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# From Standardized Assessment to Automatic Formative Assessment for Adaptive Teaching

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Abstract: The use of technology in education is constantly growing and can integrate the experience of school learning allowing an adaptive teaching. One of the teaching practices in which technology can play a fundamental role is the assessment: standardized, summative and formative. An Automatic Assessment System can offer fundamental support to teachers and to students, and it allows adaptive teaching: promoting practices of formative assessment, providing effective and interactive feedback, and promoting self-regulated learning. Our university has successfully developed and tested a model for automatic formative assessment and interactive feedback for STEM through the use of an Automatic Assessment System. This article presents a training course for teachers focused on the adaptation of questions designed for standardized assessment to questions for formative assessment to develop mathematical skills, problem solving and preparation for INVALSI (national standardized tests). The teachers created questions with automatic formative assessment, reflecting on how to adapt the requests to the different needs of students and how to create guided learning paths. The activities created by the teachers, their reflections on the training module and on the activity carried out with students are analyzed and discussed.



## 1 INTRODUCTION

In recent years, educational technology is constantly evolving and growing and can be used to integrate the experience of school learning and offer adaptive teaching. Thanks to the new technological tools, teachers can have concrete support in offering all students personalized teaching to their different needs and their different cognitive styles. Technology can be an additional resource in the classroom and at home, able to support and help students in the cognitive, educational and training process. Certainly technology is able to improve learning only if it helps effective teaching strategies, for example when it allows to increase the time dedicated to learning, when it facilitates cognitive processes, when it supports collaboration between students, when it allows to apply different teaching strategies to different groups of students or when it helps to overcome specific learning difficulties.

One of the teaching practices in which technology can offer fundamental support to teachers but also to students is assessment. For a standardized or summative assessment, where the goal is to measure students' learning outcomes, an Automatic Assessment System (AAS) offers the possibility to automatically evaluate, collect and analyze student responses, saving time in correcting tests. In Italy, the best known example of national standardized assessment are INVALSI tests (https://invalsi-areaprove.cineca.it/) in the Mathematics, English and Italian disciplines (Bolondi et al., 2018, Cascella et al., 2020). From the past three years onwards, the tests for grades 8, 10 and 13 are computer-based while the tests for grades 2 and 5 are still taking place on paper.

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An AAS can offer fundamental support also for a formative assessment. Formative assessment is a process in which students are active protagonists and have the opportunity to understand what has been or has not been learned and how to learn it. Students can also understand the progress made and the difficulties they have in learning. For example, through formative assessment they can be trained in self-assessment to better prepare themselves the INVALSI tests by receiving feedback on the quality of their work and advice on how to improve.

Our university has successfully developed and tested a model for automatic formative assessment through the use of an AAS for STEM and other disciplines. This article presents a training course for teachers focused on the adaptation of questions designed for standardized assessment to questions for formative assessment with the use of an AAS to develop mathematical skills, problem solving and preparation for INVALSI tests. The 8-hour course was aimed at teachers of lower and upper secondary schools within the national Problem Posing and Solving project and was carried out entirely online. 17 teachers attended the course. After 4 weekly synchronous online meetings lasting one hour, teachers were asked to create at least 3 questions with automatic assessment for a formative test (one for assessing knowledge, one for solving a problem and one for justification) and experiment them with one of their classes. In creating the questions, the teachers reflected on how to create questions that would adapt to the different needs of students and guide them in preparing the tests.

The teachers were also asked to answer two questionnaires, one at the end of the preparation of the questions and one after the experimentation in the classroom. In the results section, the activities created by the teachers and their reflections and observations on the proposed training module and on the activity carried out in the classroom with students are analyzed and discussed.

# 2 THEORETICAL FRAMEWORK

## 2.1 Adaptive Teaching, Formative Assessment and Feedback

Every teacher, in their class, deals with a great variety of students. For example, there may be multicultural classes, students may have different learning styles, individual attitudes and inclinations or learning disabilities. However, the learning objectives are common to all students. In order to ensure that all students achieve the same objectives, tailor-made teaching of each student's characteristics, needs and sometimes even curiosities can be adopted. Adaptive teaching is defined as "applying different teaching strategies to different groups of students so that the natural diversity prevalent in the classroom does not prevent each student from achieving success" (Borich, 2011).

Some of the strategies for adaptive teaching are formative assessment, feedback and self-regulated learning.

