THE SCHOOL AND ITS PROTAGONISTS: THE TEACHERS

V Seminar "INVALSI data: a tool for teaching and scientific research"

Edited by
Patrizia Falzetti

FrancoAngeli

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Index

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Introduction

by Patrizia Falzetti

The educational system is directly related with the issue of the quality of life with its processes regarding the person, the citizen, and the worker.

INVALSI is part of the Evaluation National System and has got a crucial role not only because it systematically and regularly makes standardized tests on students' skills and abilities but also because it helps school-principals and teachers to improve their knowledge about evaluation and self-evaluation tasks.

Teachers are essential in the learning process: at first, they are facilitators, thanks to their emphatic abilities, expert in building successful and fruitful relationships and in creating a context of cooperation, in order to promote a harmonious development of each student and a peaceful learning environment.

This book collects some papers submitted during the V edition of the Seminar "INVALSI data: a tool for teaching and scientific research" and it talks about the training of teachers.

Authors of the first chapter will tell us about an interdisciplinary research project aimed at identifying teachers' training needs in the Italian context and at suggesting some guidelines to improve teaching practices.

The second chapter is addressed to prospective primary school teachers. Here, authors will present a research about the gap between Maths INVALSI tests and teaching/learning practices in Italian schools.

In chapter three, authors will propose the MEL Model (Modello per l'Educazione alla Literacy, that is Model for Literacy Education), useful for teachers and all stakeholders training about reading literacy to gain all necessary knowledge to support students and help them to become expert readers.

Finally, the research of chapter four will focus on the material design provided for an English training addressed to upper secondary schools.

Papers collected in this book are a limited and non-exhaustive example of the utility of INVALSI data. Year by year, the catalogue of the open-access series “INVALSI PER LA RICERCA” has been greatly enriched as further confirmation of a worthwhile mutual dialogue between academics and school actors. As Statistical Service we hope this partnership could last and may generate many other research works.

1. An exploratory study on the connection between INVALSI assessment and Mathematics teaching-learning processes at the Primary School level

by Eleonora Faggiano, Annarita Monaco,
Ottavio G. Rizzo, Valentina Vaccaro*

In this paper we present an interdisciplinary research project aiming at identifying the teachers' training needs at national level and to propose guidelines for the improvement of teaching practices, regarding the use of Mathematics INVALSI standardized tests. In order to study the connection between INVALSI assessment and Mathematics teaching-learning processes at Primary School level, a survey was designed and administered to a total sample of 526 primary school teachers. Early results of the survey are presented and discussed showing the existence of a meta-didactical conflict concerning discourses about didactical processes like assessment, students' abilities and mistakes, etc.

In questo lavoro si presenta un progetto di ricerca interdisciplinare volto a identificare i bisogni formativi degli insegnanti a livello nazionale e a proporre linee guida per il miglioramento delle pratiche didattiche, riguardanti l'utilizzo delle prove INVALSI di Matematica. Al fine di studiare la connessione tra la valutazione INVALSI e i processi di insegnamento/apprendimento della Matematica nella scuola primaria, è stato progettato e somministrato un questionario a un campione di 526 insegnanti di scuola primaria. Vengono presentati e discussi i primi risultati del questionario che mostrano l'esistenza di un conflitto meta-didattico riguardante i discorsi sui processi didattici come la valutazione, le capacità e gli errori degli studenti ecc.

* The authors are grateful to the other members of the SIRD Research Group on INVALSI – Didactics and Disciplinary Knowledge: Ira Vannini (general didactics coordinator), Ferdinando Arzarello (math education coordinator), Barbara Balconi, Giorgio Bolondi, Federica Ferretti, Daniela Maccario, and particularly among them to Violetta Lonati for her contribution to the writing of this paper.

1. Introduction

Data from Large Scale Assessment (LSA) can be considered as tools that teachers can use in a systemic perspective for the design and implementation of meaningful teaching and learning activities. Moreover, teachers can use data from LSA to give back to students, through the practice of formative assessment, detailed information on their learning. This use can also encourage students to develop meta-cognitive skills about various components of the learning process (Hanna, David and Francisco, 2010). This is also true, in our view, for the Italian standardized assessment program developed by the INVALSI Institute. A series of macro-phenomena has emerged in the Italian school system as a consequence of the INVALSI standardized tests: these macro-phenomena are connected not only to the disciplines, but also to disciplinary teaching, and more generally to educational aspects, which are connected also to the school and to the teachers' evaluation culture. In particular, the INVALSI standardized assessment program has provoked and provokes a series of research questions and issues concerning: the reading and interpretation of data; the analysis of teachers' training needs; the analysis of how the two variables listed above may affect the teachers' attribution of meaning to the various INVALSI items.

An interdisciplinary research project was started in 2017 highlighting the need to interpret the above-mentioned complex phenomena, with the aim of identifying the teachers' training needs at national level and to propose guidelines for the improvement of teaching practices, regarding the use of Mathematics INVALSI items. The project is conducted by the "INVALSI Group – Didactics and Disciplinary Knowledge" of the SIRD (Italian Society for Educational Research) on general education and disciplinary education, composed of disciplinary experts and pedagogists. Among the various elements to be analyzed, there are undoubtedly factors related to the perceptions and opinions of teachers that can facilitate or inhibit the didactic impact of the tests. A crucial interest is therefore the understanding of the attitude and meanings that teachers attribute to the INVALSI assessment. This contribution shows the first results of the project aimed at investigating, through the voice of teachers, the link between the INVALSI Math assessment and the Mathematics teaching-learning processes at Primary School level.

2. The research project

Since the beginning, the goal of the mixed group of researchers involved in the project was to start an exploratory study to investigate the meaning that

teachers attribute to the INVALSI items. Indeed, these items rarely appear to be used to implement formative assessment. With this purpose, researchers agreed to build a research tool through which investigating the perceptions of Mathematics primary teachers with respect to the INVALSI tests.

The tool – that will be described below – is a survey that was firstly administered to 105 teachers (Try Out). This initial phase made it possible to test the questions in the survey. The survey was then partially modified, based on the analysis of the data collected with the Try Out. The revised version of the survey was administered to 427 teachers (Main Study). In this paper we used only the data relating to the Main Study which has a total of 421 valid cases. Data collected in the two campaigns were encoded and analyzed using a statistics software for data analysis (IBM SPSS Statistic 27). Early results of this analysis are presented and discussed below.

3. Terminology

In order to avoid any possible confusion, the following conventions in the use of terms are established.

An INVALSI standardized *test* is composed of *items*, some items may be subdivided into *parts*, *students answer* to the items, eventually choosing among *options*, and the national-wide results constitute INVALSI *national data*.

Our survey, on the other hand, is based on a *questionnaire* composed of *questions* (we will use the notation Q*n* to refer to the *n*th question), usually composed of *options* or *ranking scale*, to which survey *participants* gave *responses*.

4. The research tool

The purpose of the empirical, descriptive and correlational survey was to analyze the knowledge, teaching experiences and beliefs which primary school teachers have and use to read and interpret Math INVALSI items and data. Specifically, the aim of the survey is: to investigate the beliefs of teachers regarding the knowledge and skills detected by the INVALSI standardized tests; to explore the proximity/distance between the functions and contents of the INVALSI items, on the one hand, and beliefs and statements about the teaching practices of teachers, on the other hand. In order to specify the different research variables we were interested in, and the research hypothesis concerning the relationships among the variables, we built the framework in figure 1.

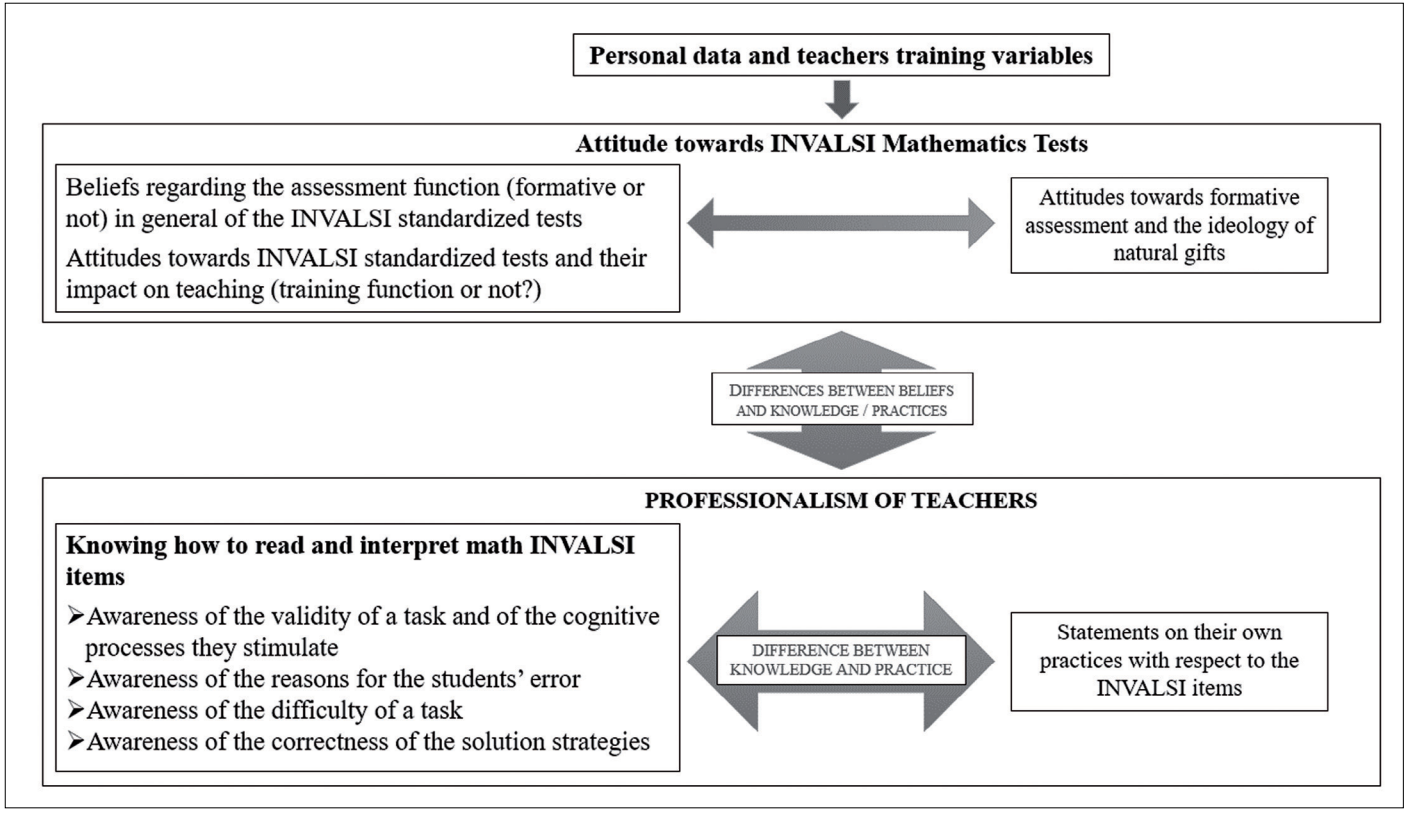


Fig. 1 – The research variables framework on which the survey is based

According to the research variables framework, the questionnaire consists of the following three sections:

– one concerning Mathematics education (how teachers interpret the INVALSI items and their results);
– one relating to aspects of general education (which beliefs and attitudes teachers have and how they pour them into teaching practices);
– one that collects personal data and context information.

In the first section, seven INVALSI items of grade 5 or 6 are presented in their original formulation. For each of them, questions are proposed aimed at detecting the pedagogical knowledge of the Mathematical content – the so called Pedagogical Content Knowledge (Shulman, 1986) – by the teachers (misconceptions, recurring errors, level of difficulty). In addition, comparative questions are proposed on the proximity/remoteness of the seven items from teaching practices and National Guidelines (Indicazioni Nazionali, 2012; Italian Ministry of Education, 2018) and on the effectiveness of the considered INVALSI items in assessing certain skills.

The second section proposes three sets of questions regarding: the opinions of teachers on the INVALSI assessment program; the educational usefulness of the INVALSI items; the didactic practices connected to the INVALSI items; the attitude towards the ideology of natural gifts (Ciani and Vannini, 2017).

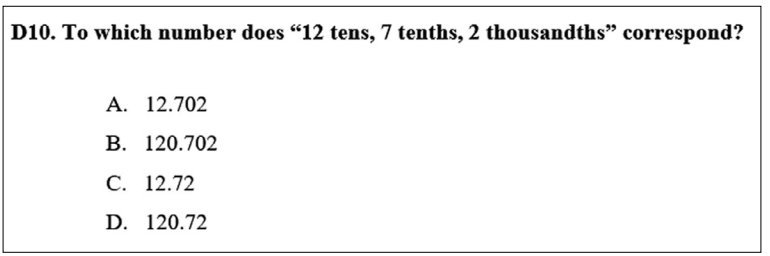
The data collected in the third section relates to professional training as well as personal data. For example, we asked teachers to indicate: how many years they have been working as teachers; how long they have been teaching in the current school; how long they have been tenured, if any; which administrative duties they perform in their school, if any, etc.

5. Early results

First of all, thanks to the analysis of the third section of the questionnaire (personal data and context information) it is possible to outline the characteristics of the sample: 68% of the participants were invited to fill in the questionnaire by their School Headmaster; 71% of the participants teach in Piemonte or Emilia-Romagna (two northern regions, which constitute together 15% of Italian population); 90% of the participants are tenured teachers; 21% of the participants actively participate in the school administration (members of the senior leadership team). Although the sample, albeit large, cannot be considered to be representative, the data collected provide us with a wide range of different information to reflect on.

Herein we present some early results of teachers' responses to the first section of the questionnaire. INVALSI items and survey questions were translated by the authors from Italian into English.

To give a first insight into the richness of information gathered through the questionnaire, we start dealing with an INVALSI item (figure 2) that in 2009 resulted to be quite a difficult item for 5th grade students: indeed, only 33% of Italian students gave the correct answer.


D10. To which number does "12 tens, 7 tenths, 2 thousandths" correspond?

A. 12.702
B. 120.702
C. 12.72
D. 120.72

Fig. 2 – Item 10, grade 5 Mathematics INVALSI test (2009) (authors' translation)

We were interested in investigating teachers' understanding of the difficulty of this item. For this purpose, without informing participants about the percentage of the correct answer given by the students, we asked: *Q6. On a 1 (very easy) to 10 (very difficult) ranking, how difficult do you think the item is for 5th grade students?*

As it can be seen in figure 3, 79.5% of the teachers estimated the difficulty to be at most 5, hence, although the item required to manage a non-trivial conversation transformation between two different semiotic registers (Duval, 1993), we can say that this item was not considered to be a difficult item.

This result confirms what was found in the Try Out (Arzarello and Ferretti, 2021): teachers' perception of students' difficulties does not correspond to the INVALSI national data. Despite this discrepancy, results also confirm that, among the seven items used in the questionnaire, the item in figure 2 is the one which is considered the "most suitable for assessing learning" (with 86.2% of the teachers which evaluate its suitability ranking it 3 or 4 out of 4) and one of the "most commonly used in assessment tests" (with 87.6% of the teachers which state to use this type of item in their assessment tests – ranking it 3 or 4 out of 4 in the relevant question). At a meta-didactical level, this reveals an apparent inconsistency that is under investigation with quantitative and qualitative methods.

Another example of the questions in the survey is the one concerning the INVALSI item in figure 4.

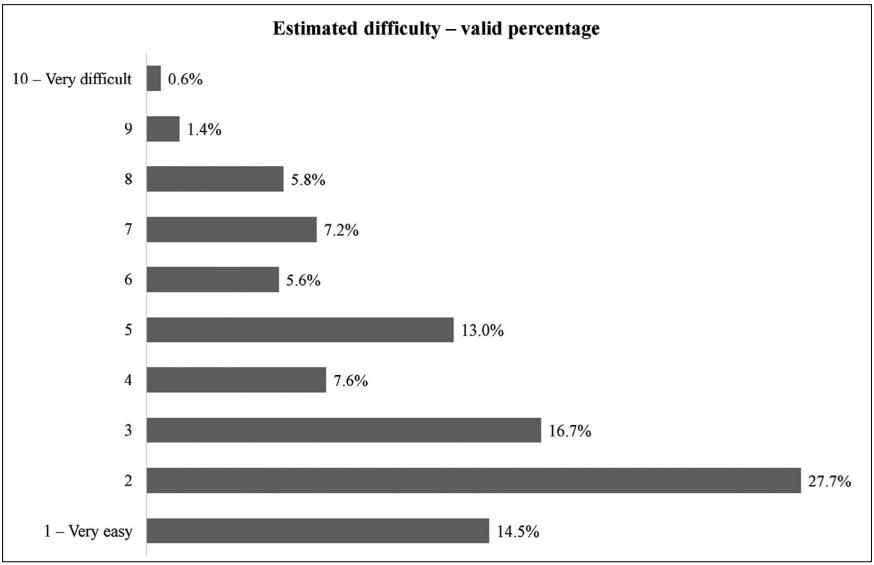


Fig. 3 – "How difficult do you think the question [in figure 2] is for 5th grade students?"

