

# ENHANCING FORMATIVE ASSESSMENT PRACTICES IN UNDERGRADUATE COURSES BY MEANS OF ONLINE WORKSHOPS

GIOVANNINA ALBANO<sup>1</sup>, ANNA PIERRI<sup>2</sup>, CRISTINA SABENA<sup>3</sup>

<sup>1</sup>University of Salerno, [galbano@unisa.it](mailto:galbano@unisa.it)

<sup>2</sup>University of Salerno, [apijerri@unisa.it](mailto:apijerri@unisa.it)

<sup>3</sup>University of Turin, [cristina.sabena@unito.it](mailto:cristina.sabena@unito.it)

*In this paper, we report a research study concerning the use of online e-learning platform for enhancing formative assessment strategies through which the students are asked to provide feedback on their peers' productions and are therefore activated as instructional resources for one another. In playing the assessor role, students are prompted in developing continuous reflections on their learning processes. The activity has been experimented at undergraduate level in two different Universities in Italy, with courses with different mathematical contents. We describe the design of the activity and analyse the first experimental results.*

*Keywords: formative assessment; peer review; blended learning; online workshops.*

## INTRODUCTION

Shared experiences and literature review (Larreamendy-Joerns & Leinhardt, 2006) show evidence of the integration of online instruction practices at University level. The benefits of such practices seem to be mainly found in the freedom of the students to move at their own pace. Nonetheless, there is not enough literature reporting the actual added-value of online support with respect to the traditional face-to-face (f2f) instruction. Then, the key question becomes how online platforms can be used for formative assessment (FA) in blended learning, and how students accept and use them.

Research has also widely shown the effectiveness of a correct implementation of FA practices for improving mathematical learning in school context (Hattie, 2009). In the last decade, mathematics education research has been focusing on FA as a teaching practice (e.g. the Mathematics Assessment Program: <http://map.mathshell.org>), also with the support of new technology (see the FaSMEd Project: <https://microsites.ncl.ac.uk/fasmedtoolkit/>). Research has focused mostly on primary and secondary school levels in f2f context. Undergraduate contexts with a large numbers of students are a great challenge for adapting such models of FA processes, where the teacher-students interactions, also at one-to-one level, may play a key role.

Our investigation takes place at the University level in a blended learning context, that is a learning environment where traditional f2f lectures are supported by further teaching/learning activities conducted through a web-based platform<sup>1</sup>. In the light of previous experience on e-learning platform to engage students themselves as responsible of their own learning process and of their peers (Albano, 2011; Albano & Pierri, 2014), in this paper we report on the use of a specific advanced tool of the web-based platform Moodle (called "workshop") in order to support peer work in the view of online FA, intended as "the application of formative assessment within learning online and blended settings where the teacher and learners are separated by time and/or space and where a substantial proportion

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of learning/teaching activities are conducted through web-based ICT” (ICT stands for Information and Communication Technologies) (Gikandi et al., 2011, p. 2337). Our focus is first on the didactic function and, accordingly, the choice and the didactical design of the tools to ensure that the desired result is achieved (Chevallard & Ladage, 2008). The core of the design is that students are asked to provide feedback on their peers’ productions and are therefore activated as instructional resources for one another, through cycles of online FA workshops. In the following, we present the theoretical model for formative assessment, which guided our design. We then describe the experimental settings (involving two different Universities in Italy, at the University of Salerno and at the University of Torino), and present our didactical design. Data analysis is still on-going: first results and implications are presented in the paper; additional results will be provided in the conference presentation.

## **FORMATIVE ASSESSMENT WITH TECHNOLOGY**

FA or assessment *for* learning (contrasted to assessment *of* learning) includes activities and practices enacted by teachers with the aim of improving students’ learning. As largely shared within education literature, FA is conceived as a teaching method, where “evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited” (Black & Wiliam, 2009, p. 8).