The definition of formative assessment that we adopt is that of Black and Wiliam (2009), well known in the literature: “Practice in a classroom is formative to the extent that 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”. The authors conceptualize formative assessment through the following five key strategies:

- Clarifying and sharing learning intentions and criteria for success;
- Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding;
- Providing feedback that moves learners forward;
- Activating students as instructional resources;
- Activating students as the owners of their own learning.

Sadler conceptualizes formative assessment as the way learners use information from judgments about their work to improve their competence (Sadler, 1989). Formative assessment is opposed to summative assessment (assessment where the focus is on the outcome of a program) because it is an ongoing process that should motivate students to advance in the learning process and provide feedback to move forward. In Mathematics education, summative assessment design is generally affected by psychometric tradition, that requires that test items satisfy the following principles (Osterlind, 1998):

- Unidimensionality: each item should be strictly linked to one trait or ability to be measured;
- Local independence: the response of an item should be independent from the answer to any other item;
- Item characteristic curve: low ability students should have low probability to answer correctly to an item;

- Non-ambiguity: the question should be written in such a way that students are led into the only correct answer.

Questions built according to this model are generally limited in the Mathematics that they can assess. The possible problems are reduced to those with one only solution, deducible through the data provided in the question text. If problems admit multiple solving strategies, the only information detected is the solution given by students, thus removing the focus from the process, which is essential for assessing Mathematics understanding (Van den Heuvel-Panhuizen & Becker, 2003). Having no information on the reasoning carried out by students, on the resolutive strategies adopted by them and on the registers of representation used, if the student provides a wrong answer, it is not possible to understand the type of error made by students and to provide correct feedback.

In adaptive teaching, feedback takes on a very important role to reduce the discrepancy between current and desired understanding (Hattie & Timperley, 2007). Effective feedback must answer three main questions: "Where am I going?", "How am I going?", "Where to next?". That is, it should indicate what the learning goals are, what progress is being made toward the goal and what activities need to be undertaken to make better progress. A feedback can work at four levels: task level (giving information about how well the task has been accomplished); process level (showing the main process needed to perform the task); self-regulation level (activating metacognitive process); self-level (adding personal assessments and affects about the learner).

Self-regulated learning is a cyclical process, wherein the students plan for a task, monitors their performance, and then reflects on the outcome. According to Pintrich and Zusho (2007), "self-regulated learning is an active constructive process whereby learners set goals for their learning and monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features of the environment". In the self-regulated learning students become masters of their own learning processes.

Technologies can help offer increasingly adaptive teaching: to activate effective strategies for formative assessment, to give feedback that differs according to level and to students' responses and to activate self-regulated learning (Kearns, 2012).

An Adaptive Educational System (AES) uses data about students, learning processes, and learning products to provide an efficient, effective, and customized learning experience for students. The system achieves this by dynamically adapting instruction, learning content, and activities to suit students' individual abilities or preferences.

Our model of automatic formative assessment allows to offer adaptive teaching (Barana, Marchisio, & Sacchet, 2019; Marchisio et al., 2018), to assign different activities to students according to their level and to promote engagement in Mathematics at school level (Barana, Marchisio, & Rabellino, 2019). The AAS also allows you to automatically collect and analyze all students' answers, the results of the checks and the data on their execution (start, end, duration, number of attempts, etc.). In this way, the model allows at the same time to provide students with high quality information about their learning and to provide teachers with information that can be used to adapt teaching.

## 2.2 Our Model of Formative Automatic Assessment and Interactive Feedback

In a Virtual Learning Environment (VLE), formative assessment can be easily automatized in order to provide students immediate and personalized feedback. Using Moebius AAS (https://www.digitaled.com/products/assessment/), our research group has designed a model for the formative automatic assessment for STEM, based on the following principles (Barana, Conte, et al., 2018):

- Availability of the assignments to students who can work at their own pace;
- Algorithm-based questions and answers, so that at every attempt students are expected to repeat solving processes on different values;
- Open-ended answers, going beyond the multiple-choice modality;
- Immediate feedback, returned to students at a moment that is useful to identify and correct mistakes;
- Contextualization of problems in the real world, to make tasks relevant to students;
- Interactive feedback, which appears when students give the wrong answer to a problem. It has the form of a step-by step guided resolution which interactively shows a possible process for solving the task.

This model relies on other models of online assessment and feedback developed in literature, such as Nicol and Macfarlane-Dick's principles for the development of self-regulated learning (Nicol & Macfarlane-Dick, 2006) and Hattie's model of feedback to enhance learning (Hattie & Timperley, 2007). The model was initially developed to improve the learning of STEM disciplines but in recent years we have also experimented with the model for language learning (Barana, Floris, Marchisio, et al., 2019; Marello et al., 2019).

