context examples, videos of real-life situations in teaching maths, assessment tools, training paths, etc.) and the web repository for the analysis of the scenes of teachers in class. The work was checked and verified both *in itinere*, through feedback regarding the individual works that were made during the various phases, and at the end of the course, through an interview meant to comment the work done during the whole path of the project.

Besides always being available on the platform, the videos were also checked and discussed during the training course. The classes were scheduled in order to alternate such moments to moments of lecture, discussion about the grid, group work and planning of potential classroom activities. The lectures had the aim of introducimg both basic notions and specific notions, fundamental in order for each participant to be able to express their point of view regarding the examples of assessment that were in the video sequences in the platform. These kinds of activities allowed sharing everyone's opinion, everyone's experience and methodologies among the course's participants, in order to strengthen and enhance the teachers' knowledge on project didactics and on formative and summative assessment and assessment for learning.

As it is described in the section of the National Guidelines for the First Cycle dedicated to the assessment, "La valutazione precede, accompagna e segue i percorsi curricolari. Attiva le azioni da intraprendere, regola quelle avviate, promuove il bilancio critico su quelle condotte a termine. Assume una preminente funzione formativa, di accompagnamento dei processi di apprendimento e di stimolo al miglioramento continuo" (MIUR, p. 13)[1].

Now that I am a teacher I can take advantage of what I've learnt during the training.

1. Trad. "Evaluation precedes, accompanies and follows the curriculum. It activates the actions, it regulates those already initiated, and it promotes the critical balance on those completed. It assumes a formative function, accompaning the learning processes and stimulating continuous improvement".

4. Observing and using the video-analysis grid: my experience

I took part to the course "La valutazione formativa per il miglioramento della didattica della matematica nelle scuole secondarie e nella formazione professionale" (formative assessment for mathematics education development in secondary school and vocational education) as a pre-service teacher. After participating to that course, I started to teach in school (grades 6-8).

During classes, each participant received a video-analysis grid that was used to analyse videos from the web-repository. Some of these video were viewed during the course lessons, they were chosen among the several available on the platform that was open for all the course participants.

The grid was useful to me for, at least, three reasons. First of all, the 126 videos in the web-repository are labelled; in this way, each user can choose those videos that are more pertinent to his own research according to his specific interest. It is possible to search specifically for each indicator in the grid, to look for Italian of non-Italian videos, to compare different class dynamics, different ways of acting – by teachers and students – and different didactical strategies.

The second reason is in the usage of grid to analyse videos. Such an activity was often proposed during the lectures in the course. Videos have always been selected with a perfect adherence to the topic that was discussed in the work groups; so there was room for debate, ideas sharing. This was possible also to me, as a pre-service teacher.

The grid is divided in five blocks, each one is about a specific aspect or moment of formative assessment: such division is, in my opinion, doubly useful: on one side it allows to focus the attention to the single evaluation phases in the chosen video; on the other side it offers the opportunity to analyse each of those phases in a itemized and detailed way. The chance to look at teachers and students in "real class life" moments is a precious experience for those who do not still have experience as teacher in school, but also for those who do. Such activity gives the opportunity to interface with yourself and more experienced colleagues. So, using the grid, that moment was even more formative than expected: we had a useful tool to choose what to look at, a set of shared criteria to analyse videos; it is a concrete tool to analyse critically the proposed dynamics.

To these positive features, I would add a third reason: the using the grid as an analytic observation tool in my classes, especially in some phases of formative assessment activities. First of all, it is useful to me to structure *a priori* the different phases of assessment: sharing of evaluation

criteria with students, the administering of the task, data collection, self-assessment or peer-evaluation, formal interactions.

Along my experience as a teacher in a middle school, it was very important the presence of a tool to plan *a priori* such fundamental moments. Last, but not the least, the grid is useful to focus the attention to the single moment composing the different phases of formative assessment, especially when you evaluate your own behaviour. Participating to these classes, I learned that, when a lesson includes formative assessment, it is both an end and a beginning: after sharing the criteria and aims, we design a suitable task for our students (according to times and contents); we administer the task in such a way that students can stay calm and the teacher can collect as much information as possible. Then there is room for feedbacks. Such a moment is the beginning on a new path that has to be "invented" basing on the analysis of the information collected by the teacher at the end of a formative assessment activity.

5. Conclusions

Looking back to our experiences along the FAMT&L project, we can realize that each one of us had different but similar gains. As young mathematics teachers we felt that our training during university concerning the theme of formative assessment was not enough. Participating to the project gave us the opportunity to reflect on how important formative assessment is for our practice in the classroom, but we realized also that we did not have enough tools (or maybe enough awareness and certainty) to realize it significantly and effectively with our pupils.

At the end of the project, we would not say that we feel as experts of this topic; however, we all feel the strong belief that we will re-invest what we have learnt in our future classes. In particular, the possibility of watching videos (about our classes or others') and discuss about them together with other colleagues appears to us as a strongly formative experience in the sense that it was the change to form and give shape to new practices and/or to reshape those that were already in our classes.

Finally, we open up some questions for us and for those others that were involved in the project: how can we, as teachers, promote the culture of formative assessment? Can we imagine exporting the model proposed by FAMT&L as training for future pre-service and in-service teachers? We would suggest that "yes" is a good answer.

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9. Strengths and weaknesses: quality of the project and possibilities for improvement

by *Seerp de Blauw*, Rob Velder**

1. Introduction

To measure the effective change in teachers' assessment practice participating in FAMT&L pilot training course, the European partners have defined a specific evaluation model of the course.

Effective evaluation of a training is seen as an important step for different reasons (see paragraph 2.2).

During the development of the training course and web-repository in the FAMT&L project a strategy was put in place for evaluation based on five steps. The fifth and final form of evaluation is the evaluation of the pilot training course.

Adopting the Kirkpatrick model (Kirkpatrick, 1959) we designed a specific plan to evaluate and validate the course model. In particular, specific evaluation instruments have been designed, as some questionnaire to be administrated before, during and after the training path. These tools are common for all partners but everyone was able to choose whether to add specific questions to detect, for example, opinions and beliefs on specific topics of the school.

This chapter outlines theory on evaluation and the use of critical friends (9.6) and the evaluation strategy defined in the FAMT&L project. Both literature and strategy are focussed on evaluation of professional development in teacher education. Hence in paragraph 2 references are made to literature on professional development since this has implications for the design of the training courses and evaluation strategy and outcomes. The defined evaluation strategy is described in paragraph 3. The role of critical friends and obtained feedback is focus point of paragraph 4. The fifth and final paragraph outlines the outcomes of the evaluation and strong and weak points of the designed pilot training course.

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2. On the theory of evaluation

Effective evaluation begins even before a program starts:

> Trainers must begin with desired results and then determine what behaviour is needed to accomplish them. Then trainers must determine the attitudes, knowledge, and skills that are necessary to bring about the desired behaviour(s). The final challenge is to present the training program in a way that enables the participants not only to learn what they need to know but also to react favourably to the program (Kirkpatrick, 1993).

It is important that the results are defined in measurable terms so that all involved can see the ultimate destination of the initiative. Clearly defined results will increase the likelihood that resources will be used most effectively and efficiently to accomplish the mission.

2.1. *Levels of evaluation*

Researcher referred to Kirkpatrick model that was first introduced in 1954 by Kirkpatrick. In 2008 an expansion of the original four levels was mad in the Kirkpatrick Partnership model. Finally in 2010 Jim and Wendy Kirkpatrick clarified the original four levels in the *New World Kirkpatrick model*.

Level 1: Reaction

To what degree participants react favourably to the training or customer Satisfaction.

Engagement: The degree to which participants are actively involved in and contributing to the learning experience.

Relevance: The degree to which training participants will have the opportunity to use or apply what they learned in training on the job.

Level 2: Learning

To what degree participants acquire the intended knowledge, skills, attitudes, confidence and commitment based on their participation in a training event.

Knowledge: "I know it".
Skill: "I can do it right now".
Attitude: "I believe this will be worthwhile to do on the job".
Confidence: "I think I can do it on the job".
Commitment: "I intend to do it on the job".

Level 3: Behaviour

To what degree participants apply what they learned during training when they are back on the job.

Required Drivers: Processes and systems that reinforce, encourage and reward performance of critical behaviours on the job.

Level 4: Results

To what degree targeted outcomes occur as a result of the training event and subsequent reinforcement.

Leading Indicators: Short-term observations and measurements suggesting that critical behaviours are on track to create a positive impact on desired results.