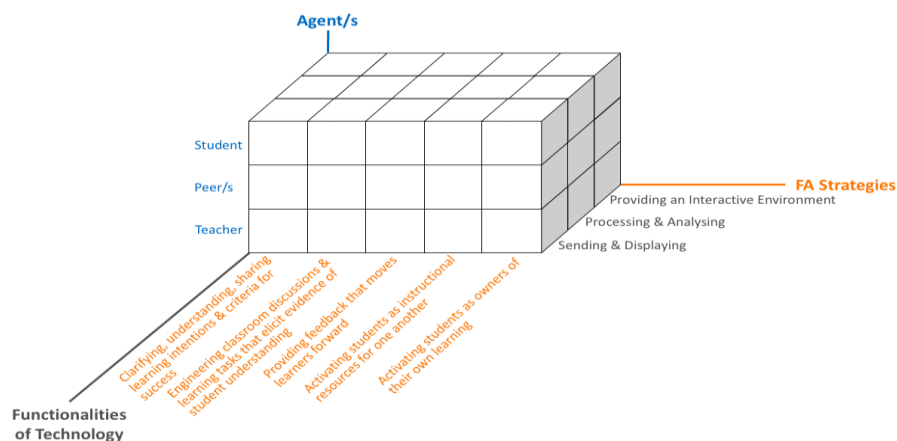
Typical FA activities are therefore those through which students have the opportunity to verify their own learning levels, plan and implement, in interaction with the teacher and classmates, the strategies necessary to achieve the learning goals. In order to base FA on solid foundations, Wiliam and Thompson (2007) considered three key processes identified by Ramaprasad (1983): (a) establish where the learners are in their learning; (b) establish where they are going in this process; (c) establish how the goal can be reached. Traditionally, the teacher is held responsible for each of the three processes, but it is also necessary to consider the role that students can play themselves and their peers, who are usually their classmates. By crossing the three key processes with the different ‘agents’ (teacher, classmates, pupil), Wiliam and Thompson (2007) have elaborated a theoretical framework for FA, highlighting that it can be developed through five key strategies:

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

In this model, three different agents intervene in FA practices: the teacher, the learner, and the learner’s peers. The teacher is responsible for clarifying learning objectives and criteria for success, which become assessment criteria (key strategy A), for organising class activities and discussions in which she can have evidence of pupils’ understanding (key strategy B) and for providing feedback to enable students to progress in learning (key strategy C). Feedback concerns the information that the student receives about her performance and is undoubtedly one of the most important tools for building a bridge between actual and expected learning. Following the definition of Ramaprasad (1983), feedback only becomes formative if the information given to the student is used in some way to improve her performance. It is therefore important that the feedback goes beyond a simple green or red ‘traffic light’ for the student, which would merely orient the student’s behaviour, and that it rather shows her what any errors, deficiencies, inaccuracies and possibly what may cause them. If the teacher succeeds in placing herself in the student’s proximal development zone (Vygotsky, 1978), structured feedback can guide her in dealing with those tasks she is not (yet) able to deal with on her

own (Shepard, 2000). Beside the teacher, learners have important roles also, both in understanding the learning objectives and criteria for success (key strategy A), and in taking responsibility for the learning of their fellow students and themselves (key strategies D and E).

Research has shown that activating formative assessment practices is highly demanding for teachers, and recent projects have investigated how technology may be exploited to support them in school classroom (e.g. the European FaSMEd project - Improving Progress for Lower Achievers through Formative Assessment in Science and Mathematics Education; Aldon & Sabena, 2015). Considering the different *agents*, the five *key-strategies* and how *technology* may support FA processes within educational contexts, a three-dimensional framework for the design and implementation of technologically-enhanced formative assessment activities has been proposed (Aldon, Cusi, Morselli, Panero & Sabena, 2017; Cusi, Morselli & Sabena, 2017). The framework is represented in the chart<sup>2</sup> in Figure 1.



**Figure 1. Chart of the FaSMEd framework, where FA strategies, agents, and functionalities of technology constitute three fundamental dimensions**

FaSMEd model identifies three main *functionalities* through which technology could support FA:

- (1) *Sending and displaying*, e.g. sending and receiving messages and files, displaying and sharing screens or documents to students;
- (2) *Processing and analysing* data collected during the lessons, e.g. showing the statistics of students' answers to polls or questionnaires, or the feedbacks given directly by the technology to the students when they are performing a test;
- (3) *Providing an interactive environment*, in which students can interact to work individually or in groups on a task or to explore mathematical/ scientific contents (e.g. the use of specific software where it is possible to dynamically explore specific mathematical representations).