### 2.3 Adaptive Teaching in the National PP&S Project

The model developed for automatic formative assessment is also used within the Italian PP&S Problem Posing and Solving Project of the Ministry of Education (Barana, Brancaccio, et al., 2018; Brancaccio et al., 2015). The PP&S Project promotes the training of Italian teachers of lower and upper secondary schools on innovative teaching methods and on the creation of a culture of Problem Posing and Solving with the use of ICT. The PP&S Project adopts the following technologies as essential tools for professional growth and for the improvement of teaching and learning: a VLE, a Moodle-learning platform, available at www.progettopps.it, integrated with an Advanced Computing Environment, an AAS and a web conference system. The tools used within the PPS project support adaptive teaching:

- The VLE allows synchronous and asynchronous discussions, collaborative learning, interactivity and interaction, integration with tools for computing and assesment, activity tracking;
- The ACE allows interactive exploration of possible solutions to a problem, different ways of representation and feedback from automatic calculations and interactive explorations;
- The AAS allows students to carry out the necessary exercises independently, to have step-by-step guided solutions to learn a method and to make repeated attempts of the same exercise with different parameters and values. The AAS promotes students' autonomy and awareness of their skills and facilitates class management for teachers.

The PP&S Project offers various training activities that allow teachers to reconsider their teaching using adaptive teaching with technologies: face-to-face training, online training modules, weekly online tutoring, online asynchronous collaboration and collaborative learning within a learning community. In this case, we proposed 8-hour online training module entitled "Automatic formative assessment for preparation for INVALSI tests", to reason and reflect on the adaptation of questions designed for standardized assessment to questions for formative assessment and to create activities with automatic assessment for developing skills and for preparation for INVALSI tests. INVALSI test materials were proposed in the training module, created to measure students' skills, in terms of formative evaluation, with the aim of training skills. The INVALSI question repository is full of very valid and interesting questions, which can be used to make lessons in the classroom every day for teaching.

## 3 FROM STANDARDIZED ASSESSMENT TO FORMATIVE ASSESSMENT

Standardized assessment and formative assessment have very different characteristics. In the standardized assessment, each item responds to a single goal, the answer to each item is independent of the answers to the other items and each question has only one possible correct answer. In formative assessment problems can have different solutions, answers to items can be dependent on each other and the solution process should be considered more important than the answer to the question (Barana et al., in press). The following lines present an example of how to transform a question for standardized assessment into a question with formative assessment through the use of the automatic assessment system.

The question is of the area "relations and functions" in the dimension of "knowing" and is made for grade 13 students. The purpose of the question is to identify the graph of a piecewise function verbally described in a real context. The text of the question is: "A city offers a daily car rental service that provides a fixed cost of 20 euros, a cost of 0.65 euros per km for the first 100 km and a cost of 0.4 euros per km over the first 100 km ". Given a figure (Fig. 1) with the graphs of four car rental contracts, the student must select the graph corresponding to the proposed offer in a multiple choice task.

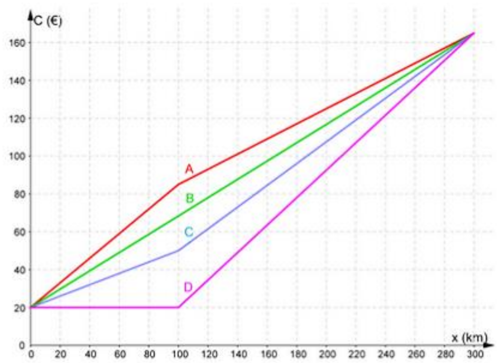


Figure 1: Graphs of four possible car rental contracts.

For the formative assessment this question can be expanded into three sub-questions in order of difficulty, keeping the same text of the problem but setting the algorithmic values. In this way the student can practice answering several times always having new data. In the first part, students are asked how much they would spend on a 10 km journey. The student (as shown in Fig. 2) can enter the numerical value and, by clicking the "verify" button, has two attempts to see if the answer is correct.


Figure 2: Response area to the first sub-question with "verify" button.

In the second part, the student is asked to choose the correct graph among the four graphs proposed (as in the previous question in Fig.1) but the advantage is that each time the problem data change, the four graphs also automatically change. In the last part of the question, the student must enter the expression of the function that expresses how the taxi fare varies according to the minutes t (Fig. 3).