2.2. *Design evaluation on training courses*

Effective evaluation of a training is seen as an important step for different reasons:

- reflection ensures a higher standard of the training course because of structured feedback and consequent adaption of model and materials;
- in the development of a training the direct feedback of participants, being the trainer and trainees, are most likely not received;
- it can create a higher commitment from future participants.

Before an evaluation can be done with effectively the outcomes of the training must be defined. The second step is the designing of evaluation instruments. Since the course is directed at formative assessment, or *Assessment for learning*, evaluation of the learning process is part of the training and can as be used for evaluation of the training course. The third step consist of collecting data and drawing conclusions. These conclusions will be used to interview the trainer and some trainees.

2.3. *The purpose of evaluation*

To begin it is important to clarify the purpose of evaluation, in term of process, product, outcomes, program and effectiveness evaluation. Following some description of each element.

Process evaluation

Process evaluation is a means of implementing and refining the program's design. This evaluation procedure addresses information about how well how well the implementation and design of the program is going and what, if any, obstacles conflict with the program's success.

The key factor in implementing this evaluation procedure is interaction between evaluators, designer and stakeholders.

Product evaluation

Product evaluation refers to ultimate decision associated with the fate of the program (Fitzpatrick *et al*., 2004). This decision may include modification or refocusing of the program under review (Stufflebaum, 2003). The outcome is a product of collections of descriptions and numerous archived judgements about the objectives, merit and worth of the program.

In order for the evaluator to arrive at a conclusion he must collect both quantitative and qualitative information from personnel and stakeholders involved. If necessary product evaluation can be divided into subcategories of impact, effectiveness, sustainability and transportability in order to gain more concise information about the long term effects of the program.

Outcome-based evaluation

In outcome-based evaluation (OBE) four types of evaluation are most commonly used:

1. Program evaluation
   This uses person-referenced or organization-referenced outcomes to determine whether a program is meeting the desired outcomes and uses.
2. Effectiveness evaluation
   This strives to report the extent to which a program is meeting its goals and objectives.
3. Impact evaluation
   This studies whether or not a program has made difference for its stakeholders compared to an alternative.
4. Policy evaluation
   This researches the equity, efficiency or effectiveness of outcomes for a program (Schalock, 2001).

Program evaluation

Program evaluation typically strives to answer the question, "What outcome is my program producing in its serving recipients?". These generally fall into four categories:

1. organization performance outcomes;
2. organization value outcomes;

3. individual performance outcomes;
4. individual value outcomes.

Outcomes must be measured for performance and consumer appraisal in the area of satisfaction and also for functionality in the area of adaptive behaviour in the role status. Evaluations are more successful if stakeholders participate in the evaluation and are engaged in the decision-making process. Program evaluations are conducted a systematic and objective processes that collect, analyse and interpret information. More specifically, program evaluation deals with collecting and documenting information about a particular program to enable valid decision making to a particular aspect of that program (McNamara, 2000). The ultimate purpose of program evaluation is to arrive at a definitive, intelligent, objective and valid conclusion regarding specific objectives and questions related to a program's overall effectiveness (Fitzpatrick *et al.*).

Effectiveness evaluation

Effectiveness evaluation strives to answer the question: "Is my program meeting its goals and objectives?" It's primary uses are:

- compare program's goals with its achieved outcomes;
- report the program's performance and value outcomes;
- provide formative feedback for program change and improvement (Schalock, 2001).

The difference with program evaluation is that the effectiveness evaluation establishes a comparison condition against which accountability and outcomes can be judged.

There are five steps for analysis:

1. performance goals;
2. purpose and comparison condition;
3. methodology;
4. data collection and analyses;
5. person- and organization-referenced outcomes.

3. External evaluators, critical friends

A critical friend can be defined as "a trusted person who asks provocative questions, provides data to be examined through another lens, and offers critiques of a person's work as a friend. A critical friend takes the time to fully understand the context of the work presented and the outcomes that the person or group is working toward. The friend is an advocate for the success of that work" (Costa, 1993).

The role of the critical friend is therefore a *strategic* one and can be important in assisting improvement. It is essentially a role of support and challenge.

Critical friendship has also been described as less formal than mentoring or coaching and probably best described as "a professional relationship based on mutual regard and the willingness to question and challenge" (Meeting the Challenge: Growing Tomorrow's School Leaders, 2005).

4. On the theory of powerful professional development

Nothing has promised so much and has been so frustratingly wasteful as the thousands of workshops and conferences that led to no significant change in practice when teachers return to their classroom (Fullan & Stiegelbauer, 1991).

Reasons why professional development programs appear to be ineffective has been subject of research in the United States Staten (Darling-Hammond, Wei, Andree, Richardson & Orphanos, 2009). Outcome is that every professional development program should be aimed at raising student achievement.

Powerful professional development deepens teachers' subject-area knowledge. Traditionally, a substantial portion of staff development has provided teachers with generic instructional skills such as cooperative learning separate from specific academic disciplines. Little attention was paid to teachers' knowledge of the subjects they teach and to instructional strategies within particular subject areas (Sparks, 2002).

A number of experts and organizations have suggested that the most promising professional development programs or policies are those that:

- stimulate and support site-based initiatives. Professional development is likely to have greater impact on practice if it is closely linked to school initiatives to improve practice;
- are grounded in knowledge about teaching. Good professional development should encompass expectations educators hold for students, child-development theory, curriculum content and design, instructional and assessment strategies for instilling higher-order competencies, school culture and shared decision-making;
- model constructivist teaching. Teachers need opportunities to explore, question and debate in order to integrate new ideas into their repertoires and their classroom practice;
- offer intellectual, social and emotional engagement with ideas, materials and colleagues. If teachers are to teach for deep understanding, they must be intellectually engaged in their disciplines and work regularly with others in their field;

- demonstrate respect for teachers as professionals and as adult learners. Professional development should draw on the expertise of teachers and take differing degrees of teacher experience into account;
- provide for sufficient time and follow-up support for teachers to master new content and strategies and to integrate them into their practice (Corcoran, 1995).

4.1. *Modelling professional change*

Many programs are based on the idea that changes in belief and attitude will cause a change in classroom behaviour. This in its turn would lead to improvement in student learning. Gusky (Gusky, Staff development and the process of, 1986) provided an alternative model, in stating that significant changes in belief and attitudes would only arise after changes in student learning outcomes. A teacher tests a change in practice and experience a change in student learning. Then they change their belief and attitude towards the change (Fig. 1).

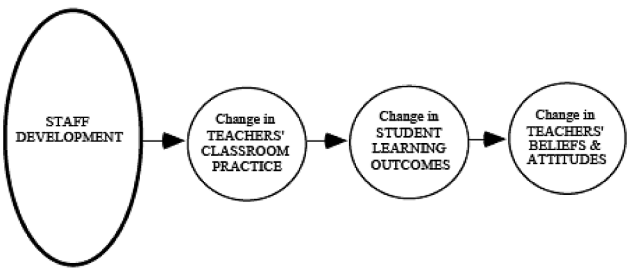

Fig. 1 - The teachers development of belief and attitude

This model can be criticized as being linear. Clarke used the same sequence of elements as Gusky but in a cyclic pattern with multiple entry points (Clarke D.J., 1988). Challenging teachers approaches, thereby creating a *cognitive conflict,* prior to them attempting to change their classroom practice could be a motivator for change (Cobb, Wood & Yackel, 1990). A further model of the teacher change process was developed by Clarke and Peter (1993), and later revised by an international research group interested in teacher professional growth as the Interconnected Model of Teacher Professional Growth (Teacher Professional Growth Consortium, 1994).

The Interconnected Model (in Fig. 2) suggests that change occurs through the mediating processes of reflection and enactment, in four distinct domains which encompass the teacher's world:

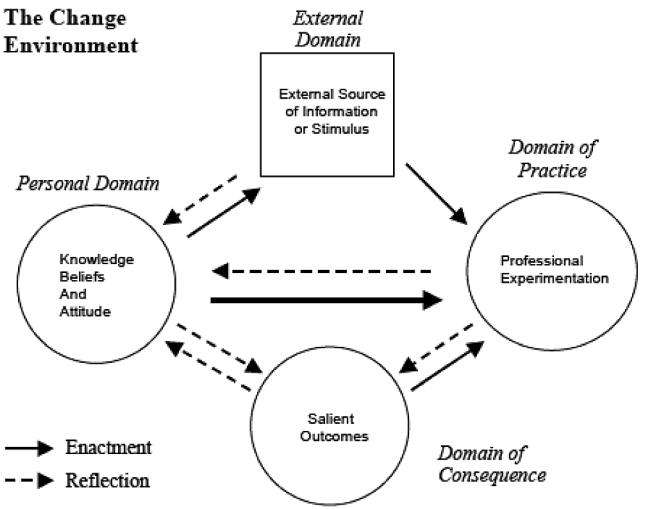

Fig. 2 - The Change Environment

This model recognizes the complexity of professional growth through the identification of multiple growth pathways between the domains. Its non-linear nature, and the fact that it recognizes professional growth as an inevitable and continuing process of learning, distinguishes this model from others identified in the research literature. This model also identifies the mediating processes of reflection and enactment as the mechanisms by which change in one domain leads to change in another. Any processes of professional growth represented in the model occur within the constraints and affordances of the enveloping change environment (Hollingsworth, 1999).