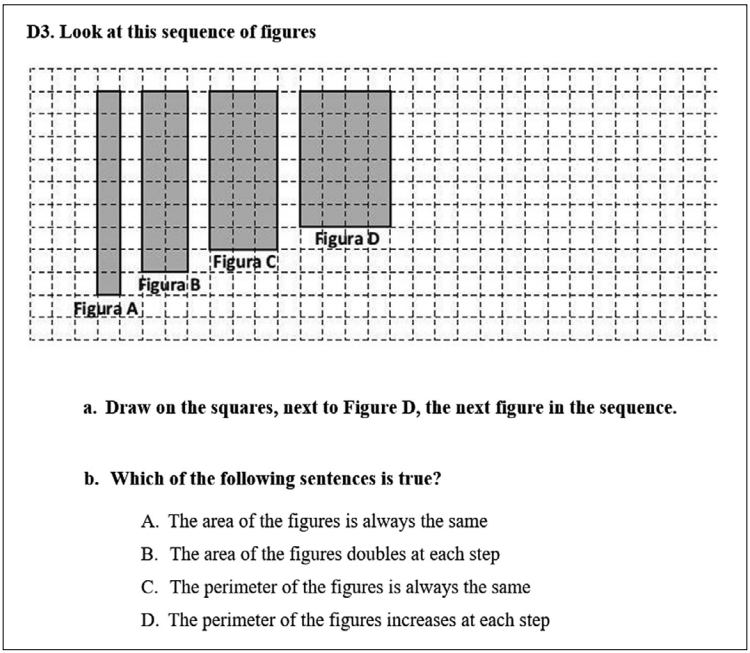


Fig. 4 – Item 3, grade 6 Mathematics INVALSI test (2012) (authors' translation)

At each step the altitude is reduced by one while the width increases by one, so the perimeter stays the same, therefore the correct answer is "C". According to the nation-wide results, 85.8% of the students correctly drew the next rectangle in the sequence. This shows that it is clear (at least in an intuitive way) what happens to the altitude and the width of the rectangles at each step of the sequence. The fact that more than half of the students that passed part "a" failed part "b" indicates that the issue at stake is the common misconception that areas and perimeters should behave in the same way (see, for example, Fandiño-Pinilla and D'Amore, 2006).

However, literature (e.g. Jacquet, 2000; D'Amore and Fandiño-Pinilla, 2005) shows that the building of a satisfactory knowledge of the relationship between perimeter and area has not only an epistemological nature but also a didactical and cognitive nature. The didactical nature has been investigated by Jacquet (2000), D'Amore and Fandiño-Pinilla (2005). The cognitive nature can be framed within what Stavy and Tirosh (1999, p. 59) call the "sameA-sameB" intuitive rule, used by students of different ages, who are asked to make comparison tasks. For this reason, in order to understand teachers' awareness of the origin of student errors, we asked participants to give their interpretation of the nationwide results in the item. In particular, we asked them (Q3) to choose one of the reasons why, although 85.8% of the students answered correctly to part "a", only 35.7% of the students correctly chose "C" in part "b", while almost the same number chose "D".

During the design of the questionnaire, we chose the following particular options to recognize different approaches by the teachers:

– "Pupils do not pay attention while reading the text": we consider this as a boilerplate answer that we expect to be chosen by a teacher not knowledgeable of the didactical and epistemological issues at play;
– "Pupils do not know area and perimeter formulae well": we can assume that most 5th grade students have a working knowledge of computing areas and perimeters of such rectangles (it is drawn on square paper, so it suffices to count the squares and make a simple sum or multiplication!), but on the other hand the item does not ask for any explicit numerical result. Hence, we hypothesize that teachers who choose this option reduce the idea of "perimeter" and "area" to the computation of their values using the appropriate formulae, instead of considering the more general geometrical concept involved in the question;
– "Pupils are led astray by the picture": this option is very similar to the first one but might be chosen by teachers who recognize that the item is about geometry;

– "Pupils believe that the area increases while the perimeter increases": this is the answer we expect from a teacher aware of the didactical and epistemological issues at play.

Table 1 shows how participants answered to Q3. It can be seen that only 21.5% of the teachers recognize that the reason for students' error is connected with the misconception that areas and perimeters should behave in the same way.

Tab. 1 – Distribution of the teachers' choices in answering Q3

	Options	*Percent*
1	Pupils do not pay attention while reading the text	34.2
2	Pupils do not know area and perimeter formulae well	2.1
3	Pupils are led astray by the picture	32.7
4	Pupils believe that the area increases while the perimeter increases	21.5
5	Other	9.5

Further elements are unveiled analyzing teachers' responses to the next two questions of the survey regarding the INVALSI Item in figure 4: the first (Q4) was meant to investigate teachers' awareness of the suitability (on a 1 – not at all – to 4 – completely – ranking) of the item in order to assess students' learning at 5th grade; the second (Q5) aimed to know to what extent (on a 1 – never – to 4 – regularly – ranking) teachers' claim to use this kind of item in their ordinary assessment test. Percentage of responses are shown in table 2.

Tab. 2 – Teachers' responses to Q4 and Q5 with respect to the INVALSI item in figure 4

Q4: How suitable do you find the item to assess students' learning of your 5th grade students?		*Q5: How often do you use this kind of items in your assessment tests?*	
Rank	*Percent*	*Rank*	*Percent*
1 (Not at all)	4.8	1 (Never)	8.6
2	24.5	2	37.3
3	47.3	3	47.9
4 (Completely)	23.4	4 (Regularly)	6.3

As it can be seen in table 2, although 23.4% of the teachers considered the item completely suitable to assess students' learning, the percentage of the teachers who declared to regularly use this kind of items in their classroom assessment tests is limited to 6.3%.

Using the Spearmans' Rho we also analyzed the correlation between Q4 and Q5: the SSPS computation returns a correlation coefficient of 0.485 with 0.01 significance. In other words, teachers state they use the kind of item consistently with how much they deem it suitable to assess students' learning. On the other hand, as it could be expected, there is a very good correlation between perceived suitability and declared use in the classroom.

Finally, we consider worthy of note the participants' answers to one of the questions of the second section of the questionnaire, when the overall results are compared with those obtained restricting the sample to the 21.5% of the teachers that recognized the reason of students' error. Table 3 shows that the percentage of the teachers who completely agreed with the claim that "analyzing INVALSI items can help teachers understand which Mathematics learning aims are to be achieved" increases from 22.2% to 33.7% if we look at those teachers that answered by choosing option "4" to Q3.

Tab. 3 – Participants level of agreement with the claim: "analyzing INVALSI items can help teachers understand which Mathematics learning aims are to be achieved"

Level of agreement	*Frequency (participants who answered "4" to Q3)*	*Valid percent*	*Valid percent of the whole sample of participants*
1 – Completely disagree	5	5.1	8.0
2	20	20.4	23.8
3	40	40.8	46.0
4 – Completely agree	33	33.7	22.2
Missing	15		

The final example we present in this paper is the one concerning the INVALSI item in figure 5.

According to the nationwide results, only 51.5% of the students were able to answer the item correctly, drawing a line perpendicular to the side AB. The difficulty of drawing the altitude of a triangle drawn in a non-standard position is well known in literature (Gutierrez and Jaime, 1999): 5th grade students are known to believe that altitudes have to be vertical, and that, even if they appear to satisfy the formal definition, "if I want it to become an altitude, I must turn the book and put it straight" (translated by the authors from Martini and Sbaragli, 2005); this phenomenon could be explained by the fact that books and teachers almost constantly show vertical altitudes and this "overexposure to prototypes may impede the growth of fuller concept acquisition" (Tsamir, Tirosh and Levenson, 2008).

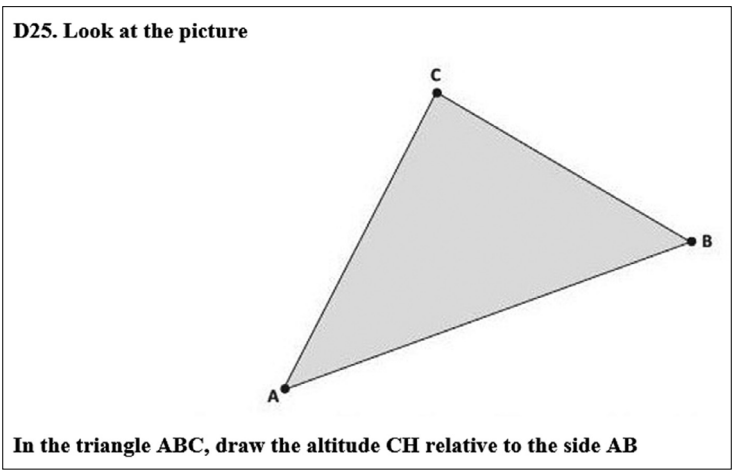


Fig. 5 – Item 25, grade 6 Mathematics INVALSI test (2012) (authors' translation)

Understanding teachers' awareness of the origin of student errors is, in this case, even more important since when a teacher proposes a strong persistent and convincing image, the image turns into an intuitive model and, the stronger the intuitive model, the more difficult it is to break it to accommodate a new image (Martini and Sbaragli, 2005). We should not discount either that such a misconception is rooted in a teacher's deficiencies in Mathematical Content Knowledge (Shulman, 1986), that "modern teacher training is slowly (and partly!) fighting" (Alatorre and Sáiz, 2010).

Similarly, to the previous item, we asked the participants to give their interpretation of the nationwide results in the item. In particular, we asked them (Q15) to explain why only 51.5% of the 6th grade students were able to answer correctly.

During the design of the questionnaire, we choose these particular options to recognize different approaches by the teachers:

– "Pupils do not pay attention while reading the text": we consider this as a boilerplate answer that we expect to be used by a teacher not knowledgeable of the didactical and epistemological issues at play;
– "Pupils do not know the definition of altitude of a triangle well": we expect that a teacher that chooses such an option just pieced together the keywords "altitude" and "correctly". The examples presented by Martini and Sbaragli (2005) show that children who know a correct definition of altitude could nevertheless require it to be vertical;
– "Pupils are led astray by the picture": we hypothesize that the teacher that gives such an answer has clearly some insight into the epistemological

and didactical issues at stake; but, given the following and much more specific option, we also expect that such a teacher has not fully connected these issues with the misconception of "vertical" altitudes;

– "Pupils think that the altitude should be vertical": this is the answer we expect from a teacher who is aware of the didactical and epistemological issues at play.

In table 4 we present the distribution of the teachers' choices in answering Q15.

Tab. 4 – Distribution of teachers' choices in answering Q15

	Options	*Percent*
1	pupils do not pay attention while reading the text	8.2
2	pupils do not know the definition of altitude of a triangle well	21.5
3	pupils are led astray by the picture	28.8
4	pupils think that the altitude should be vertical	34.6
5	Other	6.8

It can be seen that participants who recognize that the reason for students' error is connected with the misconception that the altitude should be vertical are 34.6%.

Also, for this item, we were interested in investigating teachers' awareness of its suitability in order to assess students' learning at 5th grade (Q16) and to know to what extent teachers claim to use this kind of item in their ordinary assessment test (Q17). Looking at the responses we found that 50% of the teachers considered this item completely suitable to assess students' learning and that 39% of the participants declare to regularly use this kind of item. Moreover, it can be seen that 35% of the teachers gave the maximum rank to both Q16 and Q17 (and in particular that they made up 70% of those who considered the item completely suitable to assess students' learning), however, 64.2% of them were not able to identify the reason for students' errors in answering the item. That is, 22.6% of the participants, even considering this item to be completely suitable to assess students' learning and declaring they regularly use this kind of item in their assessment tests, did not recognize the reason for students' error.

Finally, we consider worth noticing that, even if participants recognizing the reason for students' errors make up 21.5% for the item in figure 4 and 34.6% for the item in figure 5, those who were able to recognize both the issues were only 9.2%. However, 64.8% of the teachers consider the two items suitable (partially or completely) to assess 5th grade students' learning

and 49.9% of the teachers declare that they make use (often or regularly) of both these kinds of items in their assessment practices.

6. Discussion

Presenting the first findings from the Try Out of the survey, Arzarello and Ferretti (2021) highlighted how teachers' responses revealed the presence of a three-fold *meta-didactical conflict*, concerning discourses about didactical processes like assessment, students' competencies and mistakes, etc. According to this point of view, the conflict can be analyzed by focusing on three different components. The first component concerns teachers' perception of students' difficulties in tackling INVALSI items: our results showed how teachers often have a perception which is not in tune with the INVALSI national data. The second component concerns the teachers' interpretation of students' answers and mistakes: with this respect, teachers' responses to the Try Out also revealed a discrepancy with the national data. The third component refers to the contradictory responses of the teachers to the questions of the survey dealing with the overall rationale of the INVALSI assessment, such as the suitability to assess students' learning or the compliance with the curriculum national guidelines (Indicazioni nazionali, 2012).

Teachers' responses to Q6 confirm the finding in the Try Out about the existence of the first component of the meta-didactical conflict. The Main Study results, indeed, also reveal an apparent inconsistency: on the one hand, teachers failed while evaluating the difficulty of the item; on the other, they claimed the item is suitable to assess students' learning and it is often used. We believe that this inconsistency requires further investigations with quantitative and qualitative methods, in order to clarify its origin and its nature. Moreover, the teachers' responses to the survey questions presented above (Main Study) also seem to confirm the existence of the meta-didactical conflict (as it emerged in the Try Out), and particularly of the second and the third components. Indeed, evidence of the existence of the second component of the meta-didactical conflict is given by participants' responses to Q3 and Q15: only 21.5% of the teachers identify that students' difficulty in answering INVALSI item in figure 4 is due to a wrong construction of the meaning concerning the relationship between area and perimeter while 34.6% of the teachers identify that students' difficulty in answering INVALSI item in figure 5 is due to the misconception that the altitude should be vertical. Hence, we can say that participants seemed to have some difficulties in recognizing the reasons for the students' error, especially if we consider also that, as high-

lighted before, participants who discern the issues at play in both the proposed items make up only the 9.2% of the total.

Furthermore, based on the participants' responses to Q3 and Q4 and on the described correlation between answers to Q4 and Q5, there is a need to further investigate the meaning teachers attributed to the expression "same kind" when they answered Q5: the apparent discrepancy in the teachers' answers, indeed, seems to bring to the fore the existence of the third component of the meta-didactical conflict. This hypothesis seems also to be confirmed by the fact that the awareness of the students' errors presents a positive correlation with the awareness that analyzing INVALSI items can help teachers understand which Mathematics learning aims are to be achieved.

Some more comments can be made analyzing participants' responses to questions Q16 and Q17, concerning the INVALSI item in figure 5. Despite the numbers of teachers that consider the item suitable to assess students' learning and declare they use this kind of item in their classroom, it seems to be contradictory that such a low number of them recognize that this INVALSI item was aimed at detecting the common misconception of the verticality of the altitude of the triangle. This discrepancy again calls to the need for further investigations aiming to shed some light on the nature of the third component of the meta-didactical conflict.

7. Conclusions

In order to analyze knowledge, teaching experiences and beliefs available to primary school teachers to read and interpret Mathematics INVALSI data, we designed and administered a questionnaire. In particular, through the analysis of participants' responses we were interested in: investigating teachers' beliefs regarding the knowledge and skills detected by the INVALSI standardized tests; exploring the proximity/distance between the functions and objects of the INVALSI standardized tests, on the one hand, and beliefs and statements about the teaching practices of teachers, on the other hand. In this paper we have presented some early results of the questions specifically concerning Mathematics education (the way teachers interpret and use INVALSI standardized tests and data). They have been interpreted using the lens of the meta-didactical conflict by Arzarello and Ferretti (2021): results seem to confirm their hypothesis and, as next step of the project, we are now going to clarify the deep structure and nature of this conflict (e.g. with respect to the knowledge and beliefs of teachers) in order to design suitable guidelines for

getting rid of it and obtaining a real improvement of practices regarding the use of INVALSI standardized tests in the school.

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2. Mathematics Teachers Specialised Knowledge and GESTINV Database

by George Santi, Federica Ferretti, Francesca Martignone

In this chapter we present a model for pre-service teacher professional development, devoted to primary school level. The objective is to bridge the gap between INVALSI results in Mathematics and teaching learning practices proposed in Italian schools. The model is based on the use of GESTINV database in both the design and implementation of the activities. We conceptualize professional development according to the Meta-Didactical transposition in which GESTINV plays the role of a boundary object in accomplishing boundary crossings between teachers' and researchers' praxeologies. We conceive professional development as a change of teachers' beliefs regarding their specialized knowledge, which covers, according to the MTSK model, both Mathematical knowledge and pedagogical content knowledge.

Nel capitolo presentiamo un modello di formazione per futuri insegnanti di scuola primaria. L'obiettivo è di ridurre la distanza tra i risultati delle rilevazioni INVALSI in Matematica e le pratiche di insegnamento-apprendimento proposte nelle scuole italiane. Il modello si basa sull'utilizzo del database GESTINV nella progettazione e realizzazione delle attività. La formazione insegnanti è concettualizzata secondo il costrutto della trasposizione meta-didattica nel quale GESTINV assume il ruolo di boundary object *nel realizzare* boundary crossings *tra le* praxeologie *degli insegnanti e quelle dei ricercatori. Noi concepiamo lo sviluppo professionale come un cambiamento delle convinzioni degli insegnanti riguardo alle loro conoscenze specialistiche, che comprendono, secondo il modello MTSK, sia le conoscenze matematiche, sia le conoscenze pedagogiche dei contenuti.*

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1. Introduction

Standardized Assessment (SA) is a practice spread all over the world, performed both by single nations and international organizations such as OCSE-PISA and IEA-TIMMS. If we want to overcome the risk that Standardized Assessment is confined to the ranking of students, schools and nations we need to develop the dialogue between standardized assessment and Mathematics education. In order to fully acknowledge the potentials and educational aims of Standardized Assessment, we need effective theoretical tools to interpret the quantitative data they provide and the macro phenomena that emerge from the *complexity* of educational systems. Furthermore, it is advantageous to overcome the educational limits of standardized assessments pointed out by Doig (2006). In fact, standardized assessment should truly impact the improvement of the teaching and learning of Mathematics. Quantitative data should be translated into refined, culturally wide-ranging and operational information for policymakers, teacher training programs, curriculum developers, principals and teachers (De Lange, 2007). We believe this is not possible without a profound *encounter* between Standardized Assessment and Mathematics education research.