Figure 3: Response area to the last sub-question with "verify" button.

The question proposes three sub-questions of increasing level with three different types of representation of the same mathematical concept (graphic, numerical and symbolic). Students can test themselves by having immediate feedback. Immediate feedback, shown while the student is focused on the activity, facilitates the development of self-assessment and helps students stay focused on the task. In addition, the interactive feedback with multiple attempts available encourages students to test themselves and immediately rethink the reasoning and correct themselves.

# 4 METHODOLOGIES

The training module proposed to analyze the characteristics of the INVALSI math tests in order to create activities with automatic formative assessment for developing mathematical skills. The three dimensions of mathematical competence evaluated by the INVALSI tests were analysed (knowing, solving problems and justifying) through the creation of examples of questions for grade 8, 10 and 13. The course did not require prerequisites and was open to all teachers of the PPS Community, to those who already had experience with the automatic assessment system and to those who had never used it. The duration of the course was 4 weeks and included 4 one-hour synchronous online meetings, carried out through a web conference service integrated with the platform of the Project. In the following months, the teachers were asked to create 3 questions with automatic assessment: one designed to assess knowledge, one for solving a problem and one for justification. In particular, the teachers could choose a question with standardized assessment and modify it in a question with formative assessment, reflecting on how the transformation was carried out. After that, the teachers experimented the questions with students in one of their classes and shared the questions with the PPS Teacher Community. The video recording of the online meetings was also made available to all the teachers of the Community.

To understand the appreciation of the training module and to see how the teachers dealt with the process from the standardized to the formative assessment, we analyzed the questions created by the teachers and the answers to the two questionnaires. The teachers were asked to answer the initial questionnaire at the end of the four synchronous online training meetings. In this questionnaire the teachers were asked if they had already used the automatic assessment system, if they liked different aspects of the training course and the proposed methodologies and which aspects according to them are favored by the use of the automatic formative assessment with students. The teachers also had to explain in detail the questions created for the formative assessment and the class of students chosen for testing the activities created.

For each question, the teachers had to indicate:

- The dimension of the question (knowing, solving problems or justifying);
- The title of the question in the AAS;
- The main goal of the question;
- The topic of the question;

- The material from which they took inspiration for the creation of the question (from an INVALSI question, from a textbook, from the internet, from none of these because they invented the question);
- The strategies adopted to adapt the question to the automatic formative assessment.

After making the students carry out the activities they created, the teachers had to answer a final questionnaire. In this questionnaire, the teachers were asked to explain the activity carried out with the students. In particular they had to describe:

- Where the activity was carried out by students (in the classroom, in the in the computer lab of the school or at home);
- Which students were involved (all students or only some of them);
- Students' appreciation of the activity;
- Difficulties reported to the students;
- Changes made to the activities after the experimentation;
- The aspects favored by the use of the automatic formative assessment with students.

To carry out the analysis, a group of experts (the group of researchers who conducted the analysis) examined all the 51 questions and classified them according to the characteristics described by the teachers (size, main topic and main objective, etc.) and according to the completeness of the question, the number of sub-questions for adaptivity and the type of register required of students. For each category and sub-category the various parts of each question and the types of response areas chosen by the teachers were discussed, to reason about the possible difficulties that the teachers had (both in the transition from a question for standardized assessment to a question for formative assessment and in the use of the automatic assessment system). For each dimension, the strategies used by the teachers to adapt the question to the formative assessment were collected and analyzed.

Then an example of question was chosen for each dimension, which was more exemplary of all the questions created by the teachers.

# 5 RESULTS

## 5.1 General Overview of the Participants in the Module and the Activities Carried out

17 teachers from the PPS Community, one from the lower secondary school and all the others from the upper secondary school, took an active part in the course. 70% of teachers had already taken a course on the use of an automatic assessment system and 65% of teachers had already used it with a class or group of students. The typology of institute in which the teachers teach was very varied: Linguistic High School, Industrial Technical Institute, Scientific High School, lower secondary school, Technological-Electro-technical Institute, Classical High School. The subjects taught by the teachers are: mathematics (59%), mathematics and physics (24%), mathematics and computer science (12%) and mathematics and sciences (6%).

The teachers created three questions each for a total of 51 questions, one for each dimension. They used several sources to choose the standardized assessment question to be transformed into the formative assessment question: an INVALSI question (37%), an exercise/problem found on a textbook (37%), an exercise/problem found on internet (6%), an exercise/problem found in the Maple TA repository of the PPS (10%). In the remaining 10% of cases, the teachers directly created a new question.

