INVALSI DATA SUPPORT IN POLICIES AND SCHOOLS

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

edited by
Patrizia Falzetti

FrancoAngeli

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3. The INVALSI tests for teaching: teachers' beliefs about the validity of INVALSI tests and teaching practices implemented

by Elisa Truffelli, Barbara Balconi, Daniela Maccario*

This chapter originates from an interdisciplinary research project involving experts in the didactics of mathematics, general didactics and assessment, with the aim of investigating the beliefs and attitudes of primary school teachers on the connection between the INVALSI mathematics tests and teaching-learning processes.

The survey was administered in the 2019/2020 school year in the form of a semi-structured questionnaire aimed at investigating: teachers' awareness of the learning objectives detected by the INVALSI tests, their conceptions of errors in mathematics, the use of the tests in daily didactics, misconceptions about standardised tests and the concept of assessment. The tool was administered to a non-representative national sample consisting of 526 fifth-grade mathematics teachers at primary schools.

The analyses presented focused on the one hand on the link between teachers' beliefs on the type of knowledge and skills detected by the INVALSI tests and on the validity of the tests themselves, and on the other hand on the convictions and statements regarding the teaching practices usually implemented by the teachers. The interpretation of the links that emerged on a correlational basis, between the two blocks of variables, showed how teachers' beliefs influenced the direction of their didactic choices. Teachers who score high on the considered indices and factors perceive themselves as professionals and believe that learning can and should be constructed. Recognising the validity of the INVALSI tests in relation to the skills they demand of students on the one hand, and their usefulness for analysing, reflecting and planning didactics on the other, affect the type of prevalent use they make

* The chapter was conceived and designed jointly by the authors. Paragraph 1 and 7 are to be attributed to Daniela Maccario; Barbara Balconi wrote the paragraphs 2 and 3, Elisa Truffelli wrote the paragraphs 4, 5 and 6.

of the test in the classroom context: a use aimed mainly at developing skills rather than at teaching-to-test and aimed at improving the didactic proposal to students to help them strengthen their skills.

Il presente contributo nasce all'interno di un progetto di ricerca interdisciplinare, che ha coinvolto esperti di didattica della matematica, di didattica generale e valutazione, con l'obiettivo di indagare convinzioni e atteggiamenti degli insegnanti di scuola primaria sul legame tra i test INVALSI di matematica e i processi di insegnamento-apprendimento.

La rilevazione è avvenuta nell'anno scolastico 2019/20 attraverso un questionario semi strutturato volto ad indagare: la consapevolezza dei docenti in merito agli obiettivi di apprendimento rilevati dai test INVALSI, le loro concezioni sugli errori in matematica, l'uso dei test nella didattica quotidiana, le misconcezioni in merito alle prove standardizzate e l'idea di valutazione. Lo strumento è stato somministrato ad un campione nazionale non rappresentativo costituito da 526 docenti di matematica di classe quinta di scuola primaria.

Le analisi presentate si sono focalizzate da un lato sul legame tra convinzioni dei docenti sul tipo di conoscenze e abilità rilevate dai test INVALSI e sulla validità dei test stessi e dall'altro sulle convinzioni e dichiarazioni in merito alle pratiche didattiche messe in atto abitualmente dagli insegnanti. L'interpretazione dei legami emersi su base correlazionale tra i due blocchi di variabili ha evidenziato come le convinzioni degli insegnanti abbiano influenzato la direzione delle loro scelte didattiche. Gli insegnanti che hanno punteggi alti sugli indici e fattori considerati, si percepiscono come professionisti e credono che l'apprendimento possa e debba essere costruito. Riconoscere la validità dei test INVALSI in relazione alle competenze che sollecitano negli alunni da un lato, e l'utilità dello stesso per analizzare, riflettere e progettare la didattica dall'altro, incidono sul tipo di uso prevalente che essi fanno del test nel contesto di classe: un uso volto principalmente allo sviluppo di competenze piuttosto che al cosiddetto "teaching to test" e orientato a migliorare e adattare la proposta didattica agli alunni, per aiutarli a potenziare le loro competenze.

1. Theoretical and epistemological framework

Can INVALSI tests be a useful tool to support teachers' reflexivity on how to improve the quality of mathematics teaching in primary schools?