4.2. *Organizing professional development*

First content then concept

The purpose of professional development must guide the way this is organized. Effectiveness of one-day-workshops does not appear to be great if it goal is to change teacher behavior in classroom situations. First focus must be on teacher skills that improve student learning, then a choice must

be made for an appropriate way or environment in which this skill can be learned.

Conditions for success

Five principles for a learning environment for teachers have been concluded on a trial-and-error basis. There might be others, not mentioned principles. If one of these principles are missing, there might still be a successful professionalization strategy. However, experience shows the change of success is lower. These principles have only been researched in an environment aimed at raising teacher skills in the use of classroom formative assessment (Wiliam, Keeping learning on track: Classroom assessment and the regulation of learning, 2007):

- Choice:
  An individual teacher can best determine which development has the greatest impact on the learning of his or her student. Therefore the teacher must have the choice what to develop.
- Flexibility
  There are many techniques in formative assessment. These do not have to copied but can be changed. Small changes can have great effects. A teacher must have the freedom to change fitting the circumstances. A teacher who has the opportunity to change a technique, is more inclined to use it more often.
- Small steps
  Teachers learn on the fly, that means during their everyday teaching. Therefore changes should be made in small steps. It also gives the teacher to practice the technique more often and through repetition integrate in a daily practice.
- Accountability
  There are many factors that influence students achievement. A teacher can only influence one, the learning environment in the classroom. Research shows that the teacher does make the difference. Therefore he or she must be held accountable for the classroom environment. The teacher must improve skills to improve students achievement and teacher leadership must demand a improvement attitude from teachers.
- Support
  Consequently to accountability teacher leadership must support the teacher in time, focus and facilitate. The school and leadership take responsibility in supporting the teacher:
  - create expectation of continuous professional development;
  - keep focus on learning that improves student achievement;
  - facilitate in time, place and support;
  - encourage risk-taking and defend it.

4.3. *Structure*

An effective way to organize professional development satisfies (most of) the conditions mentioned in the previous sections of this chapter. It gives the teacher a choice and a structure to improve. It is vital to learn with professionals and make room for discussion and sharing ideas. This can be done effectively in a *Professional learning community.*

Professional learning community

A professional learning community (PLC) is a method to foster collaborative learning among colleagues within a particular work environment or field. It is often used in schools as a way to organize teachers into working groups of practice-based professional learning.

> If schools are to be significantly more effective, they must break from the industrial model upon which they were created and embrace a new model that enables them to function as learning organizations. We prefer characterizing learning organizations as "professional learning communities" for several vital reasons. While the term "organization" suggests a partnership enhanced by efficiency, expediency, and mutual interests, "community" places greater emphasis on relationships, shared ideals, and a strong culture – all factors that are critical to school improvement. The challenge for educators is to create a community of commitment – a professional learning community (Dufour & Eaker R.E., 1998).

Lesson study

Working in a PLC must be organized as well. *Lesson study* is a professional development process that Japanese teachers engage in to systematically examine their practice, with the goal of becoming more effective. This examination centers on teachers working collaboratively on a small number of "study lessons". Working on these study lessons involves planning, teaching, observing, and critiquing the lessons. To provide focus and direction to this work, the teachers select an overarching goal and related research question that they want to explore. This research question then serves to guide their work on all the study lessons.

While working on a study lesson, teachers jointly draw up a detailed plan for the lesson, which one of the teachers uses to teach the lesson in a real classroom (as other group members observe the lesson). The group then comes together to discuss their observations of the lesson. Often, the group revises the lesson, and another teacher implements it in a second classroom, while group members again look on. The group will come together again to discuss the observed instruction. Finally, the teachers produce a report of what their study lessons have taught them, particularly with respect to their research question.

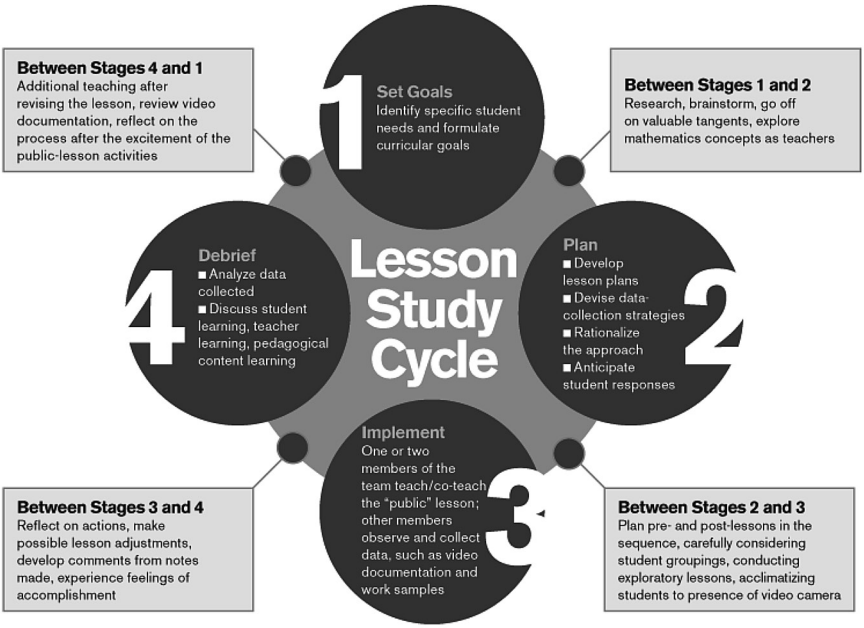

Fig. 3 - Lesson Study Cycle

5. Focus of evaluation

5.1. *Structure of evaluation*

To evaluate the development and effectiveness of the teacher training, evaluation guidelines are divided into four categories. The first category was aimed at the the training model and how it is derived from the questionnaires. This was folowed by an evaluation of the content of the training and how this was derived from the questionnaires. The third again aimed at the training model from the point of view of the trainer and trainee. This was done in two phases. The first phase was in the design process, before training was done and secondly after the training. The fourt and final category was targeted the content of the training from the point of view of the trainer and the trainee again in two phases being the design process, before training is done, and after the training.

Fig. 4 - Evaluation guidelines

5.2. *Methodology*

The evaluation as a whole was structured in the before mentioned four categories. Detailed design of the evaluation proces and instruments was done in four steps.

Step 1: Defining outcomes

Outcomes are defined as learning goals of the training:

1. I, the trainee, of the training course on formative assessment:
2. know a theoretical framework on formative assessment;
3. can arrange a classroom situation in which formative assessment is fully integrated;
4. can analyse a classroom situation with predetermined indicators;
5. can explain why formative assessment is an educational intervention with a high rate of effectiveness.

Step 2: Evaluation instruments

For the porpoise of evaluation of the training course researcher created and used two questionnaires:

- questionnaire to be used during the training;
- questionnaire to be used after the training.

Since there is a long and a short training designed there will be two questionnaires to be used either during a long or during a short training. Both evaluation instruments are related to all four levels of evaluation.

Step 3: Collecting data and drawing conclusions

From the data collected conclusions will be stated. These statements are the basis of step 4, the interview of the trainer and some trainees.

Step 4: Interview trainers and trainees

The porpoises of both interviews are:

- to validate the stated conclusions;

- to obtain advice on how to improve the training model and content
- to get other feedback that could not be concluded from the questionnaires.

5.3. *Elucidation on focus points*

The evaluation of the development and effectiveness of the teacher training was done by the use of instruments such as interview and questionnaires in combination with an interview. As reasons for evaluation we distinguish process evaluation, product evaluation and outcome-based evaluation. The latter can be divided in program evaluation and effectiveness evaluation

These instruments have been chosen because they give the most amount of information in the most efficient way.

For each category of evaluation possible evaluators are defined. We distinguish external and internal stakeholders. An external stakholder is defined as a stakeholder is in no way affiliated with the FAMT&L project or any of its participating universities or schools. An internal stakeholder internal can be affiliated with a participating university or school, but not with the project itself. Table 1 shows the involvement of the different stakeholders in the eveluation process.