In this study, we present a model for pre-service teachers' professional development that profits from data collected by the Italian National Evaluation Institute for the School System (INVALSI). In particular, we want to create a link between the Italian National Evaluation System and pre-service teacher professional development programs in order to improve Mathematics teaching school practices. Our model creates a connection between INVALSI data and Pre-service Teacher Professional Development (PTPD) to trigger a virtuous loop between Standardized Assessment, PTPD and Mathematics teaching. Our model relies on GESTINV database.

GESTINV is the pivotal tool of a model for teacher collaboration devised by Ferretti, Gambini and Santi (2020). Teacher development is conceived as the sprouting of a new identity (Golding *et al.*, 2016) that involves beliefs, attitudes and values regarding both Mathematics Knowledge (MK) and Pedagogical Content Knowledge (PCK) (Carrillo-Yañez *et al.*, 2018). The new identity is the outcome of a sociocultural activity mediated by specific tools. Ferretti *et al.* (2020) envisage PTPD as the interplay of a Community of Inquiry (Jaworski, 2006) and the Mathematics Teacher Specialized Knowledge – MTSK (Carrillo-Yañez *et al.*, 2018) that outlines the culture contributing to teacher identity. GESTINV serves as the mediator of this sociocultural activity.

After a brief presentation of GESTINV and of the theoretical perspective that framed and guided our study, this paper shows how we have implement-

ed our collaborative Pre-service Teacher Professional Development program widely, involving primary pre-service teachers.

2. GESTINV

GESTINV is a friendly tool for teachers, researchers and all the stakeholders involved in the education system. The GESTINV database collects in a structured way a broad range of information regarding the Mathematics tests that the Italian National Evaluation System issues annually and that involves all Italian students of grades 2, 5, 8, 10, 13. GESTINV rests on the theoretical framework of INVALSI (2018) that informs both the construction and the selection of the items. Its complex structure, triggers the use of Mathematical content knowledge, Mathematics education theoretical tools, ideas about teaching and learning; altogether, they amount to a conceptual and cultural tool (Ferretti and Bolondi, 2019; Bolondi, Ferretti and Giberti, 2018). This tool allows users to carry out focused and cross research concerning the national tests, available from 2008, according to Mathematical contents and their relationship with the National Guidelines, the results of the tests and the related percentages – percentage of correct, incorrect, invalid and missing answers and, for multiple choice task, the percentage of each option – school level, content keywords and statistical features (characteristic curves, distractor plots, ITN).

There are many ways you can use the database; you can in fact carry out different forms of searches:

- National Guidelines: Learning Objectives and the Goals for the competences development of the Ministerial Guidelines for each school levels and paths;
- Keywords: there are about 200 keywords that identify the main topic for each item;
- Full Text: the database allows you to find the full text of an item by typing in the search record one or more of its words;
- Processes: the vertical cognitive processes outlined by the INVALSI theoretical framework – six both for Primary Level and Secondary Level;
- Rates: national rates of correct/incorrect/invalid answers;
- Typology: types of test questions (multiple choice, open questions, etc.);
- Guided Search: it is possible to carry out a cross search (with and/or logical connectors) involving all the parameters mentioned above.

The impact of the GESTINV database has been assessed both quantitatively and qualitatively, through standard indicators such as the number of

registered users (more than 16,643), the number of accesses (on average, 200 every day), the time spent on the website and other parameters. These data, along with its structured information (Ferretti, Giberti and Lemmo, 2018), promote GESTINV as a tool to implement in the design of teacher professional development models (Ferretti, Gambini and Santi, 2020). Given the teachers' acquaintance with such a tool, it can be easily used both in the training sessions and their everyday practice.

3. Theoretical perspectives

To fully understand the effectiveness of GESTINV and the use of INVALSI data in teachers' professional development, we reckon that an institutional approach as Chevallard's (1999) *Anthopological Theory of Didactics* is the most appropriate to pursue the aim of our research. In fact, the use of GESTINV to develop Mathematics Teachers' Specialized Knowledge requires the interaction between three important institutions: the Italian Ministry of Education in charge of the Standardized Assessment via INVALSI, the schools and the universities to which the teachers and the researchers belong respectively. Our model for teacher professional development intertwines the community of Mathematics education researchers with the community of Mathematics teacher. The aim is to share and discuss practices and reflections on these practices among preservice teachers and teacher educators (researchers). The outcome of these activities is two-fold. On the one hand, we consider teacher education a developmental process that entails an individual change (Guskey, 2002): transformation of beliefs, convictions (D'Amore and Fandiño Pinilla, 2004), Weltanshauungen regarding Mathematics, teaching-learning processes, the students, the political and social role of the education system. Such a change cannot be a solitary, individual and autonomous process, instead it is constitutively a sociocultural activity resulting in the transformation of the teacher's individual's identity. We need to conceptualize and outline the specific knowledge and professional skills that we would like teachers to achieve as a result of the change they undergo in their education process. We are referring to a wide range of knowledge that includes Mathematics, epistemology, pedagogy, didactics, psychology, etc.

To describe and interpret some variables in the teacher education processes and account for their mutual relationships and evolution over time, we resort to Arzarello's *et al.* (2014) *Meta-didactical Transposition*: This model takes into consideration the practices of Mathematics educators/researchers and those of teachers, when both communities are engaged in teachers' education

activities. It is an adaptation of the Anthropological Theory of Didactics to teacher education, through the integration of further elements. Arzarello and colleagues' model interweaves the following elements: the institutional dimension, the meta-didactical praxeologies, the double dialectics, brokering processes and the dynamics between internal and external components.

For the scope of this chapter, we will focus only on the institutions, the praxeologies and the brokering process. We refer the reader to Arzarello *et al.* (2014) for more details about the model.

Mathematical knowledge lives in the *institutional dimension* where Mathematical objects emerge from socio-cultural activities shared by individuals belonging to one or more institutions. The relation with Mathematical knowledge is both *personal and institutional* (Chevallard, 1992). Teachers' education is characterized by the dialectics between the *personal and institutional* relation to knowledge. In professional development, one of the outcomes of the meta-didactical transposition is the dialectics between the teachers personal meaning of didactical phenomena and the scientific/institutional meaning brought by the researchers. In the case of professional development, the institutions involved in the programs take into account the community of teachers and the community of researchers.

The Anthropological Theory of Didactics conceives human activity as a praxeology, which is made up of a set of tasks that drive the practice (*praxis*), the techniques that allow individuals to solve the problems, and the knowledge and discourses (*logos*) that ground the techniques. Within the Meta-didactical Transposition, praxeologies become *meta-didactical praxeologies* in that they refer to the practices and reflections, which characterize teacher education processes. Meta-didactical praxeologies deal with practices and the theoretical reflections developed in teacher education activities. Furthermore, in teachers' professional development programs, the interaction between the community of teachers and the community of researchers triggers a dynamics in the praxeologies that amount to, firstly, shared praxeologies and eventually to new teachers' and researchers' praxeologies.

The above arguments highlight that Meta-didactical Transposition rests on the interrelation of the community of teachers and the community of researchers and the ensuing interrelation of their respective praxeologies. The Meta-Didactical transposition does not give such an interrelation for granted; therefore, the model inserts the notion of brokering that accomplishes the contact between the two communities mentioned above. Brokers may belong to both the community of teachers and the community of researchers, but they should be able to achieve the connection between the two communities (Rasmussen *et al.*, 2009). It could be a teacher expert in Mathematics and

Mathematics education or a researcher expert in teacher training and with strong connections with everyday school Mathematics practice. The communication between the two communities, realized by brokers, is termed by the Meta-Didactical transposition *boundary crossing* and the tools, ideal or material, implemented in the brokering process, the *boundary objects* (Bowker and Star, 1999). Boundary objects are meaningful tools in both the communities they put in touch, although with different nuances and uses that characterize their respective praxeologies. Boundary objects can be material artefacts, digital technologies, Mathematical procedures, etc.

Our teacher professional development program can be seen as an instantiation of the Meta-Didactical Transposition model.

In regard to the institutional dimension, the teacher education process involves the Italian Ministry of Education via the INVALSI institute, Italian Schools and Universities. We highlight that a strong interrelation between such institutions is fundamental for the whole Standardized Assessment process, independently from the teacher education program at stake. We can say that our proposal for teacher education is rooted in and consubstantial to the institutional dimension.

In our Pre-service Teacher Professional Development Program, the role of the broker is typically held by researchers in charge of Mathematics Education courses for prospective teachers at the university level.

Researchers/teacher educators and teachers share praxeologies and reflect on them. Pre-service teachers have been exposed to tasks and techniques regarding Mathematical knowledge, Mathematics teaching and learning and, within their university curriculum, general didactics, psychology, assessment etc. Researchers bring to the fore tasks and techniques related to the epistemology of Mathematics and Mathematics education studies. The resulting shared praxeology could be, for example, the analysis of Mathematical contents and pedagogical ones in a problem of positioning rational numbers on the number line by coordinating several semiotic systems.

What really marks the coherence of our program with the Meta-Didactical Transposition model is the brokering process carried out by GESTINV that serves as a boundary object. In fact, the impact and significance of GESTINV both in the researchers' and teachers' communities allows us to ascribe to GESTINV the status of a *boundary object* that fosters *boundary crossings* between the aforementioned communities.

On the one hand, GESTINV is a product of research carried out within INVALSI Standardized Assessment processes. On the other hand, it is a tool broadly used by Mathematics teachers in Italy, from primary to high school levels.

In our research, we characterize the role of praxeologies in the Meta-Didactical Transposition in terms of the nature of the practices and the emergence of knowledge and professional skills achieved by the Pre-Service Teachers. The initial studies on Meta-Didactical Transposition (Aldon *et al.*, 2013; Arzarello *et al.*, 2014; Martignone, 2015) took into account teacher knowledge by referring to research on Mathematical Knowledge for teaching (Ball *et al.*, 2008). In our studies, we look at praxeologies as practices that grow within a Community of Inquiry based on Mathematics Teacher's Specialised Knowledge Model outlined by Carrillo-Yañez *et al.* (2018).

Social interaction within a community of practice accounts for the production of terachers' subjectivities. Sociocultural perspectives in Mathematics education (Radford, 2008; Sfard, 2008) have shown the role of social-communicative practices in a cultural-historical context both on the learning processes and the construction of identity, as two sides of the same coin. We believe that we can extend and adapt these research findings to Mathematics teacher's professional development, since their training can be envisaged as the production of a professional identity as they engage in the learning of Mathematical knowledge and pedagogical content knowledge. Furthermore, within the sociocultural perspective we are advocating here, Mathematical knowledge and knowledge for teaching (pedagogical content knowledge) are not fixed a priori entities that must be taken for granted. They are continuously reflected and refracted in social and communicative activity that allow us to make sense of cultural-historical constructs and we call this sense making process learning. Teacher's professional development cannot disregard this feature of thinking and knowing. Jaworski (2006; 2014) adds an important feature that characterizes a community of practice (Wenger, 1998) that is, inquiry, which unfolds in terms of critical thinking, questioning, doubting, bringing new points of view, etc.

The transformation of a community of practice into a community of inquiry requires participants to look critically at their practices as they engage with them, to question what they do as they do it, and to explore new elements of practice. Such inquiry-based forms of engagement have been called "critical alignment" (Jaworski, 2006). Critical alignment is a necessity for developing an inquiry way of being within a community of inquiry (Jaworski, 2014, p. 77).

Therefore, within this conception of a community of practice, we can think of "inquiry as a way of being in which teachers take on the mantle of inquiry as central to how they think, act, and develop in practice and encourage their students to do so as well" (Jaworski, 2014, p. 77). We see how belonging to a community of inquiry results in a special attitude, a mode of

being and becoming that defines the way teachers act, feel, think, learn and teach. This new attitude has important implications on the way teachers are going to handle in their daily work the complexity of Chevallard's triangle. We are referring to Chevallard's acknowledged structure of Mathematics teaching-learning practices whose vertices knowledge, pupil and teacher (Chevallard and Joshua, 1982), are inseparably intertwined. An attitude of inquiry allows the teacher to be tuned with an intrinsically unpredictable, uncontrollable, fluid and flexible situation, i.e., the Mathematics classroom, which requires constant interpretation and reinterpretation in order to design and carry out activities, make decisions and handle social interaction. The subjectivity that the teacher realizes during their professional development in a community of inquiry cannot be separated from their Mathematical knowledge and knowledge for teaching (Pedagogical Content Knowledge).

The importance of knowledge in teaching, concerning a specific school subject, is internationally acknowledged; already in the mid-80s, Shulman (1986) focused on the concept of teacher knowledge and proposed the definition of Pedagogical Content Knowledge (PCK). His innovation was the outlining of this knowledge of the content, specific to teaching. Within this line of research, over the last few years several works have tackled different aspects concerning teacher knowledge. To investigate teachers' knowledge, these studies did not set off from the contents listed in school curricula but focused on empirical approaches in order to understand the Mathematical Knowledge needed for and in teaching. Carrillo-Yañez and colleagues (2018), introduce the Mathematics Teacher Specialized Knowledge (MTSK) model. MTSK coordinates two extensive areas of knowledge, the Mathematical Knowledge (MK) and the Pedagogical Content Knowledge (PCK) that meet and intersect in the teacher's system of beliefs (fig. 1). MK is the knowledge possessed by a Mathematics teacher in terms of a scientific discipline within an educational context and PCK is the knowledge relating to Mathematical content in terms of teaching-learning processes. Beliefs about Mathematics and its teaching and learning lie at the "center" of the model (fig. 1) to "underline the reciprocity between beliefs and knowledge domains" (Carrillo-Yañez *et al.*, 2018, p. 240). In the model, MK and PCK are divided into three sub-domains. The MK contains Knowledge of Topics (KoT), Knowledge of the Structure of Mathematics (KSM), and Knowledge of Practices in Mathematics (KPM). In the MTSK model, the PCK "is a specific type of knowledge of pedagogy which derives chiefly from Mathematics" (Carrillo-Yañez *et al.*, 2018, p. 246). The three subdomains of PCK are the Knowledge of Mathematics Teaching (KMT), the Knowledge of Features of Learning Mathematics (KFLM) and the Knowledge of Mathematics Learning Standards (KMLS).

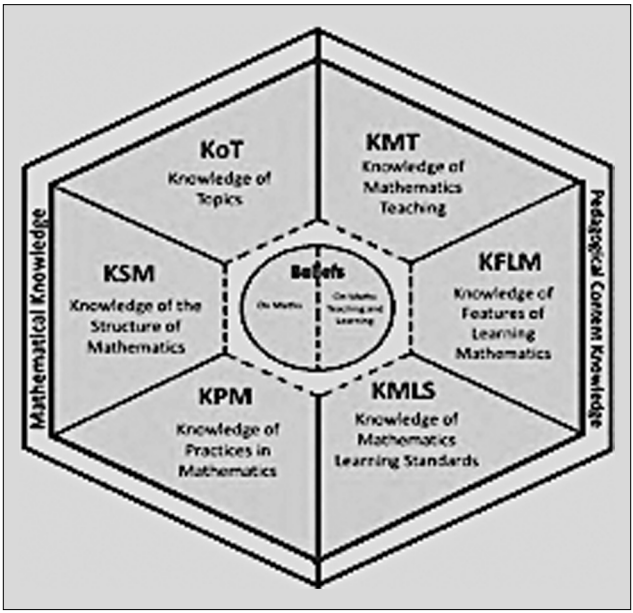

Fig. 1 – MTSK model

Source: Carrillo-Yañez *et al.* (2018)

We would like to draw the attention of the reader on the fact that in our study the features of the inquiring practice, in which the teachers engage and align, are entangled with the change and construction of the system of beliefs that lies at the core of the MTSK model. In our understanding, the change of beliefs is triggered by questioning, doubting, discussing, exploring, investigating etc. both MK and PCK within the community of inquiry. We now have all the elements that contribute to our model for the development of teachers' Mathematical Specialized Knowledge, conceived as a *Meta-didactical Transposition*. Praxeologies occur within a community of inquiry and GESTINV is the boundary object that accomplishes the boundary crossings. The outcome related to the logos level of the praxeologies can be interpreted by the Mathematics Teacher Specialized Knowledge (MTSK) model (Carrillo *et al.*, 2018). In the following section, we provide the structure of the model that we implemented in university courses for pre-service Mathematics teachers.

4. Teacher Professional Development Model

The overall methodology of our research program is based on the following cycle: Standardized Assessment (SA) carried out by INVALSI; Results of Large-Scale Assessment inform a large-scale Teacher Professional Development (TPD) making use of GESTINV and e-learning platforms; TPD translates into more effective and aware Mathematics school practices, in turn tested with SA that initiates a new cycle.

In this study, we focus on the PTPD based on the following methodology:

– *Introduction of the activity*. The researchers address the Mathematical content selected for the activity from a conceptual and epistemological point of view. The researchers present some of the functions of GESTINV that the teachers will use in their inquiry. The researchers discuss with the pre-service teachers the Mathematics education constructs, also looking at learning difficulties that will be useful for the activity;
– *Analysis of an example*. The researchers discuss with the whole group of pre-service teachers a didactical macro-phenomenon using GESTINV to prompt reflections on teacher MK and/or the PCK;
– *Group activity*. Pre-service teachers autonomously divide into sub-groups of maximum 4/5. The researchers assign a task covering a Mathematical content, a learning difficulty, and objectives and goals of the Italian National Guidelines. The small group activity is carried out according to a Community of Inquiry strongly interacting with GESTINV. The group activity aims at the construction of a multimedia product, an artefact, the design of an activity for students etc., which should highlight pre-service teachers' reflections, convictions and beliefs;
– *General discussion*. The sub-groups present their materials to the big group. Each presentation is discussed within the Community of Inquiry in order to highlight beliefs and convictions, tackle doubts, difficulties and unclear contents regarding both the MK and the PCK and outline the subdomains of the MTSK that emerged from the activity. Another setting for this final phase requires each sub-group to prepare a written presentation that is exchanged so that each sub-group presents orally to the big group the material of another sub-group. The final discussion, based on the oral presentations, is performed with the same characteristics of a Community of Inquiry.