Can educational research answer this question? If so, through which approaches? On the basis of these questions, a study was developed to collect

and analyse mathematics teaching practices concerning the administration of national tests in primary schools. This research involved the development of an original tool to study the teaching of mathematics with regard to the INVALSI test framework. The project is part of an interpretation of pedagogical-didactic research as a scientific field that aims to increase the wealth of knowledge available on teaching action in order to guide teachers' practical-operational decisions. From this point of view, teachers are considered professionals whose job is to stimulate, guide, and support students' learning towards the acquisition of skills or rather deep, meaningful and useful forms of learning. The main levers of professional intervention by teachers are the selection, organisation and presentation of concepts and logics inherent to the study disciplines through the implementation of teaching activities tailored to the pupils' and classes' circumstances. The research presented below responds to a vision whereby educational research is developed as a process that surveys classroom management practice by involving the protagonists. It is then analysed and reflected upon with a view to enriching the existing theory in a key way that is beneficial to improving the practice itself (Zanniello, 2023) by means of professional reflection and decision-making processes of teachers. Didactic research is thus committed to building evidence that opens interpretative paths while adhering to the experience of teachers' classroom management in order to construct useful knowledge for their professionalisation. Let us analytically discuss the salient aspects of this theoretical-epistemological standpoint.

1.1. Studying didactic mediation and the "de facto curriculum"

Teaching action in terms of how a teacher teaches mathematics to support student learning with regards the administration of INVALSI tests has been identified as the object of investigation. Teaching action is considered in terms of "didactic mediation", from a processual and interactive perspective. Reference is made to a conception of knowledge and learning of a basically Piagetian and Brunerian constructivist matrix (Damiano, 2013), with Vygotskian references (Lenoir, 2017), according to which the indispensable condition for learning to take place is to allow the subject to consciously intervene in the situations he or she experiences. This dynamic is developed at school through the mediation of the teacher, who assumes the role of learning facilitator when, by activating appropriate forms of communicative exchange with pupils, he/she offers them the opportunity to interact with the teaching situation – in a mental and/or practical sense

– and to reflect on what they are experiencing, thus triggering a process of structuring and restructuring their knowledge. Teachers' actions can also be considered "medial" insofar as they are operationally translated into the production and management of "mediators" or representations of reality in terms of the various disciplinary knowledge to be taught. It has been observed that this "metaphorisation" activity (Damiano, 2013) can take place through the implementation of a combination of languages: active, based on direct and operational experience; analogical, based on forms of simulation, also of a ludic nature; iconic, based on used and produced images, fixed and moving, analogical and digital etc.; symbolic, through combinations of sign-formalisms with the power to evoke objects and phenomena in abstract and synthetic terms, to foster the construction of knowledge without having to resort to direct experience. In the context of this study, an approach was tested to try and "bring to light" some salient aspects of the phenomenology of the didactic mediation processes used by teachers for the administration of INVALSI tests, and thus to intercept aspects of the *de facto curriculum* (Perrenoud, 1993) generated in relation to the "Rilevazioni nazionali degli apprendimenti scolastici" (Italian National Surveys of School Learning). These are processes that are little known even by the teachers themselves, at least in an explicit and formalised perspective, the analysis of which could prompt reflection on how to improve teaching so as to promote increasingly effective forms of learning.

1.2. Studying teachers' processes of interpretation and action

The survey and analysis of the phenomenology of the teaching processes generated by the administration of National Tests was also conducted with reference to a conception of teaching as an activity of a professional nature, in line with interpretations that have been widespread in literature since the 1980s. It is believed that teachers can be considered professionals insofar as their work essentially consists of performing non-routine intellectual acts in pursuit of objectives in complex situations, in which they operate with a significant degree of autonomy and responsibility (Damiano, 2004), from a personal and educational background made up of multiple knowledge. (Paquay *et al.*, 2006; Tardif and Lessard, 2004). In their work, professional teachers draw on a multiplicity of interpretative frameworks, both of a theoretical-general nature and derived from experience; from these resources, they analyse the problems to be addressed in the classroom and possible solution strategies (Altet, 2010), in a kind of dialogue with the sit-

uation that passes through action – "reflection-in-action" – (Schön, 1983). This process involves the recognition, revision and development of one's theoretical-conceptual and operational models (Vergnaud, 2010), or habits of action (Barbier, 2017). According to this perspective, the theoretical-didactic criteriology on mathematics teaching implied in INVALSI tests can act as a framework for teachers to attribute meaning to classroom teaching processes "if" and depending on "how" it is used in relation to their professional experience and the concrete situations they habitually face. The research project thus developed around this focus of investigation in order to observe certain junctures in the practical processes of attributing meaning to the National Test framework.