Regarding the dimension of "knowing" the strategies they used to adapt the question to the formative assessment were:

- After a first closed-ended question by inserting an adaptive section in which, in the event of an incorrect answer, the student is guided in the resolution procedure;
- Creating an algorithmic question so that you can carry it out several times with different data;
- Inserting a final feedback that allows students who have made mistakes to understand them and to correct themselves;
- Making an algorithmic multiple choice question to bring out the most common misconceptions about a topic;
- Inserting multiple areas of answers to understand different aspects.

In the dimension of "solving problems" the strategies that the teachers used to adapt the question to the formative assessment were:

- Asking questions with different registers (tracing a graph, filling in a table and inserting a formula);
- Contextualizing the problem in a real situation;
- Making the question algorithmic;
- Setting up computations to recognize the correct solution process in a multiple choice question and adding a guided path in case of errors;
- Guiding the student in the resolution in the event that students do not immediately respond correctly;
- Using an adaptive question to help students who cannot solve the problem by guiding them step by step to the final solution.

In the "justifying" dimension, the strategies that teachers used to adapt the question to the formative assessment were:

- Inserting after a closed-ended question a question with gaps in the text with missing words to choose from a list;
- Giving students the opportunity to rephrase their justification after seeing the correct answer;
- Developing a theoretical reasoning step by step;
- Realization of a demonstration by inserting various multiple choice questions;
- Adding to an open answer the possibility to draw the graph of the solution.

We asked the teachers how useful the various tools proposed were for the creation of the questions. Table 1 shows the responses of the teachers on a scale from 1="not at all" to 5="very much".

Table 1: Tools used by teachers for creating questions.

| | |
|---|---|
| Explanations followed during online meetings | 4.8 |
| Notes taken during online meetings | 4.5 |
| Videos of online tutoring | 4.6 |
| The material available on the platform on the use of Maple TA | 3.9 |
| INVALSI site | 3.9 |
| INVALSI tests archive (https://www.gestinv.it/) | 3.6 |
| Other materials found on the internet | 3.0 |
| Tutor support via forums | 3.8 |
| Support from other teachers via forums | 2.9 |

## 5.2 Examples of Questions Created by Teachers

### 5.2.1 Dimension of Knowing

In the following example, adaptation of questions designed for standardized assessment to questions for formative assessment is done in several ways. For the creation of the question, the teacher took inspiration from an exercise/problem found in the Maple TA repository of the PPS. In the starting question (Fig. 4), students were simply asked to enter the equation of a line.

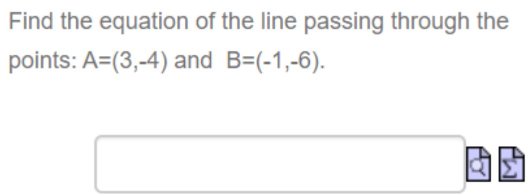


Figure 4: Example of question for standardized evaluation of the dimension "Knowing".

The student can find the equation of the line in many different ways and using different representation registers (formulas, graphs, tables, etc.). At the end of the reasoning, in this type of question, students insert only the final equation they have found. In this case, an incorrect answer does not provide the teacher with precise information on the nature of the student's difficulty. At the same time, the simple "wrong answer" feedback does not give students information about their mistake and how to overcome it.

In the question created by the teacher, the request is divided into two sub-questions. In the first part (Fig. 5), the student must insert the equation of the straight line passing through two given points, however having two attempts available. By clicking on the "verify" button, the student can know if the answer entered is right or wrong. In case of wrong answer, the student can reason again to the question and try to give a new answer.

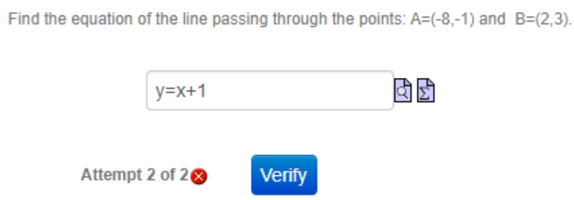


Figure 5: First part of the example question of the dimension "Knowing".

If the answer is correct, the question ends. In the case of an incorrect answer, a two-step guided path is proposed to students to review the necessary theory and correctly answer the question (Fig. 6). Students next to the response area also have a button to preview the inserted answer and an equation editor to insert it.