At the end of the activity, the MTSK Model was presented to the pre-service teachers and they were asked if and how, in their opinion, the activities had increased their knowledge in reference to each subdomain of the model. Data relating to 52 questionnaires administered to the pre-service teachers after the final discussion have been collected and analyzed.

5. Analysis of an example

In this section, we will show, by means of the analysis of an example, the link established by GESTINV between INVALSI data and PTPD. We describe how the structured data provided by GESTINV informs the contents of the activity plan mentioned above and the production of materials that show pre-service teachers reflections, triggered by the INVALSI items.

The reflections on Mathematics pre-service teacher's specialized knowledge could transform their future Mathematics school practice and their interpretation of the data provided by the standardised tests, as to accomplish an improvement of the Educational System. We have collected data concerning results that involve the implementation of INVALSI data via GESTINV and the first uses of our PTPD design at a local level.

In almost all the analyzed questionnaire responses, pre-service teachers declare an increase in their Knowledge of Mathematics Teaching. By way of example, we show a path centered on an INVALSI question and some feedback in this direction. The Knowledge of Mathematics Teaching – KMT concerns the theoretical, personal and institutional, knowledge specific to the teaching of Mathematics (Carrillo-Yañez, 2018). Included in KMT are the use of resources and materials useful for teaching; knowledge of different ways of representing specific content is therefore needed, perhaps using metaphors, situations or explanations. Some of the pre-service teachers say that the analysis of the following INVALSI Mathematics task (fig. 2) was helpful in strengthening their knowledge regarding the teaching process of Mathematics concepts.

The researchers chose this INVALSI task because it shows clearly some possible mistakes linked to rational number representations. By means of the analysis of the task researchers and pre-service teachers can share ideas and reflections. INVALSI task results show that many Italian students seem to give a wrong interpretation of the fraction as a number: fraction seems to be considered as two numbers with a line between them and there are different interpretations of these symbols. As stressed by Pitta-Pantazi (2014) "a number of studies concentrated on the way that the conceptualization of whole numbers may affect students understanding of rational numbers and make sense of decimal and fractions notations". The students' difficulties in ordering and positioning rational numbers on the number line, especially when represented as fractions are well known (Behr and Bright, 1984; Saxe *et al.*, 2007; Ni and Zhou, 2005).

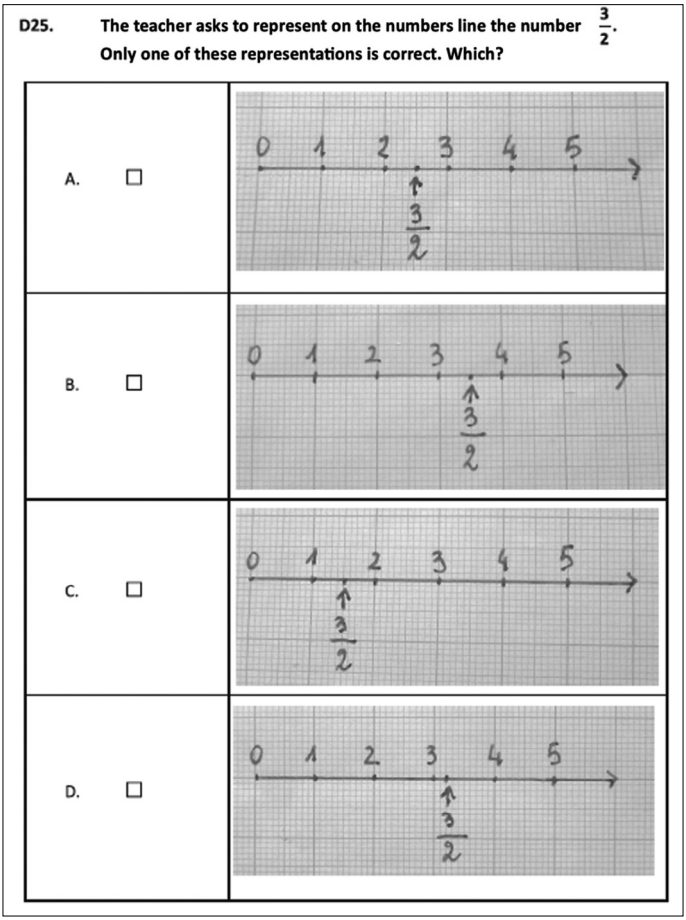

Fig. 2 – Task D25, 2018 Mathematics INVALSI test grade 5

The number line plays a crucial role in the teaching-learning processes of Mathematics at different school levels: it is a tool with a high didactic potential, which allows a simple and intuitive representation of complex Mathematical concepts (Skoumpourdi, 2010). It is used over the years for counting, for making estimates and for representing various numerical sets; it is often used as a geometric model for arithmetic operations, to measure and compare quantities and also in an interdisciplinary key as a timeline. In the specific case of the question under scrutiny, we are in the presence of a graduated number line; the graduated number lines are hybrid representations, consisting of a line and a scale, and the management of both meanings conveyed by the single representation is by itself an important learning goal. The content

is linked to the theme of breaking down units into equal parts and therefore to fractions and decimal numbers (Iuculano and Butterworth, 2011). As underlined by De Wolf and colleagues (2014), on the number line, some difficulties relating to the management of the different representations of rational numbers are made particularly visible, both in terms of the comparison and ordering of fractions and their comparison with decimals. Some difficulties that pupils may have encountered are the identification of the units that make up the partition and the consequent correct identification of the positioning of the numbers. The issues inherent to the number line therefore involve different knowledge and Mathematical skills and deserve particular attention both in didactic planning and in the interpretation of difficulties.

During the PTPD researchers address the Mathematical content selected for the activity from an epistemological and educational point of view. Moreover, they discuss with pre-service teachers the research results and aspects of their MK and/or PCK involved during the task analysis. Then they present some of the functions of GESTINV that the pre-service teachers will use in their inquiry. Per-service teachers work in groups and focus their analysis and activity on the INVALSI task presented (fig. 2) and on other tasks selected from GESTINV. At the end of the activity the pre-service teachers reflect on their activity and their Knowledge of Mathematics Teaching – KMT.

The task (fig. 2) requires recognizing, among the various answer options, which one indicates the correct position of the fraction 3/2 on the number line. Option A could identify pupils who place the fraction halfway between the digits 2 and 3 that make up the fraction. Option B could identify the pupils who give the fraction 3/2 the meaning of 3 and a half. Option D could identify the pupils who read the fraction 3/2 as 3.2.

In the following graph we can see the results at the national level (tab. 1).

Tab. 1 – Results referred to Task D25, 2018 Mathematics INVALSI test grade 5

Answer	*Percentage*
Answer A	25.3
Answer B	23.3
Answer C	17.1
Answer D	32.9
Missing or INVALID	1.4

Source: www.gestinv.it

As we can see, only 17% of the students answer correctly and the other wrong options have all been fairly chosen.

We present below some excerpts of the pre-service teachers taken from the questionnaire regarding the features entailed with this task that emerged from the final discussion. They have stressed the fact that the discussions concerning this INVALSI task have increased their Knowledge of Mathematics teaching (KMT).

For instance, a preservice teacher declares that:

PS_33: To better develop these concepts we performed several activities, most of which were drawn from the INVALSI and tests that reported topics such as "fractions of areas" or "numbers lines". These have allowed us to learn strengths and difficulties contained in the various tasks and notice possible mistakes made by students.

Another pre-service teacher referred to the importance of the use of different representations within the teaching practices:

PS_48: The study of the different types of representation has highlighted the importance of managing and learning semiotic transformations within the same register. Since children may not understand that we are talking about different representations of the same object, it is important to make them aware and propose different problems to them, working on the concept through the various representations.

6. Final reflections

Standardized assessment can play a crucial role in developing the Mathematical literacy of a nation. Its impact develops along two possible trajectories. On the one hand, it provides a thorough analysis of the learning of Mathematics highlighting macro-phenomena emerging in the school system and the ensuing weaknesses and potentials related to different school levels and Mathematics content knowledge. On the other hand, standardized assessment can also indicate where and how we can intervene to improve the learning of Mathematics at the level of the school system. This is the theme of our work. In order to accomplish such an objective, quantitative data should be translated into refined, culturally wide-ranging and operational information for policymakers, teacher education programs, curriculum developers, principals and teachers (De Lange, 2007). We believe this is not possible without a profound encounter between standardized assessment and Mathematics education research. In the present study, we focused on a model for pre-service teachers' professional development that profits from data collected by the Italian National Evaluation Institute for the School System (INVALSI). The outcome is the emergence of beliefs, knowledge on Mathematics and teaching and learning.

We have shown how the implementation of GESTINV in teacher professional development programs as a *boundary object* allows *boundary crossings* between research in Mathematics education and the school teaching-learning practices. During the PTPD researchers and pre-service teachers shared meta-didactical praxeologies regarding the analysis of INVALSI tasks. New praxeologies entail a change in the teachers', specialized knowledge that are crucial for the improvement of Mathematics teaching and learning. Our research requires further developments and deepening both at the theoretical level and in the experimental-practical implementation of our model.

As regards the first issue, we believe it is necessary to go deeper into the relationship between the theoretical tenets of INVALSI as a Standardized Assessment process and Mathematics education research. In regard to our professional development program, we need to implement our model – tested in university courses involving the authors – at a large scale using digital platforms taking advantage of research in this topic as reported in the ICMI STUDY 25, THEME D (Bolko and Potari, 2020).

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3. MEL: Model for Literacy Education. Teacher education and professional development in literacy teaching

by Tiziana Mascia

International reading surveys have broadened our knowledge of the development of reading and writing (reading literacy), which is now considered a lifelong learning process. Several studies have shown the positive impact of teacher training on the quality of teaching, but in Italy there is no specific professional development in literacy education. The main objective of this research is to assess the Italian situation; describe factors influencing literacy and define relevant knowledge and skills required for teacher training in literacy education.

Le indagini internazionali hanno ampliato la nostra conoscenza sul processo di sviluppo della lettura e della scrittura (reading literacy), processo oggi considerato come un percorso di apprendimento permanente. In tale contesto la scuola svolge un ruolo fondamentale e l'insegnante qualificato si pone come mediatore per l'educazione alla lettura di bambini e ragazzi. Numerosi studi hanno dimostrato l'impatto positivo della formazione dei docenti sulla qualità dell'insegnamento; tuttavia, non esiste in Italia un piano di sviluppo professionale specifico sulla literacy. L'obiettivo principale di questo studio è valutare la situazione nel nostro Paese; descrivere fattori che influenzano la literacy e definire i parametri rilevanti per la formazione dei docenti e l'educazione alla lettura.

1. Introduction

Which fundamental principles should be included in a reading training programme for teachers? And what are the effects on literacy education after teachers have participated in and completed the training programme de-

signed for this study? These are the key questions that guided the research process in which an attempt was made to understand how training in reading pedagogy and literacy education can make teaching more effective, especially with an approach that takes into account the particular Italian cultural context of low propensity to read.

This research work lies in the scientific field of reading pedagogy and literacy education and has called upon knowledge from several fields such as statistics, educational psychology and school librarianship. The evaluation of the MEL-Model for Literacy Education was carried out by means of a survey of teachers and students in Comprehensive Schools in the North and South of Italy in areas defined "at risk and with a strong immigration profile". Findings suggests that reading literacy education is multidimensional, dependent on many factors, and that the MEL plan can be used, with a potentially beneficial impact, in in-service training and as professional development resource for trainee and in-service teachers and professionals working in the field.

2. Literacy in Italy

A society in which reading has a primary role is better informed and more likely to preserve a democratic culture. In this context, readers can evaluate what they read, are able to analyse and connect information from different sources to build and develop critical thinking skills (Morais, 2018). However, our society has seemingly lost the meaning of the true value of literacy; the path to becoming a reader is often underestimated and associated only with the technical ability of being able to decode a written text. A reader is, in fact, a person who has an active participation in society: not only with the act of reading, but also frequenting bookshops, libraries, critically evaluating different resources – printed or digital – such as books, newspapers, blogs or articles. Indeed, the definition of literacy has changed over time to properly express this crucial role of literacy: today "literacy is the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts. Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society" (UNESCO, 2004, p. 13). This new definition finally captures the breadth and value of literacy and its powerful influence on people's quality of life as a means of identifying and achieving personal goals in an increasingly digital world (Mascia, 2018a).

Several benchmarks suggest the existence of a real educational emergency (Save the Children, 2017). According to ISTAT (2020), only 40% of the

people interviewed declared having read at least one book over the course of a year: these limited percentages lead Italy to report one of the lowest reading rates in Europe. Critical issues do not only concern the low number of readers. Students' reading skills, observed in the latest PISA surveys (OECD, 2013a; 2013b; 2016), are lower than the average of the OECD countries: a performance that "ranks Italy between the 29th and 37th place in the overall ranking of all participating countries and between the 23rd and 28th position among the 34 OECD countries" (INVALSI, 2016, p. 65). The Save the Children report *Illuminiamo il futuro* highlights huge discrepancies among the Italian Regions, in many of which there is a lack of quality education capable of supporting children from their first steps to adolescence. In these regions there is a lack of availability of early childhood services, well equipped schools, recreational and cultural activities that can truly help interrupting the intergenerational chains of poverty (Save the Children, 2015).

The issue of literacy is a matter of concern in Italy not only for children. According to the United Nations education agency, almost 50% of Italians do not retain what they have learned during their school careers and therefore have lost some of the ability to use reading or writing in everyday life situations. Basically, one out of two Italians is unable to read a text of average difficulty (UNDP, 2009). The international survey PIAAC – Programme for the International Assessment of Adult Competencies (ISFOL, 2014), assessed that 70% of Italians, aged 16-65, do not reach level 3 in literacy skills. These results led Tullio De Mauro, then president of the Expert Commission of the PIAAC project (ISFOL, 2014), to suggest some important steps be taken to improve education and transversal skills, such as literacy.

In 2012, the High Level Group of Experts on Literacy (EU High Level Group of Experts on Literacy, 2012) had already moved in this direction, advising EU countries to focus on key areas in order to increase literacy skills and motivation. Among these areas, fundamental is the quality of literacy teaching in schools, which requires in-depth and specialised knowledge. In fact, several studies have shown that there is a positive relationship between teacher preparation and student performance in the domain of reading (ELINET, 2016; NICHD, 2000; 2006; Nye, Konstantopoulos and Hedges, 2004; Snow, Griffin and Burns, 2005).

3. Research questions, hypothesis and objectives

Despite this educational emergency, no specific theoretical and practical training in literacy is provided for in-service teachers in Italy (Balbinot *et al.*,

2016): there are limited empirical studies linking teachers' competences on reading pedagogy to literacy education. In the Italian school system, "reading specialist professionals" are not provided as in other European countries (Eurydice, 2011). The lack of a continuous professional development model in the field of reading literacy is compounded by a system in which teachers are not provided with the incentives to achieve the necessary skills to grow students as critical readers who can actively participate in society (UNESCO, 2004).

What knowledge and skills should teachers be expected to achieve in a training course in literacy education? And what are the effects of training teachers in literacy education? The purpose of this research is to provide answers to these main questions and to develop a model that can be applied, with positive impact, in continuous literacy education and as a resource of professional development (PD) for teachers in Italy. The research project "MEL: Model for Literacy Education" defined a specific model for teacher training according to international research and in line with the National curricular guidelines for pre-school and first cycle education (MIUR, 2012). This model has provided a selection of guidelines for courses related to reading pedagogy and it is targeted at the in-service training of pre-school, primary and secondary school teachers working in the particular Italian cultural context of poor attitudes to reading.

4. International surveys and data analysis

In order to evaluate how teachers, and school in general, can influence reading habits, this research study has focused on an analysis of international survey data on reading competences, the results of which provided measurement and comparison across countries around the world and could be used for policy-making at national level (ISFOL, 2014; Miller and McKenna, 2016; Mullis *et al.*, 2015; 2017a; 2017b; 2017c; OECD, 2013a; 2013b). For the purposes of this study, a descriptive analysis approach involving several levels of detail was used. The indicators of competence to define the state of the art of literacy in Italy, and to provide an international comparison among countries, include the following:

– comparison of Italy's performance with other countries participating in the survey;
– historical series analysis and evaluation of the growth or regression trend over past years' surveys;
– comparison of variances in international rankings for an evaluation of Italy's growth rate.

In this study, other key parameters were also considered, for example, indicators of excellence, and equity in instruction. Indicators of excellence are the average performance of the country and the percentage of students able to understand and communicate complex tasks (level 5 or 6: high performing students). Equity indicators, on the other hand, refer to *gender gap*, *social gap*, *native-migrant gap* and to the percentage of students not reaching basic skills (e.g., performing below level 2 in PISA). Surveys such as PIRLS, PISA and PIAAC (INVALSI, 2010; 2017b; 2017c; 2017d; ISFOL, 2014; Mullis *et al.*, 2012; 2015; 2017a; 2017b; 2017c; OECD, 2013a; 2013b; 2017) have provided comparable data on reading competencies for different age groups, making it possible to observe the progression of reading, from primary school through to adulthood, and possible gaps in the education system. Therefore, they provide a long-term vision consistent with the definition of literacy as a lifelong learning process. Why analyse international survey data in a study focused on teacher training? Findings from international surveys contain valuable information about the evolution and characteristics of readers in the Italian school context in comparison to other countries. In addition, surveys on reading literacy provide valuable insights about the challenges that need to be addressed when developing a reading education plan for teachers. This approach was chosen over direct observation of literacy education at school, as the latter would have provided only a partial perspective of the process, linked to the particular local systems of each school; it would not have allowed for the analysis of a wider framework comparable to other countries.