1.3. "How" to study teaching practices: the choice of a "deliberative" approach

Within the theoretical-epistemological framework that connotes this study, the practical-operational knowledge of teachers was considered as a form of knowledge other than the scientific-formalised knowledge on classroom management, but which should be credited as a source for its construction (Viganò, 2019; Damiano, 2006). The literature invites us to pursue this path, suggesting that the study of teachers' practical-experiential knowledge is useful for the detection of previously unexplored problems, for the conceptual and operational definition of variables, for supporting the formulation of increasingly precise cognitive hypotheses (Zanniello, 2020), and for increasing the chances of practical spin-offs of research data (Hattie, 2016). This is a perspective that presents challenges to researchers, as it requires them to accept the confrontation with an "impressive complexity of the object" (Calvani, 2019), which lends itself to being described and analysed at various levels of generality, within different interpretative frameworks, with the use of terms often characterised by a large degree of semantic and pragmatic ambiguity. The "structural" difficulty of didactic research lies in the management and development of theoretical categories whose meanings can be shared between researchers and protagonists in the field (Cardarello, 2019). These concepts can have both a "pragmatic" value – needed to conceptualise teaching processes from the teachers' point of view – and a "pragmatised" value (Pastré, 2007) – which can be linked to the theorisations produced by scientific research on teaching in order to develop them. In this scenario, the study was developed according to a methodological pathway with a "deliberative" connotation (Savoie-Zajc, 2004), starting from predefined interpretative constructs-lenses. These were

validated and operationalised within the research team according to the data collection process, with the goal of systematically reconstructing the phenomenon in question with relatively broad quantitative coverage.

The research pathway is described below, with reference to the actors involved, the various phases, the characteristics of the instrument developed and adopted, the data collected and the results obtained.

2. Presentation of the overall research project design

As discussed in the previous section, the experience of the INVALSI tests has led to the emergence in schools of a series of macro-phenomena linked to the disciplines, to disciplinary teaching and more generally to didactic aspects and the culture of evaluating teachers.

In particular, the INVALSI assessment program has raised and still raises a series of research questions and problems concerning: the reading and interpretation of data, the analysis of teachers' training needs, the analysis of how the two variables listed above can influence teachers' attribution of meaning to the experience of evaluating the tests themselves.

In 2017, an interdisciplinary research project was launched within the "General and Disciplinary Didactics" Observatory of the SIRD (Italian Society of Didactic Research) which highlights the interpretation needs of the complex phenomena mentioned above, with the general purpose of identifying teachers' training needs at national level and proposing guidelines to improve teaching practices regarding the use of INVALSI mathematics tests.

The project was conducted by the research group "Teaching Mathematics and INVALSI Tests"[1] and involved mathematics teachers, experts in general didactics and experimental pedagogy.

The aim of the research was to analyse the link between INVALSI mathematics tests and teaching-learning processes at the Primary School level, through the voice of teachers.

[1] The researchers of the project are: coordinators: Ferdinando Arzarello, Ira Vannini (University of Bologna); members: Giorgio Asquini (La Sapienza University), Barbara Balconi (University of Milan), Giorgio Bolondi (Free University of Bozen-Bolzano), Eleonora Faggiano (University of Bari), Federica Ferretti (University of Ferrara), Violetta Lonati (University of Milan), Daniela Maccario (University of Turin), Annarita Monaco (Teacher, Rome), Ottavio Rizzo (University of Milan), Roberto Trinchero (University of Turin), Elisa Truffelli (University of Bologna), Valentina Vaccaro (INVALSI, Rome).