Tab. 1 - Stakeholder involvement

		Evaluators/Stakeholder				
		Experts on formative assessment (external)	**Teacher trainers**	**Teachers**	**Trainees**	**Trainer**
A	From questionnaires to training model	x				
B	From questionnaires to content training	x	x			
A	Training model		x	x		
D	Content training		x	x	x	x
E	Training				x	x

For each category the goal of evaluation as well as means or instruments are given in the evaluation guidelines as well as the reason for evaluation. The folowing gives an overview per category.

From questionnaires to training model
Goal: to obtain feedback and recommendations on the proposed training model focused on objectives and basis on which the model is designed.
Means: interview.
Reason: process evaluation;
product evaluation.

From questionnaires to content model
Goal: to obtain feedback and recommendations on theproposed content of training model focused on outcomes of questionnaires.
Means: interview.
Reason: process evaluation;
product evaluation.

C: training model
Goal: to obtain feedback on the training model from perspective of a teacher trainerand a teacher.
Means: questionnaire;
interview.
Reason: process evaluation;
product evaluation.

D: content training
Goal: to obtain feedback and recommendations on the proposed content of training model.
Means: questionnaire;
interview.
Reason: product evaluation;
outcome-based evaluation;
program evaluation.

E: training
Goal: To obtain feedback and recommendations on the training
Means: questionnaires;
interviews.
Reason: product evaluation;
outcome-based evaluation;
program evaluation;
effectiveness evaluation.

6. Working with critical friends

In the cycle of development of the FAMT&L-project critical friends are involved at the final stage of design. The role of the critical friends is to question and challenge from the perspective of a teacher-trainer as well as teacher in order to support the reflective process and inform the mid cycle self-assessment.

At this stage of the project the critical friends provide challenges on the:

- design of the training;
- content of the training.

Therefore their expertise lies in:

- teacher trainer with expertise on curriculum design;
- in service teacher.

The following model is intended to structure the cooperation between the consortium and the critical friends. It offers a structure within which issues can be clarified and actions can be formulated.

Step 1: Critical friends are informed about the:
- approach of the consortium;
- outcomes to date;
- design of training;
- content of training in relation to outcomes of questionnaires.

Step 2: Critical friends are informed about their proposed role and scope of challenges asked by the consortium.

Step 3: Critical friends question and challenge the consortium in a face-to-face-meeting. Together, the consortium and critical friends analyse the risks, alternatives and consequences of each potential solution.

Step 4: Consortium nominates solutions which should be progressed.

Step 5: *Together, the consortium and critical friends list all* possible obstacles to achieving the solution.

Step 6: Critical friends assists to brainstorm possible strategies to minimise/overcome these obstacles.

Step 7: The consortium devise an implementation plan.

Step 8: Together, the consortium and critical friends review the outcomes of the action plan and continue the process until all relevant issues are worked through/resolved.

6.1. *Scope of challenges*

In this paragraph the scope of the challenges by both critical friends are directed and questions to guide the critical friend are given.

Product evaluation
Question: Does the approach of the consortium guarantee a:
- effective;
- sustainable;
- transportable;

training both for in-service teachers as well as students training to become a teacher?

Outcome-based evaluation
1. Program evaluation
   Question: Does the training model guarantee the specified and desired outcomes of the training?
2. Effectiveness evaluation
   Question: Does the proposed content of the training guarantee reaching the specified goals and objectives?
3. Impact evaluation
   Question: Is the proposed training of added value for in-service teachers as well as students?

Program evaluation
1. Organization performance outcomes.
2. Individual performance outcomes.
   Question: Is the proposed training functional for the purpose it was made, being the possibility to train participants with the use of a database of examples and the possibility of distance-learning?

6.2. *General advice from critical friends*

Professional development is essential for teachers to progress as teaching practitioners. But there are many challenges in integrating professional development into regular practice. How to get the most from the training?

Content of the training

Teach what you preach. Consider the importance of teaching in a formative way in the pilot course. Put more elements of FA into the course. Walk the talk. What is the heart of assessment for learning?

- Self-regulation: One of the skills teachers and students should develop is reflection on learning ore self-assessment. Trying to take in new ideas and embed them into your practice is not easy. What helps is reflection. Focus on successes, beware of pitfalls.
- Self-regulation and self-directed:

  Because adult learners are self-directed and pragmatic learners, their primary concern is the anticipation of and testing the usefulness of what they learn to improve practice rather than preoccupation with the background theory and general information. This makes them selective, yet, focused on what and how they would like to learn, thus, exercising more control over their learning (Elliot & Campbell, 2013).

- The face to face time is very valuable. Use it effectively by "flipping the classroom". This means for example that the participants watch the video or read the theory at home. So there is more time to apply the knowledge in the face to face meetings with others. And there is more time for collaborative learning and interactive dialogue.
- Let the participants practice. They will learn FA by doing, by constantly having new experiences and attempting to integrate those experiences.

Design of the training

Make the teaching (and the model of the training) and learning activities as well as the formative assessments task aligned to the outcomes, in order that the participants are helped to achieve those outcomes more effectively. This is called designing constructively aligned outcome-based teaching and learning (Biggs & Tang, 2007).

Assessment, also formative assessment is criteria referenced ore based. How well a participant (teacher) performance compares to the criteria in the outcome statement. Pay attention to describe the learning goals in a way that tells us how we would recognize if or how well participants have learned what is intended they should learn or be able to do so. Make it as explicit as you can and share the learning goals with the participants.

6.3. *Conclusions from sessions with critical friends*

It was noted there are many differences between the five designed training courses. The consortium first worked along the line that there should be a common training in every country. The end-result should be a validated training course, based on the principles of formative assessment, cooperative learning with peers.

Each partner took their individual circumstances into account and designed the training course. All courses were based on the design made by the Swiss partner. Therefore each partner did do just to the basic principles as formulated at the beginning of the project.

After the session with the critical friends the consortium in cooperation with the critical friends formulated a common core for each training.

6.4. *Micro-simulation*

Introduced by the partners from Cyprus and Switzerland, in each training there will be a practical component called *Micro-simulation*. Micro-simulation was defined:

> Simulating a lesson practice before a group of peers, where a designed implementation is used with the purpose of experimentation, feedback and improvement.

It is important to have a practical component in the training. Ultimate goal is to change the professional behaviour and the skill of implementing formative assessment should be practiced. Doing this with micro-simulation this also has the advantage of collaborative learning, peer- and self-assessment.

7. Use of formative assessment

Walk the talk. Since the outcome of the training should be a more competent teacher in the use of formative assessment, the training itself should be based on the same principles. This also contributes to the element of a Life Long Learning (Fig. 5), a teacher able to define one's one learning-need and the ability to assess the progress one's own learning and a way to improve one's own learning.

Use of questionnaire

An almost direct result of the choice to use formative assessment in the training is the questionnaire at the beginning of and at the end of the training. In this way the trainer builds an image of the present knowledge from where to start the training. The trainee sets one's own learning goals and defines success criteria. These are then made visible at the end. The starting point in each country is very different. It was therefore concluded there should not be a completely common questionnaire.

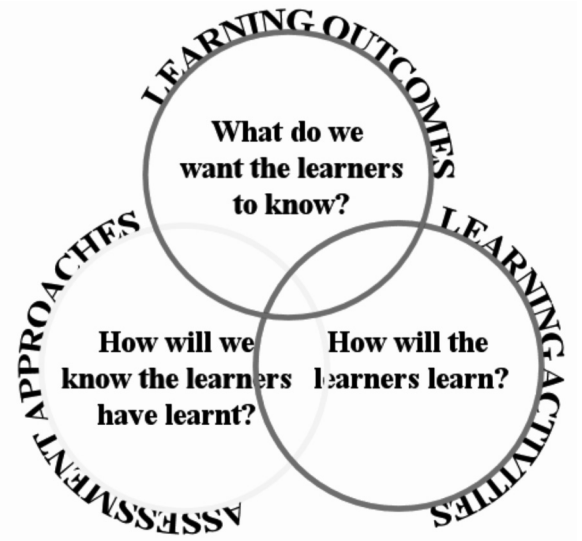

Fig. 5 - Life Long Learning elements

Use of video

The learning through video is a new and uncharted territory. First results in research show this an effective way in teaching skills such as professional teacher behaviour. This was also one of the basic principles on which the project is based. In every training there is made significant use of videos showing practices of formative assessment. These videos will be analysed by the grid as defined during the project. The same grid is used to analyse the design of formative assessment by the trainee.