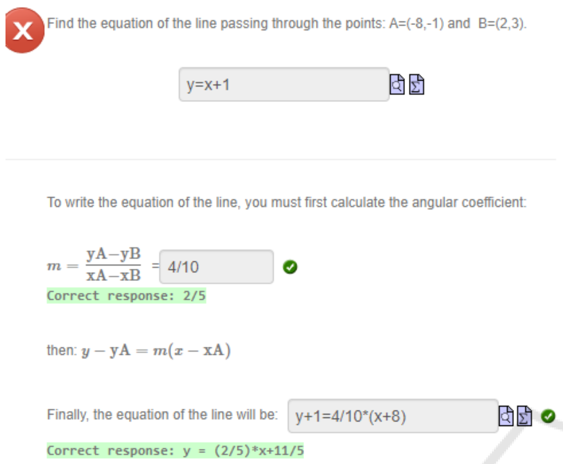


Figure 6: Second part of the example question of the dimension "Knowing".

Finally, the question has been made algorithmic, randomly varying the coordinates of the given points. In this way the student can try to answer several times and each time the points and the straight line passing through them will be different. Automatically the student has a lot of exercises with interactive and immediate feedback to practice.

### 5.2.2 Dimension of Solving Problems

The following question proposes a contextualized problem of solid geometry. For the creation of the question, the teacher took inspiration from an INVALSI question, shown in Figure 7. The main objective of the question was to calculate the area and volume of the most common solid figures and to give estimates of objects of daily life.

Compared to the starting question, the teacher added the total surface of the peeled jar as a second request and gave the possibility of having three attempts to answer (Fig. 8). The goal of the question has become to calculate the volume and the the total surface of a cylinder. The strategy adopted to adapt the question to the automatic formative assessment was to make the question algorithmic and insert the request to calculate the total area. The question was created to guide the student in the resolution.

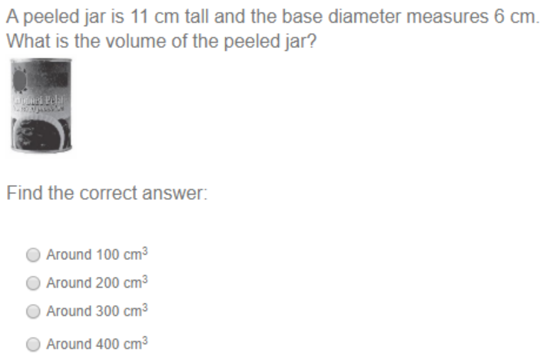


Figure 7: INVALSI question of solid geometry.

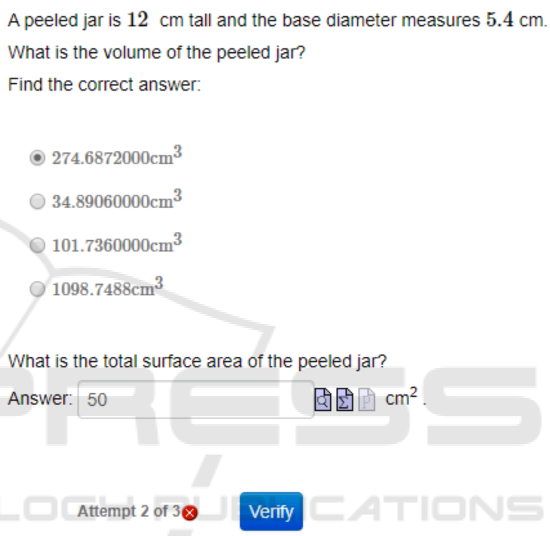


Figure 8: First part of the example question of the dimension "Solving problems".

After this first part, regardless of the correctness of the answer entered by the student, the student is guided in solving the problem (Fig. 9), through the use of different response areas (numerical value, drop-down menu or multiple choice).

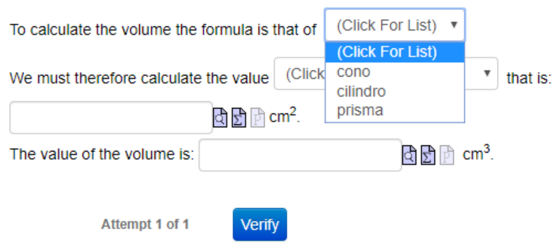


Figure 9: Second part of the example question of the dimension "Solving problems".

The student can reflect on the correct answer and review the theoretical contents. Each phase of the procedure is characterized by immediate and interactive feedback so that the student remains focused on the task and is more motivated to move forward. This type of question helps clarify to students what good performance is and offers opportunities to bridge the gap between current and desired performance. The question is algorithmic so students can try to answer several times and each time the data of the problem are different. In this way, students can practice several times and consolidate a resolution strategy.