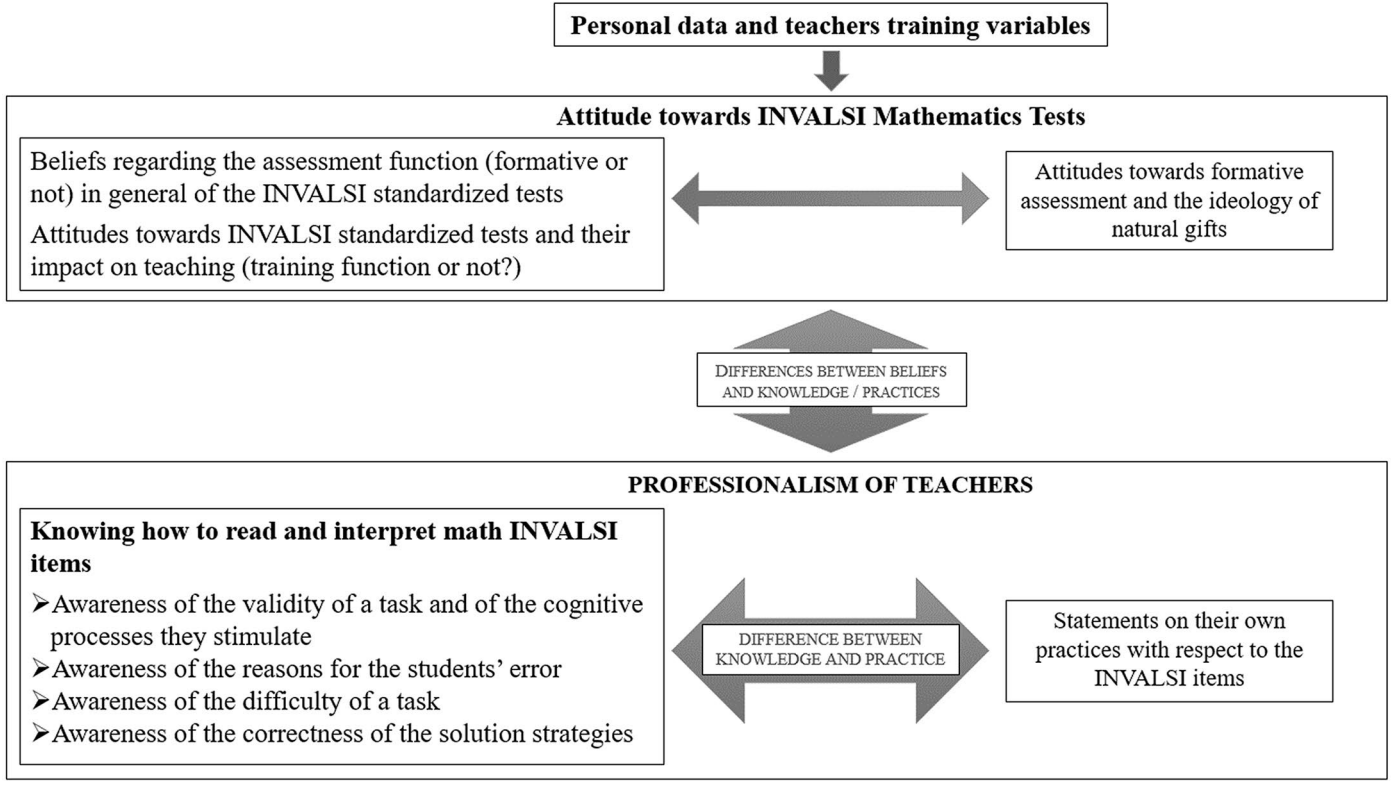


Fig. 1 – Variables and the reseach hypothesis

From the outset, the goal of the interdisciplinary group of researchers was to initiate an exploratory study to investigate the meanings teachers attribute to the INVALSI items, meanings that appear to play a crucial role in promoting or inhibiting an educational impact of the tests themselves. With this aim, the researchers shared the goal of building a research tool, i.e., a questionnaire, for collecting the perceptions of primary school mathematics teachers in relation to the reading and interpretation of the INVALSI questions and the data collected through the tests' administration.

In particular, teachers' beliefs regarding the knowledge and skills detected by the standardised INVALSI tests were investigated; the proximity/distance between the functions and contents of the INVALSI items and the teaching practices of the teachers was explored, the opinions of the teachers were collected in considering the INVALSI test as a possibility to be used in a formative assessment perspective.

To specify the different search variables and the research hypothesis of the relationships between the variables, the framework in Figure 1 was built.

2.2. The investigation tool

The framework of the research variables just described led to the configuration of the questionnaire, in three sections:

– Section1: Interpretation of INVALSI Test (examining how teachers interpret the INVALSI items and their results);
– Section 2: Style of teaching (exploring teachers' beliefs, attitudes, and their involvement in teaching practices);
– Section 3: Personal data and context information.