7.1. *Dilemma's*

Privacy concerns using videos

There remains the problem of privacy and consequent problems with the use of self-made videos and placing them in the web repository. This in some participating countries creates a bigger problem than others. Especially in the Netherlands the situation is that there are no videos available made during the project for use in the training. This was discussed with the critical friends. The solution defined is the use of videos available on the internet, mostly from English speaking countries. This resolves the problem of the lack of videos. Problem that is not solved is

the building of the web repository. Unfortunately, the sensitivity of using videos in the public domain in the Netherlands, could not be solved during this project. The devised solution was shared within the consortium and with the critical friends and seen as appropriate.

Teacher resistance

Teachers almost all have a traditional, conservative reaction towards everything considered new. It is difficult to change (professional) behaviour, let alone the behaviour of the teacher. Traditionally, teacher training is done from a push-strategy. A universal message is at the centre of the training. These kinds of trainings show almost now lasting, sustainable effect. A pull strategy, where the trainee is placed at the centre of one's own learning, and is aimed at the individual need of the trainee, leads to less resistance and a more positive effect.

7.2. *Evaluation outcomes*

To generate conclusions from five individual evaluations and two external evaluations, all items from each evaluation were correlated with others. Items that occurred in more evaluations then were named as overall conclusions. Consequently, there were items seen in evaluations that were specific to one evaluation. These can be named, and in fact important, as strong of weak points or recommendations for that individual training, not for the overall training course.

8. Conclusions

What can be concluded from all training evaluations is that the designed pilot training course was positively received by participants and named as:

- well organised;
- clear goals.

Participants showed growth in their theoretical knowledge on formative assessment, its purpose and application. Their belief was influenced in a significant way. It cannot be concluded that as a consequence teacher behaviour has changed sustainable. Teachers feel the need for more examples, experimentation and practical learning.

Learning in small groups with a lot of interaction, sharing ideas and discussions had a very positive effect on participants belief, motivation and commitment.

Tab. 2 - Product – Outcomes – Program Evaluation

Product evaluation	
Does the approach of the consortium guarantee a: • effective; • sustainable; • transportable; training both for in-service teachers as well as students training to become a teacher?	It can be concluded the training is effective in changing belief and attitude of teachers on the subject of formative assessment. In its current design and examples it is aimed at teachers in mathematics, but the model in itself can easily be transferred to be used for teachers in every other subject. The training is sustainable as it has a formative character and foremost a practical component. Teacher behaviour could be changed more sustainable through: • more time allotted to experimentation and observation; • more time between meetings; • training over a longer period.
Outcome based evaluation	
Program evaluation: Does the training model guarantee the specified and desired outcomes of the training?	The desired outcome of the training was observed in all training courses, named by trainers, trainees and external observers.
Effectiveness evaluation Does the proposed content of the training guarantee reaching the specified goals and objectives?	In most the training objectives were reached. Improved can be the ability of participants to observe and reflect on examples of formative assessment in the classroom setting. This can be done by more experimentation and practice and would require more time.
Impact evaluation Is the proposed training of added value for in-service teachers as well as students?	All participants unanimously stated the training is a major improvement on their everyday practice. The feel they learned a lot and are motivated and committed to learn more.
Program evaluation	
Is the proposed training functional for the purpose it was made, being the possibility to train participants with the use of a database of examples and the possibility of distance-learning?	As the positive effect of learning in a learning community is mentioned both by the participants as the trainer, it can be concluded that especially this part of the training is seen as a contributing factor to its success. This could imply that long distance learning would not be effective. The database and examples can be used in learning in a learning community in an effective way. Also mentioned is the need for an expert to structure the learning of the participants in the learning community. The grid for analysing videos and practice is too large and complicated.

8.1. *Strong points of the training course*

There are a lot of detailed items that can be named as strong points in the training. These items can be collected in four categories:

Use of videos

The use of videos as an indispensable part of the training. They give examples of formative techniques directly applicable in the daily practice of the participant. It gives participants the opportunity to see formative techniques being used in that daily practice and reflect on it using the devised grid in the project. This way participants understand the use an can make the transfer to their own teacher behaviour in small successful steps. They are able to control their own learning which creates commitment and motivation. The discussion based on the short teaching episodes displayed was fruitful and served as representative examples of applying formative assessment in the classroom.

Learning community

The design of the training is all about interaction. Participants learn a great deal in discussing, designing and reflecting. This makes the training in the most part formative. Learning in a community gives the opportunity to exchange opinions and ideas about teaching and assessment.

Practical component

The domain of practice is present in the training:

- microsimulation;
- in practice in classroom.

This gives the opportunity to apply formative assessment in the classroom, improve on and experiment. It fills the need for teachers to learn by practice.

Change through practice

Based on our observations and the participants' comments and feedback, after the training program the pre-service and in-service teachers' beliefs moved positively towards the purpose of formative assessment. Furthermore, their beliefs about their skills in applying formative assessment through a diversity of techniques turned also towards a more positive direction, as the participants expressed to have stronger skills. A change in focus between practice and theory, strengthens knowledge skill and participation.

8.2. *Weak points of the training course*

The weakest point in the training is time. From literature on learning and learning or teaching practice we know this takes time. Time must be seen in different contexts:

Time for training-sessions

An effective amount of time for a sessions seems to be 1,5-2 hours. It is better to have more meetings on different dates than to create a long meeting.

Time for practice

It takes time to experiment and improve. After this it takes time to integrate a teaching behaviour and automate it in one's arsenal of teaching strategies. It needs practice to learn the practice of a formative strategy and that takes time.

Time for examples and experimentation

There is a need for examples and experimentation. Within this experimentation there is a need for time to evaluate end reflect. This way of working needs time to learn.

Time between training-sessions

An integral part of the training is to practice in the classroom, observe and reflect. This takes time. Teachers have to have time between meetings to do this. In literature a period of 5-6 weeks between meetings is mentioned.

8.3. *Recommendations*

Time

As described in paragraph 6.5.3 the training can get more effective by time-management:

- time for training-sessions;
- time for practice;
- time for examples and experimentation;
- time between training sessions.

It is recommended to design sessions of 1,5-2 hours with intervals of 5-6 weeks. In between these sessions teachers must experiment in and reflect on their practice. These experiments should be part of the sessions. This learning can be done very effectively in a small teacher learning community.

Repository

Strengthen the use of the repository by enlarging the number of videos. Describing how to use the videos with small descriptive tasks can make the use of the repository effective. Training trainers to use the repository can enlarge the scale of use quickly and efficient. One can train participants in the pilot training course to use the repository in schools (becoming experts as trainer for future training-sessions).

Simplify grid of analyses

The grid is found to large and complex. There are too many items that are connected to formative assessment but can also be described as *normal teacher behaviour.* As a consequence the effectiveness of reflecting with a large grid is not as high as it can be. Focus of the grid should be on aspects of formative assessment, such as questioning, feedback. Option could be to define grids specific to strategies and techniques of formative assessment.

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10. Exploitation activities related to the FAMT&L project

by *Alessandro Gimigliano**

1. Introduction

The exploitation activity for the project *FAMT&L – Formative Assessment in Mathematics for Teaching and Learning* (538971-LLP-1-2013-1-IT-COMENIUS-CMP) funded by the Lifelong Learning Program of the European Commission started with the preparation of a work plan, modified "in progress" during the time of the project. It presented the exploitation plan for the 3-years FAMT&L project and it has been a reference document, which described the strategy and the planned tools for the exploitation of the project results. It also showed the different directions of the exploitation and gave an overview of the expected project results and the key stakeholders in the project. In order to achieve the best possible results different hypothesis of exploitation have been analyzed. The exploitation plan took all project partners into account and it was also linked to their outcomes.

The ambition of FAMT&L has been the development of a training model based on the use of videos and tailored thanks to the results of surveys among both teachers and students. This preliminary work and the analysis done has brought to the organization of pilot courses and to the making of a web repository for the video materials. The priority of the project was to promote the training of teachers in order to develop the basic skills of students in mathematics, a field of scientific education which is particularly important to ensure the right to citizenship for the new generations.

Teacher training, in FAMT&L, focuses on a crucial element of innovation for the effectiveness of school systems: conceptions and practices of (math) teachers about learning assessment of students and the possibilities given by using *formative assessment (FA).*

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The exploitation focuses on development and enhancement of teacher's competence. The special aim of the exploitation, involving all stakeholders, is to develop ideas able to reduce the gap between the ideals of a democratic school in the involved Countries and the present level of the use of assessment practices (our ideal is to have a school system which is able to use FA to have most of the pupils reaching "good levels" of knowledge, apt to help them to be responsible citizens). To apply and use the results of the FAMT&L project in practice – both during the time of the project and in the future – should enhance the ability of the teachers to fight such gap.