In our research study, we refer to the sending-and-displaying and the processing-and-analysing functionalities within undergraduate level and investigate how an online platform may be exploited to promote mathematics FA processes involving the three agents—teacher, students and peers—and in particular peers in a blended modality. Students attend traditional classes of the f2f course and participate in online activities concerning formative assessment.

## THE RESEARCH STUDY

<sup>2</sup> We thank Wright (Newcastle University) for the digital version of the chart and Ruchniewicz (University of Duisburg-Essen) for its adaptation.

## **Research context and methodology**

We experimented online FA workshops experimented in two different Universities in Italy, at the University of Salerno and at the University of Torino, in undergraduate mandatory courses with different mathematical contents. Initial trials started in years 2017-2018 and allowed us to gauge the workshop. In this paper we report on the theoretical design, the feelings of the students of the initial experiments and give some flavours of the outcomes of the current ones (year 2018-19).

At the University of Salerno, FA online workshops constitute a support to a traditional f2f course of Geometry, Algebra and Logic for freshmen students in Computer Engineering (second term). The content of the course mainly concerns linear algebra, whose learning difficulties are well known. The course foresees two written examination tests, one mid-term and one final, that are prerequisite to access the oral exams. Four online workshops have been submitted, two before each of the written tests, conceived as summary exercises in view of the test to be done. For each session, about 40 exercises have been prepared, and each of them has been submitted to groups of 3 or 4 students.

At the University of Torino, five FA online workshops have been carried out during a course of Mathematics and Mathematics Education for freshman prospective primary teachers. The course focuses on arithmetic and early algebra and one of its major goals developing teachers' argumentative competence in these topics. In each workshop, students have received a collection of 3 to 5 exercises or problems to solve, related to the topics discussed during f2f classes. Workshops have been open also to students not attending the classes.

In both cases, in FA online workshops students have been asked to solve problems/exercises and to upload their solutions within a given deadline. Then all the assignments and their solutions have been redistributed to the students, so that each student would receive a certain number of them. Students have been expected to assess them according to the given criteria of correctness, completeness, and clearness. As a final step, they have received a structured feedback from the teacher.

FA workshops have been proposed to the students as a learning support and participation was not mandatory. Data have been collected by means of the platform facilities, such as reports and repository of materials associated to students' profile. We have used quantitative analysis for investigating the effect that the online formative assessment strategy has had on the students in terms of participation to the activity in the context of the two Universities.

In order to include the students' point of view, we have submitted a questionnaire concerning the students' feelings about their participation to the activity and on the perceived effects on their learning process. The questionnaire has focused on the three steps of the FA workshops: problem solving, assessment, feedbacks. Concerning the first two, we have investigated how much difficult the tasks have been perceived by the students and which difficulties they faced. Then we have asked about the usefulness of the teacher and the peers' feedbacks. On the affective side, we have explored the students' feelings when they assumed the role of the assessor as well as of the assessed. Moreover, we have collected their views on the influence that their participation in this activity has had on the learning of the subject, the method of study and the success of the examination. Finally, suggestions have been asked for improving the activity.

### **Didactical design of FA online workshops**

The online FA workshops are focused on peer review processes implemented by using the "workshop module" of the web-based platform Moodle, followed by a structured feedback by the teacher. FA workshops allow students, on the one hand, to upload the solution of specific problems/exercises and, on the other hand, the automatic and anonymous redistribution of the productions, to be assessed by other students, related to a specific topic of the course (sending-and-displaying functionality of

technology). Assessment is guided by specific criteria established by the teacher (FA strategy A). The submission consists of plain text and optional attached files including the students' answer with respect to a specific topic assigned by the teacher.