In the first section, seven INVALSI grade 5 or 6 items are presented in their original formulation. For each of them, questions were proposed to detect:

– the pedagogical knowledge of the mathematical content – the so-called Pedagogical Content Knowledge of Shulman (1986) – by teachers (misunderstandings, recurring errors, level of difficulty);
– the proximity/distance of the seven items from teaching practices and National Indications (2012), a reference document for the didactic planning of school teachers in the first cycle of education;
– the effectiveness of the INVALSI items with respect to the assessment of certain skills.

The second section presents four sets of questions concerning:

1) teachers' opinions on the INVALSI assessment programme;
2) didactic usefulness of the INVALSI items;

3) didactic practices related to the INVALSI items;
4) attitude towards formative assessment or the ideology of natural gifts (Ciani and Vannini, 2017).

The data collected in the third section refer to professional training as well as to the teachers' personal data. For example, they were asked 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 in their current role; what activities they carry out in their school; etc.

The tool just described was initially administered to 105 teachers (Field trial). This initial phase made it possible to test the questions in the questionnaire. Subsequently, based on the analysis of the data collected with the field trial, the questionnaire was partially modified.

The new version of the questionnaire was administered to 427 teachers (Main Study), of which 421 cases are valid. None of the previous responding teachers received the questionnaire again. The data collected in the two campaigns were encoded and analysed using a statistical software for data analysis (SPSS).

It was decided to consider the answers from both campaigns valid, capitalizing on the temporal proximity of the administration, with respect to the questions that were not modified after the field trial. Thus 526 valid cases were considered.

3. First results

We start by presenting the findings obtained through the items in the third section (personal data and context information) to delineate the characteristics of the sample of responding teachers.

– 95% of the respondents are female.
– 68% of the respondents received an invitation to fill in the questionnaire from their School and in particular from their Headmaster.
– 71% of the respondents teach in Piedmont or Emilia-Romagna (which together make up 15% of the Italian population).
– 90% of the respondents are tenured teachers.
– 21% of the respondents actively participate in school life (RAV, evaluation unit, INVALSI).

The average age of the responding teachers is 50.40 years, with a standard deviation of 8.56.

Although the sample is large it cannot be considered representative, yet the data collected offer a range of interesting information that will subse-

quently be considered along with the results from the other two sections of the questionnaire.

Before proposing deeper and more specific analysis, it seems appropriate to provide an overview[2] deriving from the analysis of the simple frequencies, inherent on the one hand, the purposes that the teachers attribute to the INVALSI tests and, on the other hand, the statements regarding the useful practices that the teachers make of the tests in the classroom. This frame of reference is also functional for the definition of training guidelines for primary school teachers – general objective of the research – to support them in more conscious planning of daily activities for managing mathematics teaching-learning processes starting from the INVALSI tests.

An interesting fact to initially note concerns the average score of the answers collected in item 30 of the questionnaire which request teachers to express their degree of agreement (from 1 to 4, where 1 is represented by the statement "completely disagree" and 4 by the statement "completely agree") with respect to the objective of assessment of the INVALSI tests.

The following table (Tab. 1) shows the question and teachers' answers:

Tab. 1 – Average score for each item of the question: "INVALSI aims to assess"

Item	*Average score (range 1 to 4)*
The Italian educational system	2.87
The individual student's learning in mathematics	2.17
The professional preparation of the individual teacher	2.05
The didactic effectiveness of schools	2.72

The highest averages recorded (2.87 and 2.72) concern the teachers' agreement in identifying the assessment aims of INVALSI in the effectiveness of the Italian educational system and subsequently in the educational effectiveness of the schools, but the other two show how, to date, despite the experience of the INVALSI tests in primary school which boasts a history of more than 10 years, there is a widely diversified panorama in terms of the teachers' understanding and sharing of the primary purposes of the test itself.