Any project can be successful only if all participating parties are working in close cooperation; our plan, part of *Work package 8 – Exploitation* has been collecting the outcomes of the project and advise how these could be exploited. In this chapter we describe how all the exploitation strategy developed.

2. Objectives and exploitation strategy

To achieve the above-described goals, the exploitation strategy was to identify important organizations, fairs, meetings, workshops and events to which the FAMT&L project shall contribute and participate (in addition to other tools for dissemination of information and results better defined in the dissemination strategy). The plan has been to make use of our dissemination activities as a complement to reach relevant stakeholders and stimulate dialogue on the topics of the project. The plan defined the modality for the realization of briefings with policy and decision-makers in the educational field at national level in order to create synergies that will guarantee a successful exploitation of the project's results.

The exploitation strategy planned to:

- continuously interact with new and already involved stakeholders in order to define an on-going strategy for the exploitation of results;
- define a tailored exploitation plan that will make use of dissemination activities as a complement to reach relevant stakeholders, stimulate dialogue on the topics addressed in the project and modify the education policy in the direction of efficacy and effectiveness;
- implement the sustainability plan encouraging continuity after the co-financing by the EU will end.

The exploitation plan was made of several objectives and required a methodology.

The exploitation objectives were:

- To *develop a network of researchers and teachers* that, working together, would improve, both theoretically and practically, their knowledge and skills about FA.
- To *implement* and to keep active an *e-learning platform* that could be used by both teachers and researchers as a *video educational document repository*, usable and sharable with all colleagues, also in the future.
- To *find partners* (teachers, researchers and other *target groups*) who would apply and use the results of the FAMT&L project in their practice.
- To *spread the training model* of FA in mathematics (in synergy with the use of the platform) to groups of school teachers of the different partner countries (and others).
- To ensure that all the *knowledge* created and all the *practices* of formative assessments elaborated within the FAMT&L project *would also be used in future.*

To bring different strategic actions closer together has increased the likelihood of a solid impact for the FAMT&L project outcomes and results. In order to generate the required impact and visibility all activities had to be well coordinated: Thus the exploitation plan ran parallel to the phases of the work program and adjusted itself to the main activity of each phase.

3. Methodology

3.1. *The essential steps*

- *Elaboration of an Agreement of Cooperation with schools*

In order to strengthen the relation and collaboration between Universities and Schools for the application of the teachers' training model, an *Agreement of Cooperation* has been realized and proposed to the schools involved with the project. The agreement set up the basis for the common work on the project.

- *Collecting and studying data via questionnaires*

To have a significant view of the awareness about FA among teachers and students, we prepared and distributed questionnaires to teachers and students of the cooperating schools. Their analysis confirmed the need of better actions to improve the use of FA in the teaching of Mathematics.

- *Short videos and Pilot Courses*

Short videos for the exploitation of projects results have been realized, in particular about experiences analyzed in WP2 and WP3 and the activities carried out in WP4.

This is the key action of our project: promoting teaching and learning about FA via video analysis. The training model has been implemented in *Pilot Courses* organized by all the nodes of our projects. Moreover short videos and other materials that are stored in our *web repository* could be used also in the future and can already be used in the process of training future teachers (as university students in mathematics or education).

- *Quality check*

  "Critical fiends" have been present in several phases of the work, in order to monitor the project and collaborate to its Quality Plan.

- *Briefings with policy and decision-makers in the educational field at the national level*

  Our consortium has been creating synergies in order to guarantee a successful exploitation of the project's results through briefings with policy and decision-makers and educational agencies at all national levels and integrating FAMT&L's and other institutions' initiatives.

- *The Final Conference*

  The Final Conference of the project, in Bologna, has gathered national agencies, schools, teachers and graduate students; the aim was to have it not only as a mean to illustrate the previous work done, but also to promote a *knowledge network* with participants from many sectors (teachers, trainers, students, professionals, etc.).

3.2. *The two dimensions of our activities*

The exploitation's events and activities have been based on two dimensions:

1. *Horizontal dimension*

   Within the FAMT&L network the state-of-the art of the work has been continuously discussed among all project partners (to define priorities, impact criteria and use of the projects achievements in accordance with the project's objectives). The Exploitation Plan and the dissemination activities have been tools to reach relevant stakeholders and stimulate dialogue on the topics addressed in the project.
2. *Vertical dimension*

   There are scholars at Universities in different countries teaching and researching about the use of FA in teaching; they have been contacted and invited to a dialogue to ensure continuity in the knowledge of the state of the art for the whole network; in this way new methods and results can be easily exchanged to build up a basin of shared scientific knowledge from which to draw upon information and experiences.

4. Highlights of project's results

The main issue of the project was to promote dissemination of good practices of formative assessment in the teaching of mathematics in low secondary school.

The promotion of a new method of training for teachers is a concrete result which has been pursued mainly through FAMT&L website and network, but also with interviews and articles, seminars and with participation at conferences.

4.1. *Publications*

In particular, the work of our researchers has produced several publications and presentations (see www.famt-l.eu/publications/):

- Paraskevi Michael-Chrysanthou, Athanasios Gagatsis & Ira Vannini. *Formative assessment in mathematics: A theoretical model*. Acta Didactica Universitatis Comenianae Mathematics, issue 14, 2014.
- Paraskevi Michael-Chrysanthou. *Η διαμορφωτική αξιολόγηση στη διδασκαλία και μάθηση των μαθηματικών* (Formative assessment in Mathematics for teaching and learning) XII Pedagógiai Értékelési Konferencia, 2014.
- Laurent Jeannin, Iuliana Rossi, Athanasios Gagatsis, Paraskevi Michael, Ira Vannini, Giorgio Bolondi, Federica Ferretti, Laura Tartufoli, Silvia Sbaragli, Miriam Salvisberg, Rob Velder. *Quelle évaluation formative en mathématique au sein de ces 5 pays: Italie, Chypre, Suisse, Hollande et France: Projet Européen FAMT&L*. ADMEE, 2015 (PPT presentation).
- Federica Ferretti, Stefania Lovece. La valutazione formativa per la didattica della matematica nell'ambito del progetto FAMT&L. Le concezioni degli studenti di scuola media nei confronti degli strumenti di verifica utilizzati in classe. In *Ricerche di Pedagogia e didattica*, vol. 10/2015, no. 2, pp. 39-68.
- Paraskevi Michael-Chrysanthou, Stefania Lovece & Ira Vannini. *Exploring teachers' beliefs on formative assessment in mathematics teaching and learning in Cyprus and Italy* Conference – EAPRL, 2015.
- Stefania Lovece, Ira Vannini & Paraskevi Michael-Chrysanthou. *Methodologies and tools for the video analysis of formative assessment practices in classroom (with students aged from 11 to 16)* Conference – EAPRL, 2015.

- Giorgio Bolondi, Federica Ferretti, Stefania Lovece and Ira Vannini (Alma Mater Studiorum Università di Bologna), Elena Franchini, Miriam Salvisberg and Silvia Sbaragli (DFA-SUPSI of Locarno). *The formative assessment in mathematics education. First results of an international project.* National Conference *Encounters with Mathematics n. 29*, Castel San Pietro Terme, Bologna (6-7-8 November 2015).
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- Gagatsis, A., Michael-Chrysanthou, P., Christodoulou, T. & Elia, I. (2016). *Formative Assessment in The Teaching And Learning of Mathematics in Cyprus*. Nicosia: University of Cyprus.
- Dozio, E., Franchini, E., Salvisberg, M. & Sbaragli, S. (2015). Le convinzioni di docenti e studenti sulla valutazione formativa in matematica. *Scuola ticinese*, 3, 27-30.
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- Michael-Chrysanthou, P., Christodoulou, T., Elia, I. & Gagatsis, A. (2016). Multiple semiotic means in the use of formative assessment in secondary school mathematics. *La matematica e la sua didattica*, 24(1-2), 125-144.

4.2. *Participations in conferences and meetings*

Researcher from our network participated to the following meetings:

- XII Pedagógiai Értékelési Konferencia – 2014 Paraskevi Michael – Chrysanthou. *Η διαμορφωτική αξιολόγηση στη διδασκαλία και μάθηση*

των μαθηματικών (Formative assessment in Mathematics for teaching and learning).