Overall, the FA activity realized by means of the support of the online platform is carried out according to three sequential phases:

- *Planning*: the teacher configures setting and creates assessment forms and instructions (FA strategy A). The structures of the *Workshop* module make possible to: set the times of the various tasks; define the assessment criteria (correctness, completeness, clearness); distribute a certain number of products for each student, excluding self-assessment (we chose 3); deliver peers' feedback to students; make evident to the students the scores obtained on the basis of the scores received from their peers (processing-and-analysing functionality of technology).

- *Solving*: each student receives a problem, with the following request:

**Solve the problems:** *“Solve the following problems and for each question, give correct, clear and complete answers, explaining the reasoning behind and referring the theoretical properties used. Then upload your product, being careful to leave it anonymous.”*

Once solved the problems, the student uploads her product, set anonymous (in order to avoid any bias), which will be automatically and randomly redistributed to three peers.

- *Assessing*: each student assesses the productions of three peers, grades them and provides feedback (FA strategy C, applied to students rather than teacher) according to the following request:

**Assess and grade the received products:** *“Correct and assess the three products you received randomly from the system. The assessment is expected to be carried out according to the three criteria: correctness, clarity and completeness. For each criterion, you will be asked to give a numerical rating from 0 to 10 and to give accurate feedback. You will also be asked to give overall feedback on the work examined.”*

The criteria have been detailed as shown in the following:

- *Criterion 1 (correctness): “For each exercise, assess whether there are any errors in the solutions or solving process and whether all the answers have been given. Are the theoretical references correct, if any? Are mathematical symbols correctly used?”*
- *Criterion 2 (clearness): “For each exercise, assess whether the solution is clearly and unambiguously expressed and whether the solving process is shown and comprehensible. In other words, assess if the solving process does express clearly, precisely and unambiguously its content.”*
- *Criterion 3 (completeness): “Assess whether all the solutions have been given. When required, assess whether the processes are complete or whether there are lacking parts or gaps in reasoning, or unjustified conclusions.”*

Students are asked to give to their mates two types of feedback: an analytical one, based on the three chosen criteria, and a synthetic one, expressed with a numerical grade similar to the marks given in the final exams. We note that the request of grading the peers' works is a structural component of the Moodle workshops and cannot be avoided.

Once the students have completed all the previous steps, the teacher provides a structured feedback, making available (in a shared folder on the platform) some tasks carried out very well and that meet

all the established criteria as well as some tasks failing to reach the foreseen criteria, either because they contain typical mistakes, or incomplete answers, or unclear arguments, equipped with appropriate comments (FA strategies A and C).

### Outcomes and discussion

In this section we give an overview of the effect that the online FA strategy has had on the students in terms of participation to the activity in the context of the two Universities as well as students' feeling. In particular, at the University of Salerno (UniSA), four workshops (WS1, WS2, WS3, WS4) have been delivered to the students. As shown in the bar chart on the left (Fig. 2) and taken into account that the average number of students attending the course is 130 (orange line), we can register a high and constant participation to the activity (blue line). A positive participation has also observed in the course at the University of Turin (UniTO). Here, five workshops have been delivered to students. The bar chart on the right (Fig. 2) gives information about the level of participation (green line). That is very high if we consider that the average number of students attending the classes is about 110, compared to the total number of course participants (200 – blue line).