Assuming the hypothesis according to which the opinions and perceptions of teachers regarding the INVALSI tests promote or inhibit the didactic impact of the tests, a poor didactic impact of the tests can be hypothesised in the classes of teachers who think that the INVALSI tests assess the teach-

[2] This overview is the result of the joint work of the entire research group and aims to summarise the evidence drawn from the data and published in other works to date.

er's professional preparation. In this regard, returning to the training intent connected to the possibility of defining guidelines for teachers for improving teaching practices relating to the use of INVALSI mathematics questions – general objective of the research project – the data just presented arises in support of a formative perspective that not only takes care to explain the aims of the INVALSI tests, but also monitors the teachers' ongoing understanding and sharing.

Furthermore, the results regarding item 32 of the questionnaire are reported, aimed at investigating the statements of the teachers' use of the INVALSI test items in their classroom.

The teachers were asked how often they propose activities related to INVALSI questions to their students, or how often they draw inspiration from INVALSI questions to propose other activities to students.

The proposed index ranges from a minimum of 1, which indicates a subject who never uses similar tools, to a maximum of 4, which indicates a systematic use of these tools to assess students.

The average scores of the items of question 32 are shown below (Tab. 2).

Tab. 2 – Average score for each item of the question: "In my classroom practices"

Item	*Average score (range 1 to 4)*
I train the students to work on many INVALSI test questions of the previous years	2.86
I discuss the theoretical aspects of taking the INVALSI Tests with the students (structure of the tests, timing)	3.12
I reflect with the students in order to find "quick" and "crafty" strategies to solve the questions of the INVALSI tests	3.18
I draw inspiration from the INVALSI test for activities related to argumentation in mathematics	3.22
I draw inspiration from the INVALSI test for activities related to problem solving	3.28
I draw inspiration from the INVALSI test for activities related to the justification of one's answers	3.03

The set of questions presented identifies two potential uses of the INVALSI tests. One corresponds to a more training, performance-oriented type: the items referable to this factor concern the discussion in class on technical aspects of the questions, outlining faster solution strategies, and training students to answer correctly (1, 2 and 3). The other concerns with a use which focuses on encouraging the development of students' skills: the items referable to this factor are those relating to implement problem solving activities and argumentation of a mathematical nature (4, 5 and 6) (Truffelli and Vannini, 2021). Although the survey averages reflect a widespread

practice of the proactive use of INVALSI tests to promote students' skills, training practices linked to the tests are still quite widespread, with the highest frequency detected in selecting "often" in their use to "find quick and crafty strategies with students to answer the questions" (190), while the higher frequencies with the "sometimes" option are based on discussing the theoretical aspects of taking the tests (241) and on training students by repeating the questions of previous years' tests.

Also in this case there is a considerable diversification with respect to the most widespread uses of the test questions among teachers; however, even starting from this data, a possible path for furthering the research can be identified. Also in support of the conception of training guidelines for teachers, a more organic exploration of what are, in concrete terms, the practices defined as "training" by teachers can be evaluated through a qualitative coring.

Furthermore, two other thematic analysis paths applied by the group of researchers should be noted, the first focused on the data emerging from the first section of the questionnaire, i.e., those concerning mathematics teaching, while the second mainly concerns the teachers' attitude towards formative assessments or the ideology of natural gifts (Ciani and Vannini, 2017).

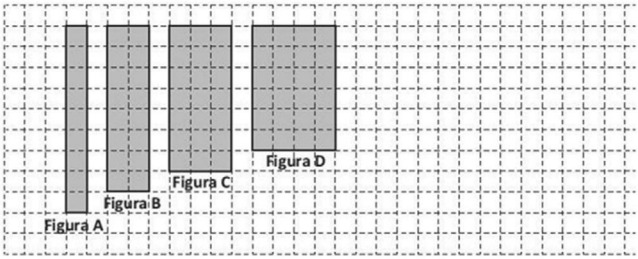
The first thematic analysis focused on the first four questions of the questionnaire which asked teachers to express their perceived degree of difficulty of the item for the students and to figure out possible reasons for the mistakes made.

The analyses conducted showed that teachers may have difficulty recognising the reasons for the errors made by students during the INVALSI tests (Vaccaro, Faggiano and Ferretti, 2021).

For each INVALSI item reproposed in the original formulation in the questionnaire, the teachers were offered four multiple choice options concerning possible correct and incorrect reasons for the error potentially made by students.

As an illustrative example of what is described above, the formulation of a question of the questionnaire that we indicate as Q3 (Fig. 1) is shown below.

D3. Look at this sequence of figures



a. Draw on the squares, next to Figure D, the next figure in the sequence.

b. Which of the following sentences is true?