### 5.2.3 Dimension of Justifying

The following question proposes an exercise concerning the tessellation of the floor, with tiles having different shapes represented by regular polygons. For the creation of the question, the teacher took inspiration from an exercise/problem found on a textbook and used an adaptive question to lead students to the correct answer by following relevant steps.

In the first part of the question, students must identify which is the regular polygon with the smallest number of sides that cannot be used for tessellation and enter the correct name in the text box. Then they must follow a guided path to justify the correct answer (Fig. 10).

The path for a guided demonstration is divided into three parts, in which the student must deal with different types of requests and different response areas (multiple choice, number values, choice from a list). Students have only one attempt available for each answer. The same path is shown to students who answer correctly or incorrectly. However, if the students answer incorrectly, they are shown the correct answer through interactive feedback. In this way students can rethink the reasoning done and reason correctly on the next request. This type of question can be very useful to train students to justify an answer by proposing a possible method. Finally, it can be very useful to alternate this type of question with open-ended questions where the student is asked to justify an answer and reason freely.

## 5.3 Observations on Experimentation with Students

Analyzing the responses of the teachers to the questionnaire requested at the end of the experimentation with students, it emerged that students carried out the activity mainly in the computer lab of the school (47%), in the second case at home (35%) and finally in class with mobile

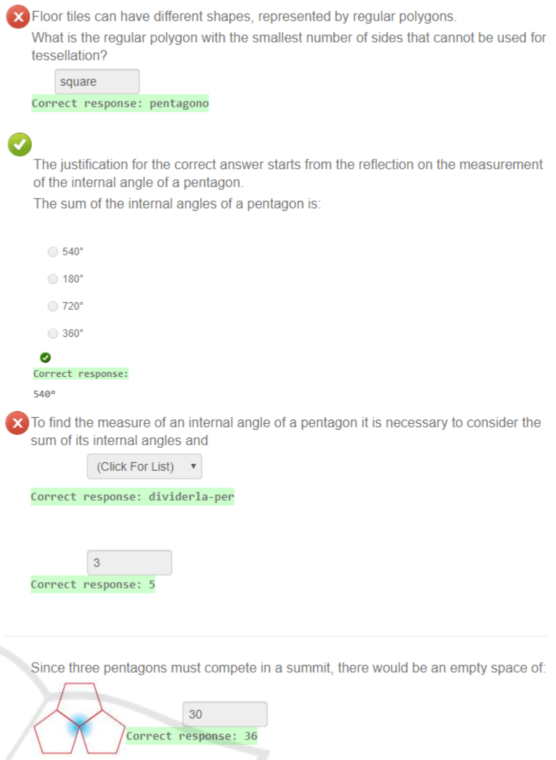


Figure 10: Example question of the dimension "Justifying".

devices (18%). In almost all cases (94%) the activity was carried out individually by students and not in groups and was mandatory for all students.

The activity with students gave the teachers the opportunity to receive very useful feedback and to reflect on the prepared activities. Half of the teachers said that at the end of the experimentation with students they would modify the proposed questions: by modifying the text of the question; adding explanations on how to answer; making the questions more accessible by proposing exercises for level groups (basic, intermediate and advanced); changing the methods of administration not as self-employment at home but as a compulsory classroom activity.

In some cases, the teachers said that students had some difficulty in carrying out the activity. They were of different types. In some cases, students encountered technical difficulties in using the technology or in using the automatic assessment system (because they used it for the first time or because they did not read the instructions correctly) and in others, they encountered difficulties in correctly interpreting requests.

### 5.4 Teachers' Observations on the Training Module

The teachers liked the contents and methodologies proposed within the training module very much. Table 2 shows the teachers' evaluations in different aspects of the module, on a scale of "1 = not at all" and "5 = very much".

Table 2: Satisfaction of teachers on the training module.

| | |
|---|---|
| Clarity of explanations | 4.9 |
| Adequacy of the themes | 4.8 |
| Completeness of the justifications | 4.6 |
| Method of conducting the course | 4.8 |
| Opportunity to interact with the tutor | 4.9 |
| Usefulness of the materials left available on the platform | 4.9 |

88% of the teachers said they were satisfied with the training module and believed that it offered interesting ideas for educational activities. All teachers would recommend the attendance of this training module to a colleague.