5. IEA PIRLS: *Progress in International Reading Literacy Study*

From the IEA PIRLS – *Progress in International Reading Literacy Study* – which provides trends and international comparisons of fourth grade students' reading achievement and students' competencies in relation to goals and standards for reading education, have emerged overall positive results for Italy, above several European countries (INVALSI, 2012; Mullis *et al.*, 2012; 2015; 2017a; 2017b; 2017c).

Italy participated in the IEA PIRLS survey in 2001, 2006, 2011 and 2016 and the positive outcome is that in all the cycles it achieved results above the EU average (in 2011 with a total score of 541, in 2006 with 551, in 2011 with 541 and in 2016 with 548). Italy has shown consistent results over time and with only minor differences between performance on comprehension of both literary and informational texts (Mullis *et al.*, 2012; 2015; 2017a). At the end

of primary school, Italian students, with an overall score of 548, achieved a positive result compared to most of the other European countries involved in the PIRLS survey. For Italy, some unique observations could be also made with respect to other countries, for example the gender gap is lower than international benchmarks and the social gap seems not to have a significant impact on final scores. Moreover, PIRLS results are consistent over time with a positive trend.

However, Italy's ranking on reading literacy is only one parameter to consider. In order to understand other factors that influence reader education, additional indicators must or need to be taken into account. Thus, for example, it was observed that the percentage of top performing students is lower than other countries and, above all, there are differences among students coming from the various Italian regions, since the macro-areas of the North West and North East contributed more to the good overall result, reporting average scores always higher than those in the South and the Islands. Another issue that should not be underestimated relates to the negative performance of Italian children in the ePIRLS literacy tests. This suggests a need focus literacy education on new skills related to digital literacy that include the ability to search, understand, critically evaluate and integrate multiple sources in open digital environments (Barzillai *et al.*, 2018).

6. OECD PISA: *Programme for International Student Assessment*

Proficiency in reading achieved by Italian students in the 4th year of primary school is not retained in subsequent years and disappears in the assessments of 15-year-old students (OECD, 2013a; 2013b; 2016; 2017). Italy's overall average score in OECD's PISA (2016) – Programme for International Student Assessment survey dropped eight points from the OECD average. Whereas Italy ranked tenth among the OECD countries that participated in PIRLS 2016, it had already dropped to twenty-second position in PISA 2015 (INVALSI, 2016). Also in the PISA 2018 survey, results for Italy were below the international average. Italy participated in all cycles of PISA and it is therefore possible to describe the evolution of average reading performance over a long period of more than ten years.

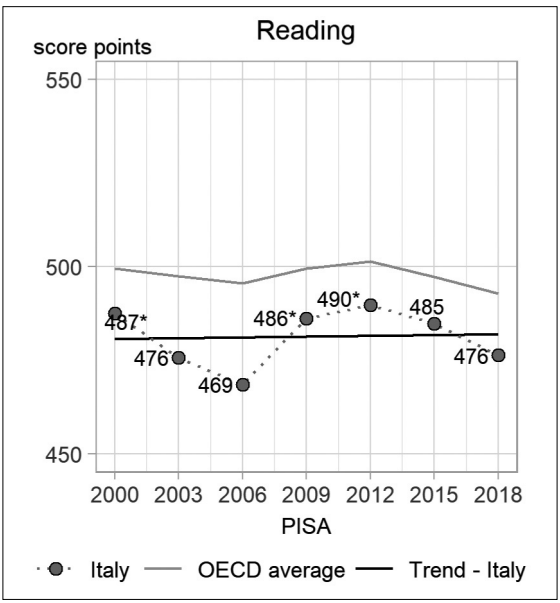

Fig. 1 – Trends in reading performance of Italian students in the different OECD PISA cycles from 2000 to 2018

Source: OECD (2019b), fig.2, p. 4

When analysing the trend over the PISA 2000-2018 cycles (the trend line in figure 1) no clear direction of change could be determined (OECD, 2019b, p. 4). In the years 2000, 2009, 2012 and 2015 Italy performed below the OECD average but close to the European average level (Balbinot *et al.*, 2016). Like a number of other countries (Spain, Iceland, Norway, France, Australia, Greece, Romania, Bulgaria, and the Russian Federation), Italy had a decline in reading performance between PISA 2000 and PISA 2006 (OECD, 2007, p. 5).

It can be observed that also in 2018 Italian students scored 476, lower than the OECD average (487) (INVALSI, 2019c). "Mean reading performance in 2018 was also below the level observed in PISA 2000 and PISA 2009 (the two prior assessments with reading as the main focus); but close to the level observed in most remaining assessments" (OECD, 2019b, p. 4). The change between 2015 and 2018 in mean performance in reading was not significant (OECD, 2019a, p.123), however, reading performance declined amongst girls and remained stable among boys.

An evident problem that has affected these results and persists from previous surveys is, among others, the skills gap between North and South of

Italy. According to the 2015 PISA survey, almost one out of two 15-year-old students (47%) in Italy do not reach the minimum level of reading skills and are from the most disadvantaged socioeconomic background, eight times more than a peer growing up in a family from a wealthy background (6%) (Save the Children, 2017). OECD PISA 2015 studies also show that "in our country [Italy] the percentage of children who come from disadvantaged backgrounds and still manage to achieve satisfactory results in PISA tests is limited to 20.4%» (Agasisti *et al.*, 2018, p. 12). "In Italy, socio-economically advantaged students had better scores than disadvantaged students in reading. About 10% of advantaged students, but only 2% of disadvantaged students, were top performers in reading in PISA 2018" (OECD, 2019b, p. 5).

For these students, education is not impacting to make a positive difference. Fifty years after Don Milani's *Lettera a una professoressa* (Barbiana, 1967), a text that denounced the inequalities of a class-based education system that advantaged the children of the rich over those of the poor, all research continues to show the impact of family status on the level achieved by students, and therefore on the realistic chance of exercising their right to citizenship (Save the Children, 2017).

7. OECD PIAAC: *Programme for International Assessment of Adult Competencies*

The decline in reading skills revealed in the PISA assessment is even more evident in the OECD's PIAAC – *Programme for International Assessment of Adult Competencies* (ISFOL, 2014). The results provided by this survey are not directly related to the age group of interest for our research, however, as the process of becoming a reader is a long-term process, it is crucial to assess how reading skills evolve in adulthood. The aim of the study was to assess adults' skills in literacy, numeracy and problem solving in technology-rich environments. These skills represent cross-cutting cognitive skills that provide a foundation for effective and successful participation in the social and economic life of advanced economies (OECD, 2012, p. 10). The first cycle of the PIAAC survey involved adults aged 16-65 from 24 countries and sub-national regions. As for literacy, the results are distributed on a scale of 500 points and various levels of reading competence, from 1 to 5 (the highest) (ISFOL, 2014): the average literacy score for adults in Italy was 250 out of 500, well below the OECD average in the PIAAC (of 273) (fig. 2).

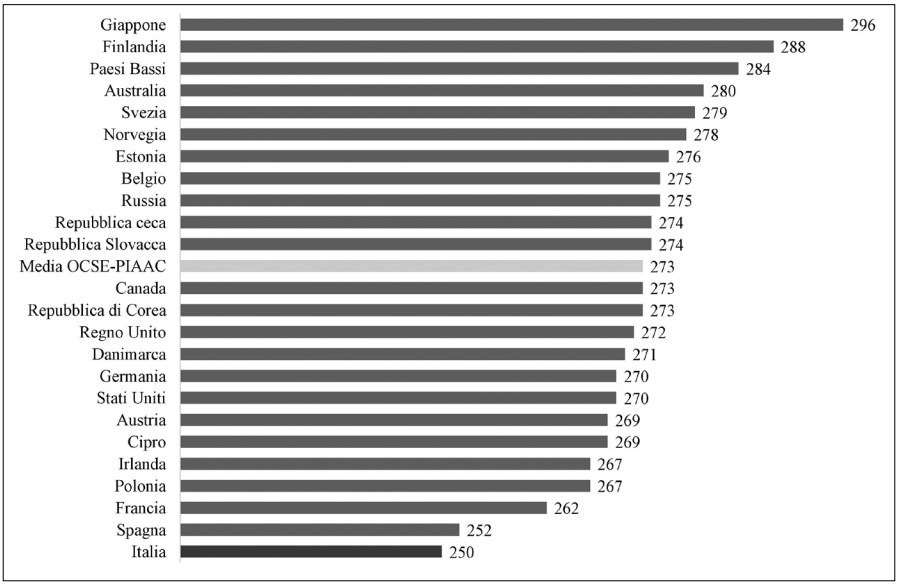

Fig. 2 – PIAAC 2012: Average literacy proficiency score for adults

Source: ISFOL (2014), figure 3.4, p. 72

More than 70% of the Italian population ranks below the minimum level 3 and only 30% rank in the upper levels 3, 4 and 5. It is concerning, for example, that Italian university graduates have the same skills level as Japanese high school graduates, or that they cannot go beyond the minimum reading proficiency level (ISFOL, 2014). In Italy, as in other OECD countries, there is a negative relationship between age and skills, i.e. as age increases, the average literacy score decreases. The skills gap between young and old is very wide in all Italian macro-regions: "The average literacy score of the Italian population is at level 2 for all age groups, going from 261 points in the 16-24 and 25-34 groups to the average 233 points reached by the most adult group (55-65 years)" (ISFOL, 2014, p. 88). The continuous decline in reading skills leads to reflection on the lifestyle that impacts on these performances. The difference in reading skills, might be related to the education received at school and extracurricular experiences from the age of 15 (OECD, 2013a).

In general, the results of international assessments have led to questions about the real educational effectiveness of school and suggest the need to re-evaluate literacy education as an educational path capable of accompanying individuals throughout their lifespan in all existential, professional and social contexts (Acone, 2017).

8. Knowledge to support the teaching of reading

The MEL research project outlined a theoretical framework on the reading development process for different age groups. If teachers are aware of the stages of reading development, they will be better able to assess progress and difficulties that may arise during their students' educational journey. Some of the fundamental areas that should be part of a specialised literacy training plan are: reading accuracy; reading fluency, vocabulary, reading comprehension strategies, reading and motivation. In the research project a selection of good practices were also explored for each of these areas.

The research project started with the study of pre-school age with emergent literacy, print awareness, phonological awareness, vocabulary and storytelling skills (ELINET, 2016; EU High Level Group, 2012; Eurydice, 2011; Garbe *et al*., 2019; Mascia, 2018b). After this, the development of decoding written text in primary school was analysed: the rules of grapheme-phoneme correspondence and the three code deciphering skills: the phonological, orthographic and semantic areas of language learning (Mascia, 2020; Wolf, 2007). While the principal task of the primary school teacher was traditionally to increase reading fluency and only later to focus on the development of vocabulary and comprehension, today's new guidelines advocate that other key competences for literacy education should also be promoted as early as possible.

Most students achieve reading fluency in primary school, but there are still many children who experience difficulties with negative implications for overall school performance. Teachers' interactive reading lessons should therefore also be directed towards enriching vocabulary, providing opportunities to apply comprehension strategies, and promoting acquisition of unconstrained skills (tab. 1).

There is a continuum of reading skills to be acquired, distinguished between constrained skills, such as decoding ability, and unconstrained skills, such as vocabulary enrichment (Paris, 2005). Unconstrained skills have a broader scope and can influence school performance. For many children, especially those from disadvantaged social backgrounds, a critical transition occurs in the later years of primary school, when the "fourth-grade slump" may be experienced (Chall *et al.*, 1990). For children raised in poverty, in families with limited formal education and in an environment unfavourable to the development of literacy, this represents the beginning of a skill-divide that can only increase with age. To prevent this trend, teachers should receive a specific training (Paris, 2005).

Tab. 1 – Skills children acquire starting in preschool that affect literacy

Constrained skills		*Unconstrained skills*	
Print-related	*Sound-related*	*Language*	*Knowledge*
Letter recognition Writing one's own name	Reciting the alphabet Rhyming	Vocabulary Grammar	Topic-specific knowledge (science, geography, social, structures)
Reading environmental print (signs, labels)	Segmenting initial phonemes (say frog without the fff)	Story structure Telling narratives	Information seeking Requesting explanations
Book handling	Invented spelling	Giving descriptions Engaging in pretend play	

Source: Snow and Timothy (2016)

In the following stage of critical reading, it was assessed that students should be intellectually flexible, able to cope with reading long and unfamiliar texts and to integrate reading with prior knowledge in different areas and in a critically oriented approach. This corresponds to OECD PISA level V. In fact, it was observed that only a low percentage (5.7%) of Italian 15-year-olds reach this level of reading in the latest PISA surveys (INVALSI, 2016). In order to achieve these goals, it is necessary to strengthen the use of metacognitive strategies, which are fundamental for reading and writing comprehension especially in disciplinary areas (Moje, 2008; Shanahan and Shanahan, 2012; 2014; Wineburg, 1991). A differentiated instruction for reading, and a transition to disciplinary literacy, is therefore required (Mascia, 2018c).

Student's reading habits change after the end of the education cycle and are influenced by educational, cultural and work-related factors. In the final stage of development, reading is used to fulfil personal and professional needs and purposes. Readers also continue to evolve according on the amount and quality of reading they practice as a leisure activity, to achieve a deeper understanding of themselves and the world (Wolf, 2007; 2018).

9. MEL Guidelines for teacher training in the field of reading literacy

Following the analysis of international survey data related to reading skill development in the theoretical framework, several guidelines were defined for specific teacher training in literacy Education. These include skills and knowledge accompanying a child's growth as a reader; teacher training and

the quality of literacy education. The guidelines, which include theoretical concepts and examples of good practices, provide the basis for the professional development model of literacy education (MEL – Model for Literacy Education).

MEL Guidelines for Pre-school teachers included:

- Guideline 1: Creating a reading environment;
- Guideline 2: Reading aloud;
- Guideline 3: Interactive reading aloud;
- Guideline 4: Print awareness;
- Guideline 5: Phonological awareness;
- Guideline 6: Narrative and storytelling;
- Guideline 7: Vocabulary;
- Guideline 8: Involving parents.

MEL Guidelines for Primary School teachers included:

- Guideline 9: Reading and motivation;
- Guideline 10: Reading fluency;
- Guideline 11: Reading comprehension strategies;
- Guideline 12: Disciplinary literacy;
- Guideline 13: Promoting writing;
- Guideline 14: Text genres and other reading resources;
- Guideline 15: School library.

MEL Guidelines for Secondary School teachers included:

- Guideline 16: Reader assessment;
- Guideline 17: Independent reading;
- Guideline 18: Classroom library;
- Guideline 19: Metacognitive strategies;
- Guideline 20: Disciplinary literacy;
- Guideline 21: Reading habits;
- Guideline 22: Shared Reading;
- Guideline 22: Reader's notebook.

The MEL guidelines are also characterised by some general principles:

- fostering understanding of both theory and practice for reading education at school;
- involving all teachers, regardless of the subject they teach. As teachers share responsibility for the growth of students' reading skills;
- promoting a shared responsibility for teaching reading and reciprocal learning among teachers;
- they can be adapted and enriched according to the context of reference and the needs of the school community.

10. Methodology and pilot project

Because of the composite nature of MEL research, in the scientific field of the pedagogy of reading, the mixed methods research methodology was chosen for integrating quantitative and qualitative approaches (Amaturo and Punziano, 2016; Clerici, Gola and Cisco, 2013; Creswell and Plano, 2007; Tashakkori and Creswell, 2007; Teddlie and Tashakkori, 2009).

Through the combined use of quantitative and qualitative survey tools, the pilot project aimed at understanding whether teachers, trained as "reading specialist" and possess more theoretical and practical knowledge on literacy education, teach and promote literacy more effectively among students. The research project "MEL: Model for Literacy Education" was conducted with the Free University of Bozen-Bolzano, promoted by the Centre for Books and Reading, involved a sample of teachers and students from two schools located in areas "at risk and with a high immigration impact" in the North and South of Italy. Table 2 shows the composition of the sample by school cycle.

Tab. 2 – Schools, classes, teachers and students that participated in the MEL project study

Grade	*Class*	*Teachers*	*Students*
Participating classes			
School: Istituto comprensivo 1 (Milano)			
Pre-school	2	4	48
Primary	4	6	85
Secondary	4	11	89
Other teachers (control group)	24	33	0
Total	34	54	222
School: Istituto comprensivo 2 (Palermo)			
Pre-school	1	1	22
Primary	5	5	85
Secondary	3	4	70
Other teachers (control group)	9	15	0
Total	18	25	177

Teachers involved in the research project participated in MEL training course, which included a series of lectures about theoretical models and MEL guidelines. The MEL training course was organised as follows:

– general presentation addressed to all school teachers ("Group A Research" and "Group B School"), which included the presentation of the

state of art of literacy in Italy and factors that impact on the reading competencies as observed in international surveys;
– frontal lectures addressed to the teachers of "Group A Research" and "Group B School" split by grade (pre-school, primary and secondary), which included a presentation of theories and principles to promote reading skills;
– detailed lectures were dedicated only to the teachers of "Group A Research" in which the guidelines and other materials available for consultation were presented (bibliography of youth literature, articles and online videos). At this stage, teachers involved in the research project attended the lectures and submitted questions on the various issues or problems experienced in classroom with students. Teachers also promoted further discussion among other colleagues involved in the MEL research project, in a spirit of "reciprocal learning";
– online distance learning program: for further study or review of the lectures, teachers were invited to consult the online distance learning program "Invito alla Lettura" by *RAI Scuola* (Mascia, 2017; 2018c; Mascia and Roncaglia, 2019).