- EAPRIL 2014 (Paraskevi Michael – Chrysanthou, Athanasios Gagatsis *Students' beliefs for formative assessment in Mathematics teaching and Learning.*
- ADMEE, 2015 (Laurent Jeannin, Iuliana Rossi, Athanasios Gagatsis, Paraskevi Michael, Ira Vannini, Giorgio Bolondi, Federica Ferretti, Laura Tartufoli, Silvia Sbaragli, Miriam Salvisberg, Rob Velder). *Quelle évaluation formative en mathématique au sein de ces 5 pays: Italie,Chypre, Suisse, Hollande et France: Projet Européen FAMT&L.*
- National Conference "Encounters with Mathematics n. 29". Castel San Pietro Terme, Bologna (6-7-8 November 2015).

The following meetings were essential steps of our project:

- Project meeting in **France** (September 2014). Discussions about how to conduct the analysis of videos. Decisions about the grid for analysis, web platform.
- Project meeting in **Holland** (February 2015). Definition of the grid for the video analysis and study of data from questionnaires.
- Project meeting in **Cyprus** (September 2015). Conclusion of analysis of data from questionnaires, summary of the results and discussion about the use of them for designing our training courses. Presentation of next phases of the Project and outstanding issue.
- Project meeting in **Switzerland** (April 2016). With the presence of academic and scientific experts as *critical friends* and for the evaluation of the state of the art of activities and preparation of the Europe Final International conference.
- Final Conference in **Italy**. It was the occasion to present the final results, create new opportunities for exchanging ideas and experiences and decide about the future of what has been realized.

Notice that every event (conference, seminars, meetings, etc.) organized within the project has been reported on our site (www.famt-l.eu).

4.3. *A competition*

The FAMT&L group organized a contest aimed to enhance the creativity of math teachers by encouraging them to use mathematics in an innovative way of expression and communication through Formative Assessment. The particular format of the contest is that the participants (teachers) are to elaborate a short video with their students creating small situations of Formative Assessment in math classrooms, so to their interest

towards the implementation of Formative Assessment techniques and practices.

Here is a brief description of how the competition was organized.

The Product

The product had to be a short video (max 5 minutes) of a teacher (and students), presenting one of the following situations:

- providing a definition/a description of Formative Assessment with any means (i.e verbally, using pictures, diagrams or other representations, with movements etc.);
- proposing a specific Formative Assessment technique to be used in mathematics teaching;
- presenting a short episode of the implementing Formative Assessment in classroom, in which a particular technique is used.

Participants

- The participants could be secondary education math teachers from public and private schools.
- Each participant was to represent his/her school.

Steps of the contest

1. Each video had to be uploaded on the competition website.
2. The best 2 participants from each country have been selected, without ranking, by each partner country.
3. All the selected participants' videos from each country have been judged in the final stage from the Jury.
4. At the conference in Bologna, the Jury announced the First, Second and Third Prize.

The Evaluation

The selection of the winner in the competition and the other finalists was conducted in the final meeting a day before the final conference. In this phase of the meeting three people of team of Swiss, three people of the Cypriot team, four of the Italian team and two researchers from Netherlands were present. French team didn't participate in this procedure. Concerning the procedure of the evaluation to choose the finalists, four criteria were set:

1. relation to formative assessment;
2. the role of the teacher;
3. effectiveness of the interaction between teacher-students;
4. effectiveness of the interaction between students.

For each criterion the members of the Jury could assign a mark ranging from 1 (low grade) to 3 (high grade) points.

The Jury

Giorgio Bolondi, Theodora Costantinou, Seerp De Blauw, Federica Ferretti, Elena Franchini, Athanasios Gagatsis, Alessandro Gimigliano, Fatiha Lograda, Stefania Lovece, Miriam Salviesberg, Silvia Sbaragli, Ira Vannini, Rob Velder.

Prizes

- First Prize: 500€ and certificate of success.
- Second Prize: 300€ and certificate of success.
- Third Prize: 200€ and certificate of success.
- The prizes have been given as equipment and material to be used in the winners' schools (such as computers, tablets, interactive white boards e.t.c).

The winners

First prize. Netherlands: Luzac lyceum Amsterdam, Uiterwaardenstraat 263, 1079 CR Amsterdam.

Second prize. Switzerland: Scuola media di Gravesano, Via Str. Regina 6929, Gravesano, Canton Ticino, Svizzera.

Third prize (ex aequo). Cyprus: Olympion Private School Cyprus, 25 Martiou 87, Palaiometocho 2682.

Third prize (ex aequo): Italy: Istituto Comprensivo N.5 Bologna, via A. di Vincenzo 55, 40129, Bologna.

4.4. *Activities towards key stakeholders*

The SUPSI (Switzerland) activities

Collaboration with DECS (Dipartimento educazione cultura e sport), which has also co-funded some FAMT&L activities).

Meetings with Experts in mathematics for middle schools from DECS to explain the project.

Meetings with responsible and colleagues for training in DFA /SUPSI to explain the project and find solutions to make a pilot training course for future teachers.

The UCY (Cyprus) activities

During the project's realization the group has contacted several national agencies.

- The University of Cyprus (UCY), where students and professors have been informed about the actions (i.e. organization of a seminar about formative assessment and the FAMT&L project) of the project. In the

UCY there are different faculties that deal with formative assessment and cooperation with them has promoted more the FAMT&L project.

- Cyprus Mathematical Society (CMS) is another agency which promoted the FAMT&L competition and the training courses. Through the CMS a 2 hours Symposium has been organized about the aim and the actions of the project and it was held within the actions of the 18th Cyprus Conference on Mathematics Education and Science. The purpose of this Symposium was to promote our training model and invite teachers to participate.
- Olympion Private School Cyprus is another agency, where the actions of the project were presented and the training model was promoted.
- Cyprus Pedagogical Association (CPA) is probably the oldest Pancyprian pedagogical research association. As part of its activities CPA organizes a biannual conference in order to provide opportunities to researchers, students and educators in Cyprus to present their educational research work. With this organization the FAMT&L actions and some of the questionnaires' results has been published in a conference and the collaboration will continue by publications with this organization and in its website.
- The Cooperation with the Ministry of Education (inspectors of Mathematics) has also given to the group access in schools where the FAMT&L project, its objectives and its results has been promoted, focusing on the training model (and this activity is still going on).
- Cooperation with Greek Universities, mainly with the National and Kapodistrian University of Athens. The group has organized and still will organize seminars in Greece, in which the actions of the project and its results can be presented.
- The Hellenic Mathematical Society (HMS) is a learned society which promotes the study of mathematics in Greece. This agency organizes an annual conference in order to provide opportunities to researchers, students and educators to present their educational research work. With this organization we have published materials about the FAMT&L actions and some of the questionnaires' results and we aim to continue the publications with this organization and in its website.
- Cooperation with Greek Universities, especially with the 'National and Kapodistrian University of Athens', the 'University of Rhode Island' (Department of Education and Mathematics-professor Avgerinos Evgenios) and the 'University of Macedonia' (Thessaloniki-teacher Anastasiadou Sofia). We will continue to organize seminars in Greece, in which the actions of the project and its results will be presented.

The UNIBO (Italy) activities

In the years of the project we had many contacts with several kinds of possible stake-holders: schools, researchers, institutions, publishing houses. The interest about the outcomes of our project has been high, and we have worked and still are working to seek collaborations with regard to two objectives:

1. to keep the web repository active, to enlarge its contents (videos and video analysis) and to give it a new institutional position;
2. to continue the research about the effectiveness of our model of formation via video-analysis (to check its influence in changing evaluation practices and ideas).

As for point 1), Unibo is working to make the sustainability of the repository possible and is exploring the ways for collaboration with several agents:

- UNIBO itself (find funds and personnel to manage the web repository);
- INDIRE (National Institute for Documentation, Innovation and Educational Research), the first research agency of the Italian Cabinet of Education which has shown interest to be involved in keeping and using the web repository;
- Publishing houses which have a sector dedicated to teachers' formation. Such actors could be involved in the publication of manuals for video analysis based on the materials of our web repository and (maybe) keep samples of it in their websites.

Our aim is to guarantee that in the future our web repository will be hosted on a platform which is adequate for teachers formation and such that its use for training activities will kept and developed.

As for point 2), contacts, exchanges and agreements are ongoing with several actors to keep a research network active and developing.

The UCP (France) activities

1. Collaboration with the Department of Education, especially for the organization of formal and informal meeting with researchers and teachers. Cooperation also with some professors and researchers of Mathematics Education, which provides a scientific supervision of the use of tool and techniques of formative assessment in mathematics.
2. Contact and exchanges with several schools and, in particular, with mathematics teachers to explain the project and to delineate teachers' formative needs.
3. Cooperation with the Ministry of Education (inspectors of Mathematics) to collaborate for FAMT&L Project achievement objectives and its exploitation.