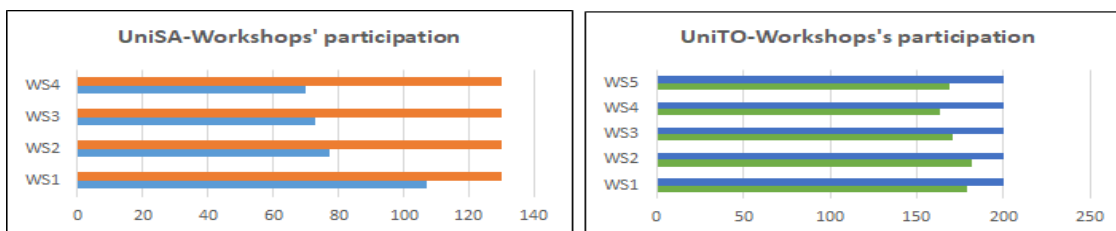


Figure 2. Workshops' participations

More in depth, we show, starting with two samples of students from the University of Turin, how the FA strategy could enhance the students' argumentation competence according to the peers' assessment. Specifically, we consider the feedbacks received from the students' assessors referred to workshops WS1 and WS2, whose topics of these workshops are quite similar. Figure 3.a shows the marks assigned to the student S1 for each criterion from the three peer assessors, named val1 (navy line), val2 (orange line) and val3 (grey line), referred respectively to WS1 and WS2. Analogous data are shown in Figure 3.b for the student S2 (the three peer assessors are again named val1 – green line, val2 – blue line, val3 – yellow line, but they are not the same students as in the case of S1).



Figure 3. Analysis of the assessment received by the students S1 and S2

It is evident how in moving from WS1 to WS2 the performance of the student S1 in the *Solving* phase is considerably improved from a point of view of correctness, clearness and completeness. Indeed, in WS1, the student S1 receives the following feedback [...*Suggestions: 1) Read the assignment; 2) Not to do your homework just for doing something, it is useless for you and also for me who I am*

*correcting your productions; 3) Whoever corrects isn't in your head, so write down all.; 4) If you have really put a lot of effort into it, you have a lot to catch up on. ...].* In WS2, as the three evaluation criteria are judged positively by all the assessors, we can assume that all suggestions have been taken into account by the students.

Concerning the student S2, we highlight the precise feedback given with respect to the correctness criteria. If we analyse the marks given by the assessor val2 in WS2 (Fig. 3.b), we can observe that S2 received the same marks for clearness and completeness criteria but a lower mark for correctness justified by the following sentence *“The exercises have been completed with clarity and completeness of content but unfortunately some parts of the exercises have been set in the wrong way and this has compromised the validity of some reasoning expressed to answer adequately and correctly to the requests of the various deliveries”*. So, it is evidence the attention that assessor students pay in reviewing the tasks she received with respect to the assessment criteria set by the teacher.

Regarding the questionnaires, we focus here only on following three aspects:

**Feeling about the role of assessing.** Many students have had the experience of helping their classmates: *“In some tasks, I have tried to steer the student examined towards the correct execution of the exercise, motivating with the right theoretical references where necessary. In those situations, I felt comfortable with the idea of being able to help”*. This goes alongside feeling responsible, not only for her own learning, but above all for peers' one. The downside to the sense of responsibility was to feel not up to the task that some students reported.

**Impact on content learning.** Among the benefits of participating in the workshops, the main ones consist in acquiring regular rhythm of studying, the self-assessment of what understood during the lectures as well as the identification and recovering of gaps that might be.

**Impact on learning approach.** The students report that the workshops made them realize how to study the subject, leading them to a more in-depth theoretical study. Benefits are also recognized from peers' comparison, allowing to develop correct and formal solving methods, focusing in particular on arguing the answers and justifying the choices made.

## CONCLUSIONS

Students are facing exams in different sessions and the questionnaires' scrutiny is not finished yet. Thus we do not have a complete picture about the actual impact of FA online workshops on their exam performance and data analysis is still on-going. However, we may trace the first considerations and implications from the study. The outcomes of the questionnaires show that most of the students recognize the possibility of comparing and interacting with peers as the main advantage of the FA online workshop. It concerns in particular the role of assessor. The investigation of the difficulties faced in the *Assessing phase* shows that the role of the assessor has made the students aware of three main critical aspects concerning mathematics learning: (a) the need of clearness and of completeness when describing the solution to a problem; (b) the attention to the communicative dimension; (c) the need of a deep understanding of the topic to be able to correctly perceive the severity of an error and to provide help. On the affective level, among the benefits of the FA online workshop crucial elements emerge, such as confidence with the subject as well as autonomy.

Almost all the students said that, if they were course teachers, they would combine classroom lessons with online FA workshops. The students have also indicated as a positive point the use of the correct solutions posted by the teacher, as a means to improve their work as assessor in next sessions of the

workshop. Some students suggest that having such optimal models at their disposal before their own assessment on the problems at stake could support them in the assessor role. We are considering this feature as an element of re-design for the future FA workshop cycle.

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