Teachers adopted and applied the MEL guidelines for reading instruction and observed students' reaction to the different proposals. Documentation of their teaching practice, provided by teachers, contained important reflections on reading instruction, contributing to the dissemination of relevant experiences in classrooms and school. Therefore, teachers felt themselves as active parts of the training process, proposed and adapted good practices to the school and local context. Teachers involved in the project also organised periodical meetings and, throughout the research period, they discussed and evaluated the new knowledge acquired during the training course.

11. Outcomes

Through the combined use of quantitative and qualitative survey tools, as part of the mixed methods approach, it was investigated whether teachers who attended the entire training program MEL could promote literacy education more effectively among their students.

The first stage of the pilot project reported findings for the primary school and showed active teacher participation in the training program, a positive impact on classroom literacy education and a clear commitment student reading. Teachers' personal beliefs in the program were crucial to its success, since teachers can resist suggestions to change the habitual methods

(Walpole *et al.*, 2010) and junior teachers may adopt approaches that are not well suited to meet the needs of children with reading difficulties. Teachers participants could include MEL guidelines in their curriculum for literacy education in classroom. In the qualitative surveys, it was observed that all guidelines were applied and difficulties experienced were minimal.

It was also found, from the quantitative analysis, that in the post-training phase, there was a greater diversification in the use of reading materials, which positively influenced literacy education (i.e. a decrease in the use of school books in favour of fiction and other types of literacy material such as newspapers and journals). Teachers had a preference for those good practices which involved active participation by the children and promoted reading for pleasure (such as visits to the local library, reading workshops in school library and reading aloud from texts selected by the students). Improvement in literacy education is also evidenced by the increasing use of metacognitive reading strategies, in particular teachers trained students' metacognitive skills that enhanced a connection between the book or text to students' prior knowledge.

The general positive trend was observed in the increase (+86%) of weekly hours dedicated to literacy education in the classroom, involving several subjects (not only during the language classes). The improvements in literacy education in classroom were also reflected in the results of the questionnaires completed by students, specifically on the time they devoted to daily reading habits (40% of the children read at least 30 minutes a day) and on the total number of books read in the three months preceding the post-survey (Mascia, 2020).

12. Conclusions

To understand the evolution of reading skills in our country and the characteristics of readers, secondary data from international reading surveys were analysed, namely IEA PIRLS for fourth-grade students, OECD PISA for 15-year-old students and OECD PIAAC for adults (ISFOL, 2014; 2016; Miller and McKenna, 2016; Mullis *et al.* 2015; 2017; OECD, 2013a; 2013b). The analysis mapped out the general state of literacy skills in Italy and outlined the parameters for teacher training in the field of literacy education. The research project also analysed the process and development of literacy competence within different age groups, finding that literacy education should focus on vocabulary enrichment; on the opportunity provided to the child/young person to apply strategies to foster comprehension processes, but also

be oriented towards promoting the acquisition of unconstrained skills that can positively influence school performance.

What core knowledge should teachers possess in order to be qualified to teach literacy? The research defines a Model for Literacy Education (MEL) to provide teachers with the necessary expertise to support students in their growth as competent readers from learning processes to reading comprehension and motivation, from assessment of critical literacy skills to support strategies for struggling readers in multicultural environments. Teacher's professional development as "reading specialists", in schools of all level, is an essential resource for addressing the achievement gap in children's and adolescents' reading skills, offering them greater prospects for active participation in society, and for overcoming the barriers posed by social inequalities to access to culture and lifelong learning.

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4. Use of INVALSI data for formative assessment activities in English teaching

by Cecilia Fissore, Marina Marchisio

The INVALSI English test was first introduced in 2018 to measure students' ability to understand written texts or spoken texts, according to the Common European Framework of Reference for Languages. Despite the Italian National Guidelines for secondary education state B2 as the English exit level to be reached at the end of upper secondary school, according to the INVALSI report of 2019, about 65% of Italian students do not reach this level in the listening test and 48% do not reach it in the reading test. To improve these results and to overcome students' difficulties in acquiring these skills, teachers can adopt formative assessment strategies. Formative assessment is a continuous process that sees students as active protagonists and that motivates them to progress in their learning. Technologies, such as an Automatic Assessment System, can offer valid support for formative assessment strategies. The aim of this research is the design of material for a training course for secondary school English teachers; the research focuses on adapting INVALSI questions designed for standardized assessment to questions for formative assessment, for developing language skills and preparing for the INVALSI tests. Some examples will be shown, highlighting the strategies adopted.

La prova INVALSI di Inglese, introdotta per la prima volta nel 2018, ha lo scopo di misurare le competenze degli studenti nell'ascolto e nella lettura, secondo il Quadro Comune Europeo di Riferimento per le lingue. Nonostante in Italia le Indicazioni Nazionali indichino il B2 come livello di uscita in inglese da raggiungere al termine della scuola secondaria di secondo grado, secondo il rapporto INVALSI del 2019, circa il 65% degli studenti italiani non raggiunge questo livello nella prova di ascolto e il 48% non lo raggiunge nella prova di lettura. Per migliorare questi risultati e superare le difficoltà degli studenti nell'acquisire queste competenze, gli insegnanti possono

adottare delle strategie di valutazione formativa. La valutazione formativa è un processo continuo che vede gli studenti come protagonisti attivi e che li motiva ad avanzare nel loro apprendimento. Le tecnologie, come ad esempio un sistema di valutazione automatica, possono offrire un valido supporto per strategie di valutazione formativa. Lo scopo di questa ricerca è la progettazione di materiale per un corso di formazione per insegnanti di Inglese della scuola secondaria. La ricerca si concentra sull'adattamento delle domande INVALSI progettate per la valutazione standardizzata a domande per la valutazione formativa, per lo sviluppo delle competenze linguistiche e per la preparazione ai test INVALSI. Verranno mostrati alcuni esempi, evidenziando le strategie adottate.

1. Introduction

School has a primary role in assuring a proper language education and the development of skills, which will allow students to successfully enter foreign universities or the job market.

In 2018, the INVALSI English test was introduced to measure some essential skills that students must possess, appropriate for their age. The tests measure the ability to understand written texts or spoken texts, according to the CEFR – Common European Framework of Reference for languages (Council of Europe, 2018). The CEFR was developed by the Council of Europe between 1989 and 1996, as part of the Language Learning for European Citizenship project, and it has been adopted by almost all countries to assess skills in a foreign language. It is a descriptive system used to evaluate the skills achieved by those who study a European foreign language and to indicate the level of language teaching in four areas (reading, listening, speaking, and writing). The CEFR establishes six progressive levels of knowledge of the language, from A1 (breakthrough level) to C2 (mastery level), and each level of the CEFR is characterized by a text describing the degree of language proficiency achieved. INVALSI has adopted the levels established in the CEFR to evaluate the preparation of students. The scales adopted range from Pre-A1 (preschool level) to B2 and the areas of competence evaluated are reading and listening, because the areas of conversation and writing are not suitable for evaluation through standardized tests.

It is important to underline that the level descriptors do not refer to morphosyntactic structures, tenses, lexical elements, etc. but they refer to the textual complexity and the operations that the reader or the listener knows how to execute. Depending on the level, the difficulty of the texts increases in terms of

topics, length, typology, degree of complexity of linguistic structures, vocabulary, reading strategies, and listening speed. Another very important feature of the INVALSI question text is the authenticity, for a communicative approach to language learning. "Authenticity" is a frequently invoked and, at the same time, strongly debated notion in English Language Teaching. The interest in this notion has increased with the development of a large corpora of naturally occurring English and the way the internet has provided easy access to varied language material. The term "authenticity" is related to notions of realness or trueness to origin (Buendgens-Kosten, 2014). In the late 1970s, H.G. Widdowson, one of the fathers of the communicative approach, introduced a distinction between authenticity as it applies to texts viewed in isolation (which he called "genuineness"), and texts in a pedagogical context: "Genuineness is characteristic of the text itself and is an absolute quality. Authenticity is a characteristic of the relationship between the passage and the reader and it has to do with appropriate response" (Widdowson, 1978). According to this definition, a text is genuine if it is a real/realistic example of discourse designed to meet a communicative purpose (unlike an artificial text for teaching language). Authenticity is present if a text is used in ways that correspond to normal communicative activities. According to Widdowson, genuineness is relevant, but the main purpose must be to match genuineness with authenticity.

The National Guidelines defined by MIUR (2010) are also closely linked to the CEFR. In fact, the Italian National Guidelines for secondary education state B2 as the English exit level to be reached at the end of upper secondary school in all institutes and study fields (except for Vocational Schools where the required level is level B1+). During high school, students should acquire:

– skills in understanding oral and written texts relating to topics of both personal and scholastic interest (literary, artistic, musical, scientific, social, economic fields);
– skills in the production of oral and written texts to report facts, describe situations, argue and support opinions;
– skills of interaction in the foreign language in an appropriate manner both to the interlocutors and to the context;
– skills of analysis and interpretation of aspects related to the culture of the countries whose language is spoken.

The National Guidelines (MIUR, 2010) also underline how it is necessary to provide for a horizontal transversality (among the various languages that students study) and a vertical continuity in the process of learning and teaching languages. To do this, students need to develop competences in different school grades using coherent approaches and methods, in order to foster the transfer of the same strategies in vertical continuity.

According to the INVALSI Report of 2019, in the listening test, the percentage of grade 13 students who do not reach level B2 is approximately 50% in the two macro-areas of Northern Italy, 64% in the Center, 79% in the South and 84% in the South and Islands. In the reading test the results are better, but the trend is the same as that observed for the listening test. At grade 13 students who do not reach level B2 are 35% in the two macro-areas of Northern Italy, 48% in the Center, 59% in the South and 66% in the South and Islands. This situation may preclude opportunities for future employment.

INVALSI standardized tests inevitably do not measure all aspects of student learning, such as environmental and social variables, interpersonal skills, and oral or written communication skills. In fact, their aim is not to evaluate students (or their teachers) but to offer an objective and external self-evaluation tool for each School. The results of the tests indicate the level of competence reached by a student, but they certainly cannot explain the reason for a positive or negative result. Only students' teachers can try to understand this aspect. A standardized assessment cannot comprehensively evaluate students or even guide and monitor their learning process (INVALSI, 2021b). This type of evaluation takes place through formative assessment: a continuous process that sees students as active protagonists and that motivates them to advance in their learning. Formative assessment is one of the most important methods for developing students' self-determination, self-efficacy, autonomy, and self-esteem. It can help students to increase their motivation to study, to acknowledge their strengths and weaknesses, to be aware of the level reached, to proceed step by step, following the feedback received, which must always be numerous and immediate.

In 2020, in order to help schools deal with the difficulties deriving from the suspension of face-to-face lessons due to the Covid-19 pandemic, the INVALSI Institute itself has created materials and training tools aimed at teachers and schools as a bridge between formative and summative assessment. Thanks to the fact that in recent years the INVALSI tests have been computer-based and thanks to the many data collected, the INVALSI materials are based on empirical data.

Technologies, such as an Automatic Assessment System (AAS), can offer valid support for language teaching and learning and one of the teaching practices in which technology can play a fundamental role is the formative assessment (Barana *et al.*, 2019; Barana *et al.*, 2020; Barana *et al.*, 2020; Barana *et al.*, 2019). The Delta Research Group of the University of Turin has developed and tested a model for automatic formative assessment and immediate and interactive feedback with an AAS (Barana *et al.*, 2018). The training activities conducted by the Research Group (Barana *et al.*, 2017)

showed the effectiveness of an automatic formative assessment, but at the same time highlighted the importance of training teachers and students in the use of technologies.

The object of this research is the design of material for a training course for secondary school English teachers. The teacher training course focuses on adapting INVALSI questions designed for standardized assessment to questions for formative assessment for developing language skills and preparing for the INVALSI tests. During the training course, teachers will have to create questions with automatic formative assessment, reflecting on how to adapt the requests to the different needs of the students and on how to create guided learning paths.

2. Formative assessment and feedback

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". Assessments become formative when the information is used to adapt teaching and learning to meet student needs. When teachers know how students are progressing and where they are having trouble, they can use this information to make necessary instructional adjustments, such as reteaching, trying alternative instructional approaches, or offering more opportunities for practice. These activities can lead to improved student success (Boston, 2002). 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.

According to Black and Wiliam (1998), efforts to strengthen formative assessment produce significant learning gains. Feedback given as part of formative assessment helps learners become aware of any gaps that exist between their desired goal and their current knowledge, understanding, or skill and guides them through actions necessary to obtain the goal. Feedback,

one of the strategies for an effective formative assessment, takes on a very important role to reduce the discrepancy between current and desired understanding. Effective feedback must answer three main questions: "Where am I going?", "How am I going?", "Where to next?". Effective feedback 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 (Hattie and Timperley, 2007). The importance of feedback is also highlighted in the literature on language assessment. Pallotti (2005) argues that giving students feedback on mistakes is much more important than correcting them. Feedback must be understood as an informative response in which the teacher informs students about the outcome of their choices, assisting them in the moment of analysis and systematization. Balboni (2011) focuses his attention on a student-centered perspective in which, through continuous feedback, students can be monitored to verify the achievement of set objectives.

The development of new technologies, and in particular the use of an AAS, can support student learning, also including the possibility of giving feedback. An AAS is often used for summative assessment because it offers the opportunity to automatically evaluate, collect and analyze students' responses. However, it can also offer support for a formative assessment, to give immediate, personalized feedback, to guide students in an exercise or to propose adaptive exercises. Moreover, teachers in the classroom deal with a large number and variety of students. They can have concrete support in offering all students personalized feedback and teaching from educational technology.

The Delta Research Group of the University of Turin has developed and tested a model for automatic formative assessment with the AAS Möbius Assessment[1].

The characteristics of the model are:

– availability. The tests are always available to students, who can take them at their own pace, with no time limits and number of attempts;
– algorithm-based questions and answers. The questions can have distinct random values on each attempt made by the student, and the answers are evaluated using code. This can be achieved through the implementation of Mathematical software algorithms on which the AAS is based;
– open answers: the use of textual response areas where the AAS searches the keywords in students' answers;
– immediate feedback. The results are quickly calculated and shown to students while they are still focused on the task. Tests with no more than five questions are used in order to increase the immediacy of the feedback;

[1] https://www.digitaled.com/products/assessment.

– interactive feedback. Immediately after answering a question, the system can show if the answer is correct and propose to the student a step-by-step guided resolution. The interactive process shows one possible way to answer the question.

Contextualization: the assignments should be developed within a real-world context which engages students more and helps them to better understand the contents.

This model was born for STEM disciplines but has also proved useful for other disciplines, for example for language learning (Barana *et al.*, 2019; Marello *et al.*, 2019). According to this model, the AAS allows the creation of adaptive questions that give students another chance when they give an incorrect response and that can be adapted to provide more information. Adaptive questions also allow the student to try a simpler version of the question, guide them through the exercise one step at a time, and present whatever other approach the instructor feels is appropriate. This type of questions with interactive and immediate feedback is very suitable for automatic formative assessment (Barana *et al.*, 2020; Corino *et al.*, 2020). The importance of immediate and interactive feedback is essential for both students and teachers. Through continuous and formative feedback, the student can focus not on the result, but on the progress made, on the mistakes made, and on the actions to be taken to improve. At the same time, teachers can progressively monitor students' learning levels and obtain valuable feedback.

3. Research object and hypothesis

The object of this research is the design of material for a training course for secondary school English teachers, focused on the creation of questions for automatic formative assessment starting from INVALSI questions for standardized assessment.

In fact, to create questions for formative assessment teachers and trainers can use multiple sources: textbooks (which all students and teachers have), internet, open online resources, or paid resources. A very precious resource that is often not considered is GESTINV (INVALSI, 2021a), the INVALSI test archive. Gestinv is an interactive archive available to teachers, students, schools and families, which collects and organizes the INVALSI test materials. The questions in the archive are made available to teachers and students to allow a better understanding of the structure of the tests and the competences examined and to offer a greater understanding of the function of the different questions. The archive of English tests, available only from 2020, still needs to

be enriched and strengthened. Nevertheless, the advantage of using the Gestiv archive is that for each question it is possible to know its properties (the areas investigated, the degree, the response given by the students, etc.) and to create test materials for the core competencies examined by National Guidelines.

The research question is: how to use INVALSI data to design automatic formative assessment activities to facilitate the learning of the English language?

4. Data and method

The documents used for the research, available on the INVALSI website, were: "The CEFR for the languages of the Council of Europe (Council of Europe, 2018) for a description of the language skills required of secondary school students and how they are assessed".

Descriptors of the levels of English for lower and upper secondary school (described in the CEFR). The reference scale identifies three levels of linguistic competence, each in turn divided into two levels, for a total of six levels: elementary A1/A2, intermediate B1/B2, advanced C1/C2. For each of the six levels there are descriptors for linguistic-communicative skills, for listening and reading comprehension and for written and oral production.

The "English tests: reading and listening comprehension" (Calanchini, Monti and Cavicchiolo, 2018) in order to study how the reading and listening tests are structured, what the constructs investigated and the objectives of the tests are, the description of the tests in relation to the levels of competence defined by the National Guidelines and the CEFR, and the articulation of the results of the INVALSI tests in levels.