The InHolland (Netherland) activities

The following table describes the contacts and activities of the InHolland group.

Tab. 1 - InHolland activities

Name of agencies	Description
Beta-partners	Network meetings with other universities and High Schools with purpose: • exchange knowledge; • in-service training; • think-tank.
SLO, VO-raad, Plexs	SLO: supporting organization for schools for development of curriculum design. VO-raad: council for high school boards. PLEXS: council for examination. Starting as a think-tank (initiated by ministry of education) to research current use of formative assessment and how to organize professionalization of school boards, examination-administration and teachers. So, actually three agencies, working both together and also apart on this subject.
Schoolinfo	Supports schools in implementing strategies for differentiated and personalized learning in a network of various partners. Organizes conferences, seminars and develops in-service training in professional learning communities.
Ministerie van Onderwijs	Ministry of Education, working with the project group on formative assessment.
Samenwerking Amsterdamse Lerarenopleidingen SAL)	Cooperation between the Institutes for Teacher Education (SAL): University of Amsterdam, Free University, Netherlands' Hogeschool InHolland of Applied sciences, Amsterdam University of Applied sciences, IPABO Teacher Training College.
ADEF Assessment	General Consultation between Directories of Educational Faculties.

4.5. *Development of strategies*

To keep the project results active and exploit its success by all participants and the network of their associated researcher and institutions, the following strategic tools have been planned and implemented:

- Formation of a Scientific Committee with participants from each of the nodes to keep track of the activities related to the repository (request of access, both individual and from agencies) and to set up rules for the use of the video material also in future.
- Signing of an agreement among the groups that made the project in order to ensure continuity to the research and development work.
- Elaboration of a Costs Plan, to maintain the repository active and to develop it.
- Contact educational agencies in each country to involve them in the project.
- Contact private operators to involve them in the project (mainly publishing houses).

5. Benefits of exploitation

To ensure that the knowledge created within the FAMT&L project will also be used in future is one of the aims of the exploitation. The expected benefits of the exploitation can be various:

5.1. *Scientific exploitation*

The project's results have been made known to scholars who do research in the field, the collected information and database of the project results are being disseminated in conferences, workshops, panel discussions and scientific publications. Furthermore, the results have been integrated into courses taught at universities.

Dissemination of innovative educational approaches

The FAMT&L project's results in their entirety have been and still will be published and disseminated by the FAMT&L website, newspaper articles, scientific journals, focused events, workshops and conferences, in particular by publicizing the platform with video materials and innovative models of teacher training.

5.2. *Planning and outcomes*

The following table gives an overview of the project planning and its outcomes:

Tab. 2 - Exploitation outcomes

Outcome	Target group	Objectives	Indicators for measurement of success
Exploitation Plan (Planning Document)	Partners	To keep track of the state of the art of our work and to exchange info	At least one person for each node has been involved in the on-going draft of the document
Agreement of co-operation with schools	Partners and stakeholders	Have a standard frame of work for cooperation with schools for all our nodes	Number of schools for the associated partners: 5 Italy, 2 Cyprus, 1 France, 2 Switzerland, 2 Netherlands
Short videos (Videos)	Partners and stakeholders	Use as main tool for the elaboration of training stra-tegies for FA. Gathered in our repository	Number of videos: 126. UNIBO (90) – UCY (16) – SUPSI (11) – UCP (9) Many students and teachers involved.
Briefings with policy and decision makers, educational agency and operators at national level (exploitation events)	Partners and stakeholders	Spread awareness about FA and its relevance; improve funding possibilities and spaces for training	See section 4.2
Training meetings with teachers	Partners and stakeholders	Pilot courses have been the main tool to introduce teachers to video analysis as a mean to improve their use of FA techniques	Pilot courses for teachers have been hold by the members of the project with different formats (6 to 30 hours modules, more than 70 teachers involved). They have been successful, as proven by the results of the relative questionnaires
Seminars about FA and the project	Partners and stakeholders	Introduce teachers and university students to FA and results of the project	Several seminars with good number of participants (university researchers and students, in service and pre-service teachers)

6. Sustainability

It is part of the ambition of the *FAMT&L* project to make a stable contribution to the development of strategies that enhance the use, awareness and development of FA in the teaching of mathematics.

One of the main goals of the project is keeping and enlarging our *web repository* that should be one of the reference points in Europe for the use of videos in FA training. The project members should also aim at creating a sustainable network and at writing state of the art reports, to facilitate the circulation of information.

Other activities can be implemented on an "as needed" basis, but at least the basic function as "observer" and "knowledge hub", should be safeguarded and made sustainable also after M36 of the project.

Unibo is working to make the sustainability of the repository possible; what is mainly needed is to have a good maintenance of the repository, to elaborate good rules and means for the access to the materials, to allow development processes.

For these objectives, the FAMT&L project's staff has elaborated an agreement for the adequate use of the repository in the five countries which has been undersigned by the project's groups; such an agreement will provide a constant scientific supervision of this tool and a coherent use of it for the formation of teachers about formative assessment.

At present, the repository is intensively used for training courses for in-service teachers and for university courses for future teachers. Actually, University students in Mathematics and Education, as future teachers, are a particularly relevant target group for our action.

The other main objective of the project was to keep a *research network* active and developing, via contacts, exchanges and agreements with several actors.

The following subjects have been involved:

- the research group in "didattica della matematica" at the University of Turin;
- the international web WiTEC;
- INVALSI (National Institute for the Educational Evaluation of Instruction and Training);
- University of South Australia (research group in the teaching of Mathematics);
- an international research group named *Video 4 teachers*, which, also following our work, has been formed at the University of Cagliari (see http://sites.unica.it/video4teachers).

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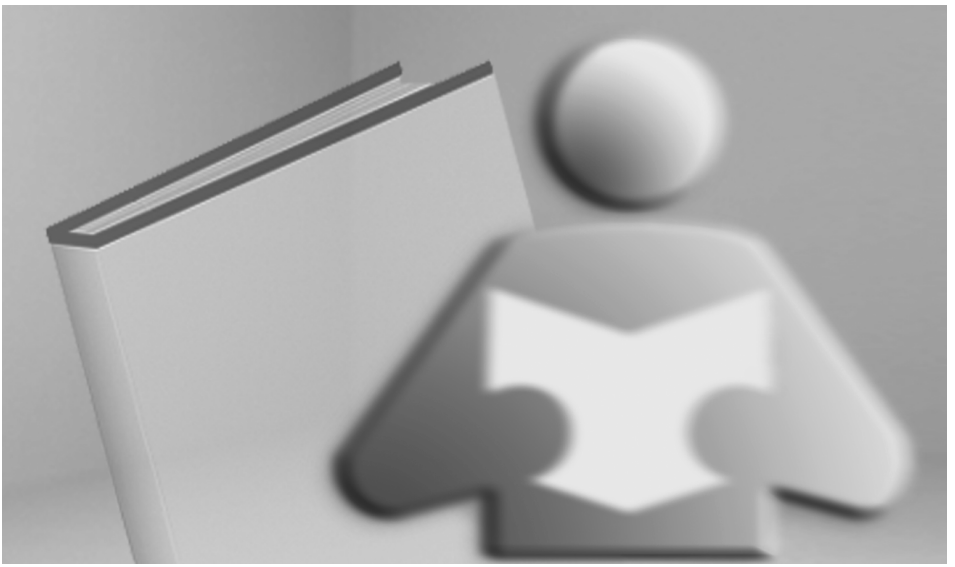

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FORMATIVE ASSESSMENT *FOR* MATHEMATICS TEACHING AND LEARNING

This book aims at describing pathways and achievements of the LLP Comenius Project "FAMT&L – Formative Assessment in mathematics for teaching and learning". The main purpose of this research project was to encourage the use of formative assessment in the teaching-learning process carried out by mathematics teachers in lower secondary school. The five partner universities involved in the Project have been the Alma Mater Studiorum University of Bologna (Italy), the University of Applied Sciences and Arts (Southern Switzerland), the University of Cergy-Pontoise (France), the University of Cyprus, and the Hogeschool Inholland (Netherlands).

Through the voices of the several actors involved in this project, the book wants to contribute to the international debate on issues regarding teachers' professionalism in the European school systems: specifically, on the development of the professional skills of teachers in the field of assessment practices and on the use of formative assessment in the classroom.

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La passione per le conoscenze