Teachers were asked how much they believe that the use of automatic formative assessment with its class can favor students with different aspects reported in Table 3. The teachers had to answer with a value on a scale of 1 to 5, where 1 = "not at all" and 5 = "very much".

Table 3: Aspects promoted by the use of automatic formative assessment for students.

| | |
|---|---|
| Review knowledge | 4.6 |
| Understand the contents | 4.2 |
| Develop problem solving strategies | 4.4 |
| Develop autonomy in problem solving | 4.4 |
| Develop justificatory skills | 4.1 |
| Opportunity to practice for tests | 4.6 |
| Possibility to practice for the INVALSI tests | 4.7 |
| Facilitate study autonomy | 4.2 |
| Promote metacognitive reflection | 3.9 |
| Promote student involvement in learning | 4.1 |
| Increase students' awareness of their abilities | 4.2 |
| Understanding mistakes | 4.2 |
| Increase motivation for the subject | 3.8 |
| Inclusion of students with BES / DSA | 4.1 |
| Student empowerment | 4.1 |
| Personalization of educational activities | 4.0 |

The values shown in table 3 are all higher than 3.8. This means that teachers believe that the use of automatic formative assessment can be an effective methodology for students, favoring multiple aspects. According to the teachers, among the aspects most promoted by the use of automatic formative assessment for students there are the possibility of developing problem solving skills, the possibility of reviewing the theoretical contents, and the possibility of practicing for math test and for the INVALSI test.

Finally, teachers were asked how much they believe that the use of automatic formative assessment with the class can favor teachers with the different aspects reported in Table 4.

Table 4: Aspects promoted by the use of automatic formative assessment for teachers.

| | |
|---|---|
| Quality of teaching materials | 4.4 |
| Greater attention to the activities proposed to students | 4.3 |
| Professional development | 4.5 |
| Greater understanding of student difficulties | 4.4 |
| Control of student activities | 4.7 |

Also in this case the values shown in table 4 are all higher than 4.3. This means that teachers believe that the use of automatic formative assessment can be an effective methodology also for teachers themselves. In particular, its use can be useful to have quality feedback on the activities carried out by students, to better understand their difficulties and to intervene with activities adapted to their needs. Further aspects identified by the teachers were:

- Greater reflection by the teacher on the content of the questions and on the way they are proposed;
- Make choices that respect the different learning styles of students, in consideration of the possibility of formulating questions of different types;
- Promote a collective discussion and dialogue lessons;
- Increase student engagement at home;
- Organize didactic activities that facilitate the students' different learning styles.

## 6 CONCLUSIONS

Our training module allowed the teachers to reflect on the characteristics of the formative assessment and on the adaptation of questions designed for standardized assessment to questions for formative assessment. Through the use of an automatic assessment system, they designed and transformed questions for standardized assessment into questions for formative assessment, reasoning about the didactic context, the topic and the objective of the application. Then they asked students to answer the questions and reflected on the activity carried out in the classroom. The teachers reflected on the aspects favored by the proposed methodologies, for students and for the teachers themselves. At the end of the module, the teachers shared the material created with all the teachers of the PP&S community so that everyone could use them and discuss them.

The teachers who participated in the training module appreciated the proposed contents and methodologies very much. They believe they have received enough tools to work independently with an automatic assessment system. The teachers are satisfied that they have experienced the activities created with students and all the teachers will continue to use the automatic assessment system during the school year with students.

The teachers believe that the use of an automatic formative assessment system can have important advantages for students, for example for the development of skills, for reviewing and for preparing for tests. There are also significant advantages for teachers, in particular for understanding the difficulties and needs of students and for proposing adaptive teaching. The importance of immediate and interactive feedback, in the proposed methodology, is essential for both students and teachers.

Certainly students may have technical difficulties in using the automatic assessment system and in particular in inserting the correct syntax. However the rigidity of technological tools can educate them to read the instructions carefully. Furthermore, it is very important that students learn to use technologies also for educational purposes. It can therefore be very important to increase the training of teachers on the use of an automatic assessment system for formative assessment and to train students to use this tool.

This type of training activity can be further developed by collaborating with the teachers in carrying out the activities in the classroom with students, in order to support them and to directly receive students' feedback on the proposed activity.

The use of automatic formative assessment supports adaptive teaching. This type of methodology supports adaptive teaching. Through the development of recent big data theory and learning analytics (Barana et al., 2019), we think it may be possible in the future to propose an adaptive educational system (AES), that uses data about students, learning processes, and learning products to provide an efficient, effective, and customized learning experience for students.

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