– The "INVALSI English test at the end of the second cycle of instruction" (INVALSI, 2018) to study the purposes of the tests in relation to the National Guidelines, the characteristics of the test contents, and the types of questions used in the INVALSI English tests for secondary school;
– the INVALSI 2019 test report (INVALSI, 2019) to analyze the sample results of the INVALSI tests. The Report presented in 2019 is the first report in which the results of grade 13 are also reported;
– examples of INVALSI English questions for lower and upper secondary school (INVALSI, 2021a) in Gestiv and in the Test Area of the INVALSI website[2];
– training videos on the INVALSIopen YouTube channel[3].

[2] www.invalsi.it.
[3] https://www.youtube.com/c/invalsiopen/featured.

The methodology adopted to design the training material and activities was the following:

– study of the CEFR and the expected skills for the English language at the end of the first and second cycle of education;
– analysis of how the INVALSI English test is structured for grade 8 and 13 and of the type of questions of the various tasks;
– analysis of the "INVALSI 2019 test report" and of the results in English in listening and reading to understand the levels reached by Italian students;
– study of examples of questions and design and implementation with the AAS of questions for formative assessment starting from the INVALSI examples;
– reflection on the strategies to be used to make formative assessment effective.

5. Results

The INVALSI questions fit very well with our automatic formative assessment model because the contexts of the texts and audio files used in the tests are real and relevant to the social and professional life of the students. Some themes are nature, science, technology, free time, media, sport, travel, art, music, etc. The tests use the analysis of authentic materials (texts and audio files) to expose students to natural language, the same one they will face in real situations outside of school. In this way, students acquire a real linguistic competence in reading and listening.

Each task is preceded by specific instructions in English, both for reading comprehension and for listening comprehension, and in all tasks the first question is the example. The example has the function of clarifying the type of questions to students, guiding them in the non-linguistic topic of the text and making them understand what type of response is required (INVALSI, 2018).

The goal of the reading comprehension test is to test all the different reading methods, in order to verify whether the student is a competent reader in all the possible types of reading that can occur in an authentic situation. The types of reading/listening that the student must adopt can be:

– Reading/Listening for gist: fast and selective type of reading/listening, to understand the main idea;
– Reading/Listening for specific information and important details: fast and selective type of reading/listening, to understand specific information or important details;

– Reading/Listening for main ideas and supporting details: careful and intensive type of reading/listening, to understand the main ideas and supporting details;
– careful and intensive type of reading/listening to deduce the meaning of a proposition or a word from the context.

To better focus the student's attention on one type of construct at a time, each task requires the adoption of a single type of reading, and the reading style to be adopted for every task is made explicit by the example. The same rule applies to the listening comprehension test. There are two main styles of listening comprehension:
– selective listening: when we need to catch specific information or important details, or if we want to get the gist of a spoken text;
– careful listening: when we need to understand the main ideas of a spoken text.

The aim of the INVALSI listening comprehension test is to test all the different listening modes, in order to verify whether the student is a competent listener for all possible authentic communication purposes (Calanchini, Monti and Cavicchiolo, 2018). The listening test is often more complex for students (and others) because the text is not available to listeners: they must know how to orient themselves in listening and recognizing the words. Listening is an active receptive skill: the listener must perform many operations simultaneously in real time; there are strategies to be activated and listening styles to be adopted in order to successfully carry out the listening processes.

The Reading test and the Listening test consist of five tasks, two at level B1 and three at level B2. In the Reading test, each task contains an authentic text and comprehension questions. Texts can be narrative, descriptive, argumentative, expository, regulatory, continuous and non-continuous (taken from newspapers and magazines, the Internet, books, manuals, brochures and leaflets, advertisements). In the Listening test, each task consists of an audio of maximum 4 minutes and comprehension questions. The audio can be a monologue, a dialogue between 2 or maximum 3 people, or a sequence of small monologues by different speakers. Audios are authentic recordings, for example interviews, lectures, conversations, television programs, podcasts, etc. Audio files can include speakers of different genders and ages with a wide range of accents, and the linguistic register can be informal as well as formal. The audio file is always played twice (INVALSI, 2018).

The types of questions for the reading test and for the listening test are:
– multiple choice questions (with four answer options in which the student must select only one option) to complete questions or sentences;

– multiple matching questions in which the student must match a part of the text with a title or a summary phrase or an image. The combination can be between a first part and a second part of a sentence, or it can be a combination of sentences, titles, descriptions, figures;
– short open answer questions in which students must provide an answer of up to four words (or numbers);
– true/false/not given questions. In this case the questions are statements that students, based on what they read, must select as true, false, or not present in the text. This typology is present only in the reading comprehension test.

By studying the materials on the INVALSI website and on Gestiv and the training videos held by INVALSI experts, 30 questions of different types (15 for the reading test and 15 for the listening test) were designed and implemented with the AAS. INVALSI questions, intended for standardized assessment, were transformed into formative assessment questions for the development of language skills. During the design of the questions, the possible strategies that were adopted to make the question formative were analyzed. During the training course, teachers will have to create questions with automatic formative assessment, reflecting on how to adapt the requests to the different needs of the students and on how to create guided learning paths. Some of these materials will serve as an example for teachers during the training course. It will also be interesting to observe and analyze the strategies that teachers will use to adapt the questions for formative assessment. In particular, it will be inspiring to compare the different strategies adopted by the teachers starting from the same question, as well as to compare them with those used by us.

6. Example of designing a question to develop reading skills

The first example is a question for the B1 level reading comprehension test. In the CEFR, the indicator for the overall reading comprehension states that student "Can read straightforward factual texts on subjects related to his/her field and interests with a satisfactory level of comprehension". The CEFR self-assessment grid at level B1 states "I can understand texts that consist mainly of high frequency everyday or job-related language. I can understand the description of events, feelings and wishes in personal letters". The INVALSI example, shown in Figure 1, is titled "A couch surfing experience". This task was also presented by INVALSI experts, in webinars and training videos on the INVALSIopen YouTube channel.

Read the text about the experience of a girl staying overnight at strangers' homes while travelling.
Decide whether the statements (1-8) are true (T) or false (F), then write the first four words of the sentence which supports your decision in the space provided.
The first one (0) has been done for you.

A couch surfing experience
Penny Sadler of Adventures Of a Carryon
One of my best vacation memories is my first and only couch surfing experience in a small town in northern Italy.
This trip came at a time in my life when I was under quite a lot of stress and really needed to get away. Only Italy would do. That's another story. I didn't think I could get a host for more than a day or two at a time and was trying to sort out how I could afford to pay for accommodations and airfare. Then, miraculously, Angelo offered to host me for an entire week. With accommodations taken care of, I booked my airfare immediately. Angelo was an experienced couch surfing host and made me comfortable immediately. He picked me up at the train station, showed me around his town, which wasn't too big but big enough to be interesting, and he knew a lot about the history so he was a really great tour guide. He worked during the day but we would meet in the evening for dinner or go out for a gelato and a walk, a typical Italian pastime. I met his friends, took the train and explored a new city every day, and just generally had this incredibly relaxing stress-free week, which was exactly what I needed. Exploring an area of Italy that I had never experienced before was the perfect way to forget myself completely. Many people have asked me if I felt nervous about staying with a stranger. The answer is no, because a friend of mine had already stayed with Angelo so I knew that I'd be safe with him. But he also had many good references on his couch surfing profile and knowing what I know now I probably would've stayed with him anyway. Couchsurfing is a great way to immerse yourself in a culture or just to get to know an area more intimately, as if you live there. I'm still in touch with Angelo today and saw him just last year for a few days. I feel that I have made a lifelong friend in Italy.

0 Penny had never been couch surfing before.
Q1 She needed to relax and forget her troubles.
Q2 Angelo agreed to provide a place for a couple of days.
Q3 They first met outside Angelo's home.
Q4 Angelo was with her all the time.
Q5 Penny visited more than one Italian town.
Q6 Sometimes Penny was worried because she didn't know Angelo.
Q7 Using cheap lodging helps one experience the true life of a place.
Q8 Penny and Angelo haven't met since.

	True [T] or False [F]	First four words
0	True	One of my best
Q1		
Q2		
Q3		
Q4		
Q5		
Q6		
Q7		
Q8		

Fig. 1 – INVALSI reading comprehension question (level B1)

Source: INVALSIopen (www.invalsiopen.it)

	True or False	First four words
Penny had never been couch surfing before.	True	One of my best
She needed to relax and forget her troubles.	○ True ○ False	
Angelo agreed to provide a place for a couple of days.	○ True ○ False	
They first met outside Angelo's home.	○ True ○ False	
Angelo was with her all the time.	○ True ○ False	
Penny visited more than one Italian town.	○ True ○ False	
Sometimes Penny was worried because she didn't know Angelo.	○ True ○ False	
Using cheap lodging helps one experience the true life of a place.	○ True ○ False	
Penny and Angelo haven't met since.	○ True ○ False	

Fig. 2 – First part of the INVALSI reading comprehension question with the verify button

In Figure 3, a possible behavior by students was simulated. For example, students might initially try to answer the questions and click the verify button to check if they answered right. In this case they have immediate feedback, while they are focused on the activity, on the correctness of the answers and on which parts, if any, were wrong (true/false or justification). Then they can try to correct themselves, still having two attempts to verify. In this way, students can actively think about the answers entered and have more attempts available. The possibility of having more attempts available through a guided and interactive path is crucial for students' self-confidence and can help to overcome the errors due to the incorrect insertion of the written answer. At the end of this first part, the students get final feedback on the correctness of their answers and, in case of an error, on what the correct answers were.

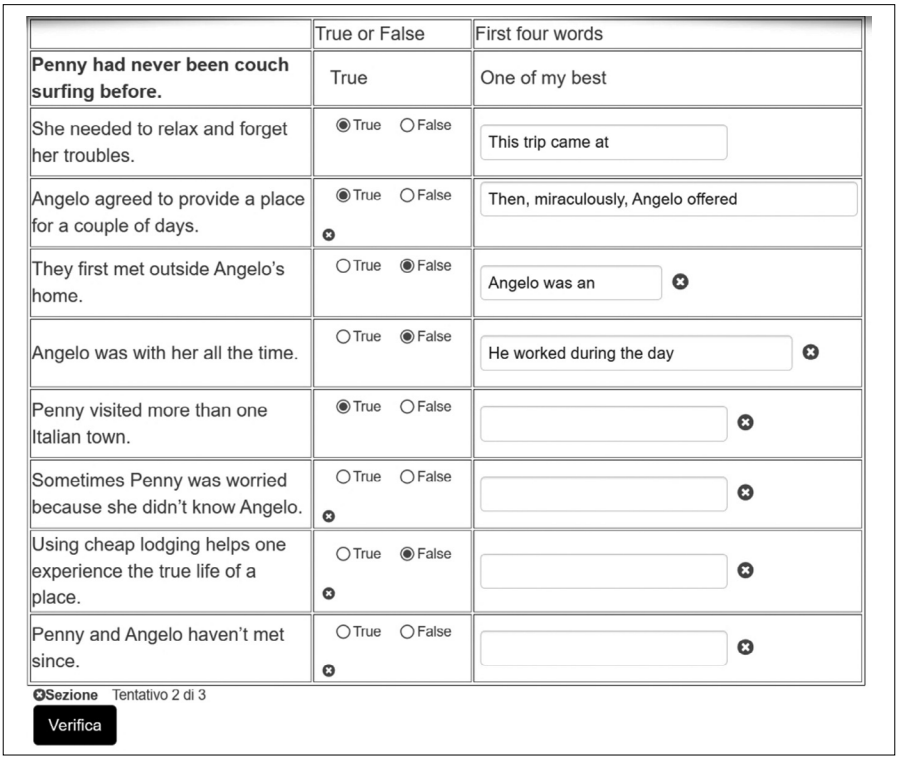


Fig. 3 – Example of immediate feedback with the verify button

The evaluation method used for this question is the "true/false/justification" method. As the instructions explain, the student must read the proposed text and the nine statements (eight plus an example). Then in the table, for each statement the student must indicate whether it is true or false (by inserting the letter T for true and F for false). For both choices, students must provide a justification by identifying the sentence in the text that contains such justification. Students are not asked to provide the words that carry the justification, but the first four words of the sentence containing it. The text is 375 words long and has a linear and clear structure. In this case, after completing the question, students can get final feedback and know if the answers given are right or wrong. However, if students have made some mistakes, they do not receive feedback on how to improve, they can only eventually try to answer the question again. Depending on how many questions we ask the student in the test, the feedback will be more or less immediate.

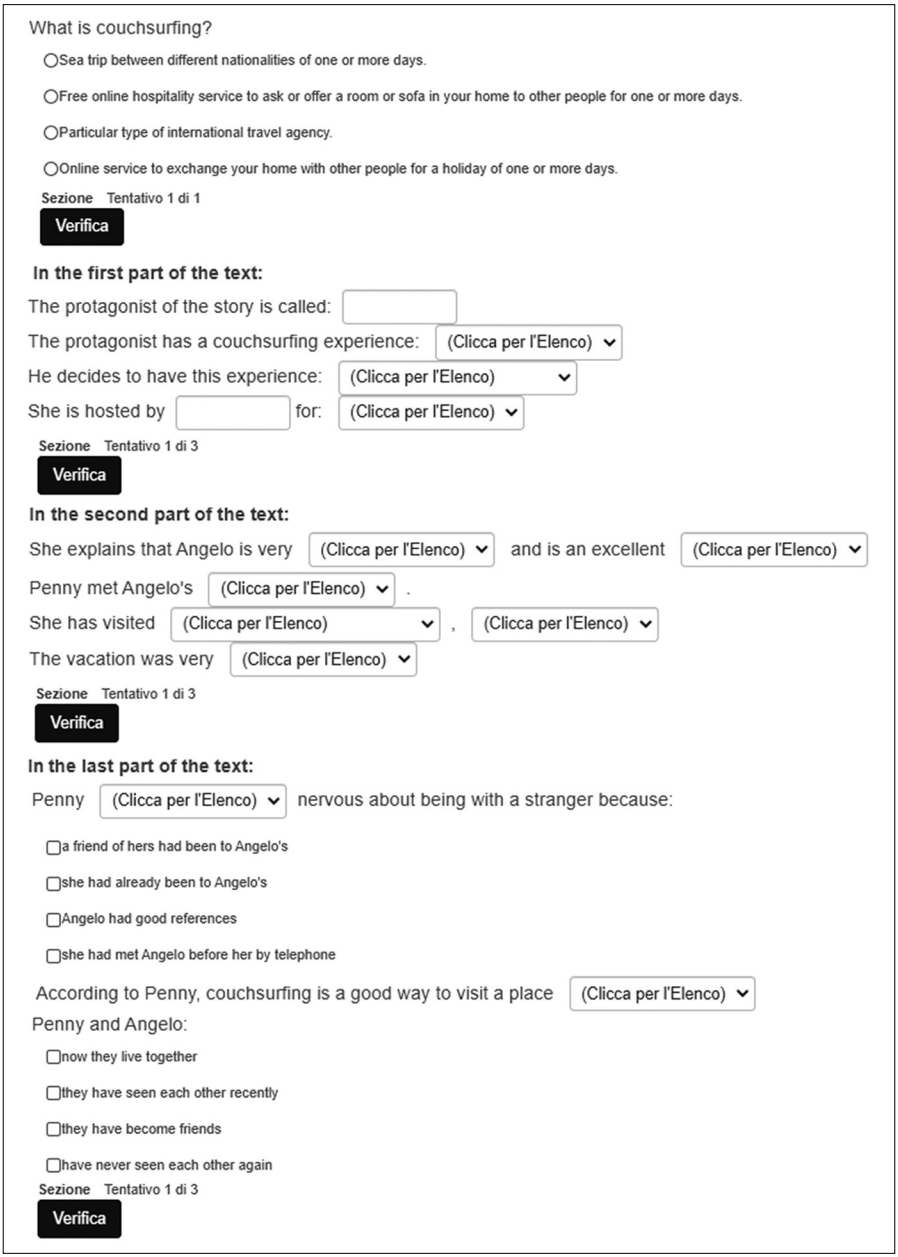


Fig. 4 – INVALSI question of reading comprehension transformed into a question for formative assessment

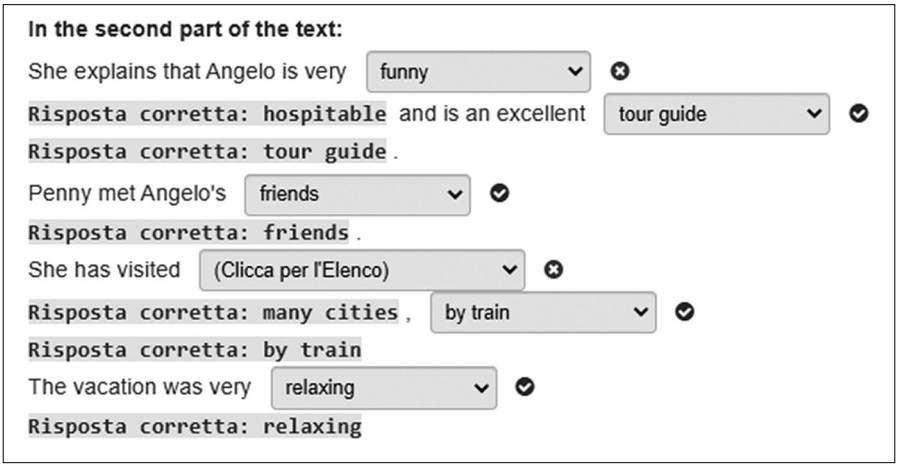


Fig. 5 – Second example of immediate feedback with the verify button

Several strategies were applied to transform the question into a formative assessment question. In the first part of the question, shown in Figure 2, the same INVALSI question is reported. After reporting instructions and text (divided into three parts), the answer mode was slightly modified to facilitate students, by writing the affirmations directly into the table and inserting a true/false multiple choice answer area. In this case, the students have three attempts to answer the question. At the end of the question, there is a "verifica" button (which means verify in Italian) that the student can click at any time (for a maximum of three times) to verify the correctness of the answers given.

After this first part, students are offered a guided path divided into four parts (Figure 4), each of them characterized by the check button at the end:

– the first part concerns the meaning of "couchsurfing", the theme of the story;
– the following parts of the question guide students to understand the parts into which the text is divided (the first, the second and the last part).

Through different types of answer areas (open answer, multiple choice and fill in the blanks with drop-drown menu) students go through the text step by step (in a reformulated way), in order to understand all aspects of the text and the statements of the initial part.

At the end of each part of the question, the students get feedback, as in Figure 3 and Figure 5, on the answers given correctly, on the mistakes made and on how to fix them. The path is guided in such a way that students cannot see the other parts of the question until they complete the question and get the feedback. Moreover, the interactive feedback with multiple attempts en-

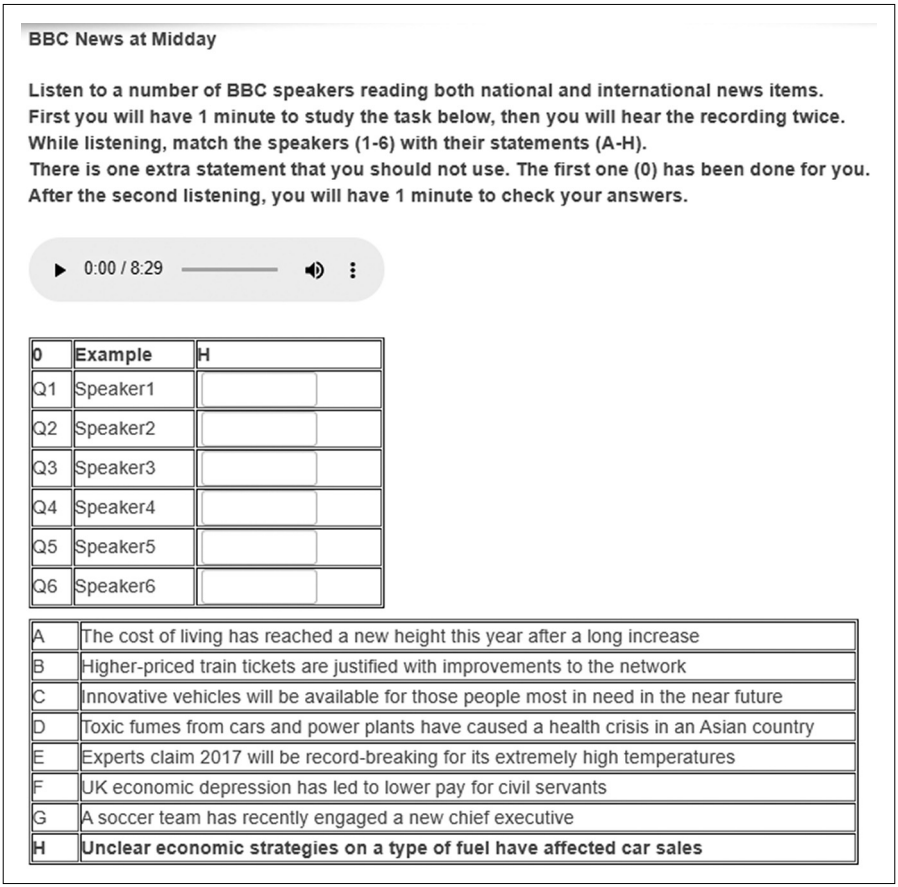
courages students to test themselves and immediately rethink their reasoning and correct themselves. All students' response attempts, final responses and grades are automatically collected within the AAS. Thanks to this, teachers can view the students' answers and all attempts to answer, thus becoming aware of the most frequent errors and any difficulties encountered, and being able to observe if and how the students managed to overcome their difficulties independently.

In this case, the strategy applied to make the formative question was to divide the text into three parts and make the students concentrate on one part at a time. In this way, students can reflect on what they had already learned from the first reading and what they had not been able to understand. The cognitive effort to understand a long text is certainly greater, and this is why the initial request is divided into three sub-requests. Another difficulty for the students is that the statements given in the opening question are not taken directly from the text, but they are reformulations of the text. So, in addition to understanding the text, students must understand the meaning of the statements. Other possible strategies for formative assessment could be: working only on more complex terms and morphosyntactic structures that students may not have understood; provide a text similar to the initial one with errors and tell the student to identify them; provide the restated initial text and leave blank spaces for students to fill in, etc. The only difficulty in automatically evaluating students' open-ended questions is that the AAS interprets the answers as strings. So correct answers that differ in spaces, missing accents, etc. are evaluated incorrectly. At the same time, in an open-ended question, the teacher must think of all the possible correct answers that the students could enter, so as not to penalize them. However, it is always possible to correct the student's assessment later.

7. Example of designing a question to develop listening skills

The second example is a question for the B2 level listening comprehension test. In the CEFR, the indicator for the overall listening comprehension states that student "Can understand the main ideas of propositionally and linguistically complex speech on both concrete and abstract topics delivered in standard speech, including technical discussions in his/her field of specialization. Can follow extended speech and complex lines of argument provided the topic is reasonably familiar, and the direction of the talk is signposted by explicit markers". The CEFR self-assessment grid at level B2 states "I can understand extended speech and lectures and follow even complex lines

of argument provided the topic is reasonably familiar. I can understand most TV news and current affairs programs. I can understand the majority of films in standard dialect".



BBC News at Midday

Listen to a number of BBC speakers reading both national and international news items.
First you will have 1 minute to study the task below, then you will hear the recording twice.
While listening, match the speakers (1-6) with their statements (A-H).
There is one extra statement that you should not use. The first one (0) has been done for you.
After the second listening, you will have 1 minute to check your answers.

0:00 / 8:29

0	Example	H
Q1	Speaker1	
Q2	Speaker2	
Q3	Speaker3	
Q4	Speaker4	
Q5	Speaker5	
Q6	Speaker6	

A	The cost of living has reached a new height this year after a long increase
B	Higher-priced train tickets are justified with improvements to the network
C	Innovative vehicles will be available for those people most in need in the near future
D	Toxic fumes from cars and power plants have caused a health crisis in an Asian country
E	Experts claim 2017 will be record-breaking for its extremely high temperatures
F	UK economic depression has led to lower pay for civil servants
G	A soccer team has recently engaged a new chief executive
H	**Unclear economic strategies on a type of fuel have affected car sales**

Fig. 6 – INVALSI listening comprehension question (level B2) implemented in the AAS

Source: INVALSIopen (www.invalsiopen.it)

The INVALSI task, shown in Figure 6, is titled "BBC News at Midday". INVALSI experts on the INVALSIopen channel also presented this question. The type of evaluation chosen for this question is multiple matching. After reading the instructions, the students have one minute to read the items of the question (shown in the second table) and then listen to the audio twice consecutively. To answer the question, students must associate short-spoken texts by different speakers with short summaries present in the items. Among

the items there is a distractor that students should not use. It is important to note that the statements are not transcripts of the audio file but are rephrased. In this way, the listening exercise is a comprehension exercise and not a recognition exercise. The authentic text proposes a series of news read by BBC speakers, of which the student must grasp the main message.

Also in this case, in the transformation of the task into a question for formative assessment, the first part of the question was kept unchanged. The answer modality has been modified using a matching answer area, in which students must associate the listened statement to each speaker (Figure 7). The audio is integrated directly into the question and lasts 8 minutes and 29 seconds. The audio available from the INVALSI site is characterized by the reading of the instructions, a minute of silence to give students time to read the items and the audio of the task repeated twice. In this way, by carrying out the exercise independently, students are guided in carrying out the activity. However, compared to an INVALSI test, students can interact with the audio file by clicking the buttons: pause, go forwards or backwards, repeat listening and stop. Furthermore, compared to the INVALSI task, students have three attempts to answer the question correctly. At the bottom of the first request there is in fact the verify button that students can click at any time to get immediate feedback on the correctness of their answers. Having the possibility to interact with the audio, students can listen to the items where they were wrong and self-correct. The ability to self-correct, improve, and rework their thoughts is very important for students' self-esteem, self-awareness and self-confidence.

Figure 7 shows an example of student response and feedback (wrong answer) after clicking the verify button. Students can try to answer the question again and have two more attempts to check the accuracy of the answers. If the answer is correct, they immediately go to the next part. In any case, at the end of this first part of the question all students have feedback on what the correct answer is. As in the previous example, also in this case students may opt for a guided listening; for example, by dividing the file into several parts and proposing a guided procedure. This process allows students to focus on one speaker at a time and better understand the audio.

In this example, we have implemented another type of strategy to deepen the understanding of the text. In the second part of the question (Fig. 8), seven statements are proposed referring to the audio file and taken directly from the original text. Listening to the audio again, students find the original words in the statements and can reflect again on their meaning. After that, they must associate each statement with the correct reformulated statement, with the same meaning. Again, the students have three attempts to answer the question.

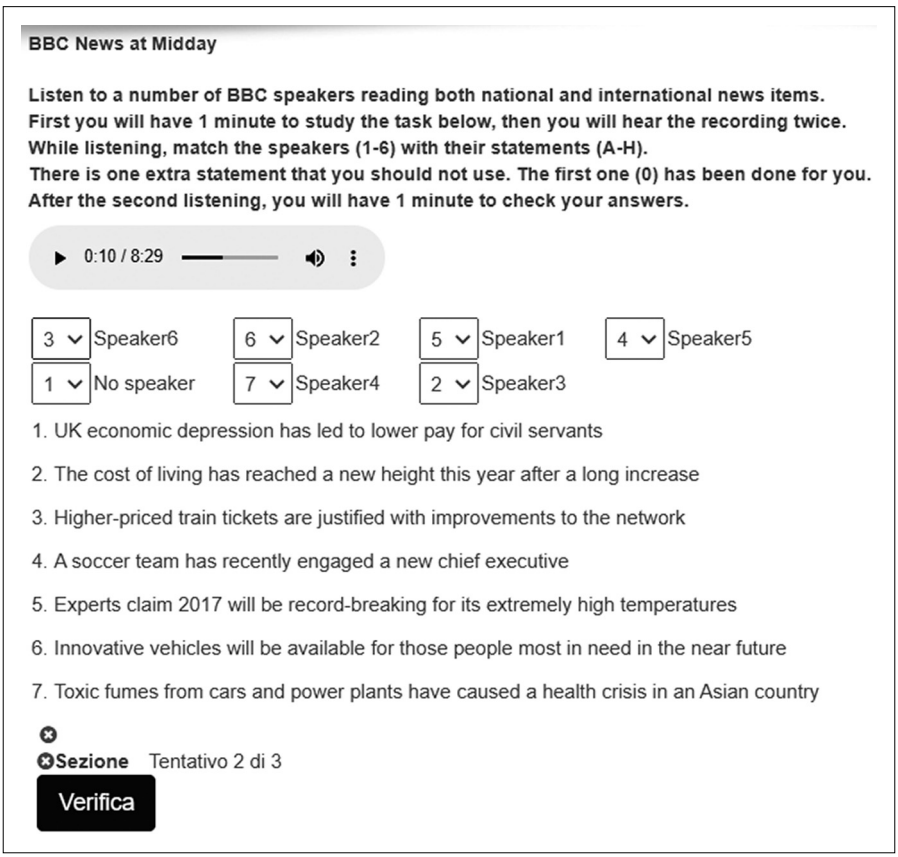


Fig. 7 – INVALSI listening comprehension question transformed into a question for formative assessment (First part)

At the end of this part, it is possible, for example, to add an open-ended question, where students can write a brief summary of the audio file, or a short news in the style of the BBC speakers. This AAS also allows to submit a file within the question to evaluate it. This feature can be used to ask students to produce and submit audio files, in order to work on speaking as well.

It is essential that students practice these kinds of listening questions. In fact, today's students are used to dealing with multimedia tools from an early age and throughouttheir life. Through an internet connection and a mobile device, they easily access videos in foreign languages for different interests and purposes (films, TV series, music, documentaries, television programs, news, etc.). Their use at school, and in general for educational purposes, is also very important and widely supported because it allows teachers and stu-

dents to easily find authentic materials and make students more passionate about the subject of interest and foreign languages. However, this type of content can impair the ability to listen without pictures (pure listening) and students can become distracted listeners when listening to audio-only files. It is also important to make students become accustomed to the ambiguity of oral language (depending on pronunciation, speaking speed, etc.). They should be aware that they may not be able to understand someone speaking a foreign language, and they should thus be trained in careful listening.

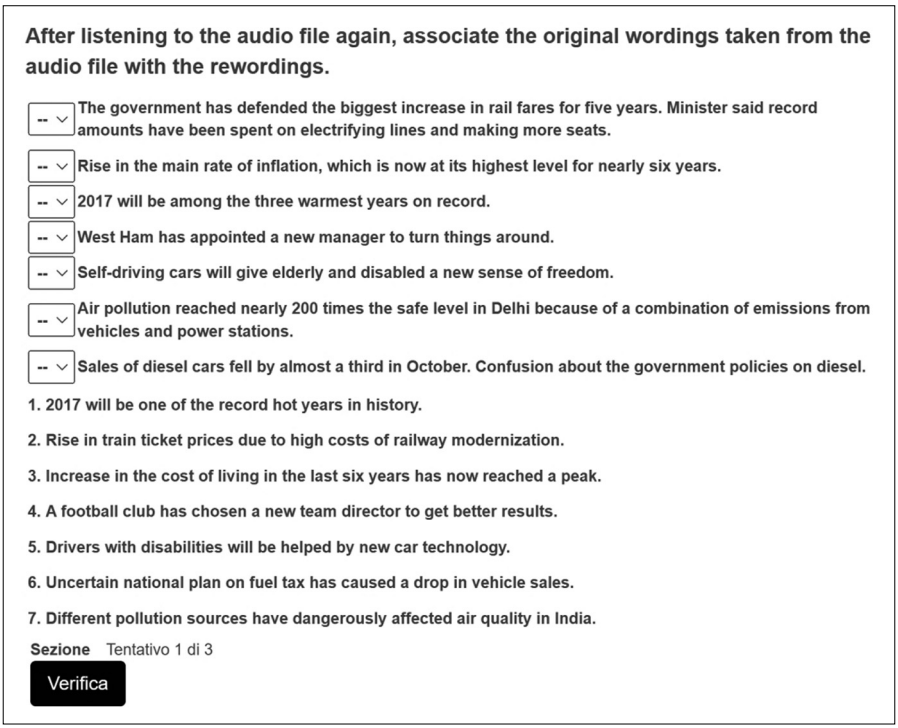


Fig. 8 – INVALSI listening comprehension question transformed into a question for formative assessment (Second part)

8. Conclusion

The INVALSI English tests for secondary school are designed to test language comprehension skills (listening and reading). According to the INVALSI report of 2019 (INVALSI, 2019), 65% of Italian students do not reach level B2 in the listening test and 48% do not reach it in the reading test.

To improve these results and to overcome students' difficulties in acquiring these skills, it is important that teachers adopt formative assessment strategies. The importance of immediate and interactive feedback, in the proposed methodology, is essential for both students and teachers. Through continuous and formative feedback, the student can focus not on the result, but on the progress made, on the mistakes made and on the actions to be taken to improve. At the same time, teachers can progressively monitor students' learning levels and get valuable feedback. For example, they can understand which aspects of the language are more complex for students and propose adaptive activities according to their level.

In this paper, the design of material for a secondary school English teacher training course was presented. Examples were shown where questions designed for standardized assessment are adapted to questions for formative assessment for language skills development and preparation for INVALSI tests. The strategies used were also highlighted, such as: to provide the student with more attempts to answer the multiple matching questions in order to reflect on the errors; to provide, in the event of an error, a sub-question to understand the error made; to divide the audio to listen to or the text to be read in several parts to facilitate students' reasoning and understand where they encounter more difficulties; to insert sub-questions to work on terminology and more complex verbal constructs; to insert sub-questions to guide them in the exercise, alternate closed-ended questions with open-ended questions to allow them to explain what they understood.

During the training course, this activity will be proposed to teachers in order to reflect on the characteristics of summative and formative assessment, to develop formative assessment skills and create materials to be used in their teaching. 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 pandemic emergency we are experiencing and the consequent online teaching following the closure of schools has made us reflect even more on how important it is to train teachers on the use of new technologies and on new teaching methods characterized by their use. Furthermore, it is very important that students learn how to use technologies also for educational purposes. It is therefore of great importance to increase the training of teachers on the use of an AAS for formative assessment and to train students to use this tool as well.

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Teachers are essential in the learning process: at first, they are facilitators, thanks to their emphatic abilities, expert in building successful and fruitful relationships and in creating a context of cooperation, in order to promote a harmonious development of each student and a peaceful learning environment.

This book collects some paper submitted during the V edition of the Seminar "INVALSI data: a tool for teaching and scientific research" and talks about the training of teachers.

Papers collected in this book are a limited and non-exhaustive example of the utility of INVALSI data. Year by year, the catalogue of the open-access series "INVALSI PER LA RICERCA" has been greatly enriched as a further confirmation of a worthwhile mutual dialogue between academics and school actors. As Statistical Service we hope this partnership could last and may generate many other research works.

Patrizia Falzetti, Technologist Director, she is the Head of the INVALSI Area of the Evaluation Research, of the SISTAN Statistical Office and of the INVALSI Statistical Service which manages data acquisition, analysis and return about both national and international surveys on learning (OECD and IEA). She coordinates and manages the process about returning data and statistical analysis to every school and to the Ministry of Education and Merit.

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