A. The area of the figures is always the same
B. The area of the figures doubles at each step
C. The perimeter of the figures is always the same
D. The perimeter of the figures increases at each step

Fig. 2 − Question Q3 of the questionnaire

Following the INVALSI item, the possible reasons for the error made by the students were subsequently proposed in the questionnaire as follows:

– "Although 85.8% of students correctly answered part "a", only 35.7% of students correctly chose "C".
– In part "b", choose one of the reasons why:
  • "Students do not pay attention while reading the text".
  • "Students do not know area and perimeter formulas well".
  • "Students are led astray by the picture".
  • "Students believe that the area increases while the perimeter increases".
  • "Students do not pay attention while reading the text": we consider this as a boilerplate answer that we expect to be used by a teacher lacking knowledge of the didactic and epistemological issues.
  • "Students do not know area and perimeter formulas well": we can assume that most fifth-grade students have a working knowledge of computing areas and perimeters of such rectangles, but on the other hand the item does not ask for any explicit numerical result. Hence, we hypothesise 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.

- "Students are led astray by the picture": this option is very similar to the first, but might be chosen by teachers who recognise that the item is about geometry.
- "Students 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 3 shows how the participants answered.

Tab. 3 – Distribution of the teachers' choices in answering Q3

Options	*%*
Students do not pay attention while reading the text	34.2
Students do not know area and perimeter formulae well	2.1
Students are led astray by the picture	32.7
Students believe that the area increases while the perimeter increases	21.5
Other	9.5

It can be seen that only 21.5% of the teachers recognised that the reason behind the students' error is connected to the misconception that areas and perimeters should behave in the same way.

The same reflection requested on this question was reproposed in relation to other items related to different mathematical contents. Similarly to what was proposed with the perimeter and area question, we asked teachers to figure out the possible mistakes made by the students.

It is interesting to report that in the four questions, the option that was generally chosen most was the students' "lack of attention in reading the text" (Tab. 3).

The weight that teachers attribute to the students' lack of attention in reading the text seems to be a symptom of a lack of awareness of the difficulties actually encountered by the students. There is the urgency of training need in terms of specific knowledge of didactic mathematics teaching and practices that make text comprehension an appropriate further subject in teaching mathematics.

Furthermore, thanks to the creation of a summary index of the teachers' responses to the four items listed, it is possible to show that 35% of the responding teachers did not identify correct interpretations with respect to the reasons for the errors and only five teachers, 1% of the total, correctly interpreted the reasons for the students' errors for all four questions.

Unfortunately, a strikingly high percentage of teachers (33.8%) identified only one of the correct reasons for the error, highlighting a concerning lack of awareness among this group (Vaccaro, Faggiano and Ferretti, 2021).

Tab. 4 – Frequencies of the "Awareness of the reasons for the error" index

Item	*Frequency*	*Valid percentage*	*Cumulative percentage*
Does not correctly answer any of the questions about the interpretation of the error	184	35.0	35.0
Correctly answers one of the questions about the interpretation of the error	178	33.8	68.8
Correctly answers two of the questions about the interpretation of the error	115	21.9	90.7
Correctly answers three of the questions about the interpretation of the error	44	8.4	99.0
Correctly answers four of the questions about the interpretation of the error	5	1.0	100.0
Total	526	100.0	

Also in this sense, it is possible to identify a further training path to follow with the teachers.

Moreover, this result seems to be in agreement with other considerations proposed regarding the first results emerging from the field trial relating to how primary school mathematics teachers read and interpret the data of the INVALSI tests (Arzarello and Ferretti, 2021). The latter had suggested the existence of a meta didactic conflict regarding the discourses on teaching processes such as student assessment, skills and errors, and not concepts of mathematics of thought per se, as in the case of usual epistemic or didactic conflicts reported in the literature (Brousseau, 1986). The cause of this conflict, referring to what Anna Sfard defines as «incommensurable discourse» (2008), seems to lie in a misunderstanding between teachers and students that occurs when the same words are used but have different meanings, being unaware of the reciprocal differences in their use. If not overcome, the resulting conflict can have serious consequences for the success of teaching/learning processes in the classroom. Arzarello and Ferretti propose considering this conflict as a reference also for discussing what emerged from the data presented in the first section of the questionnaire, identifying three different components: how teachers perceive the difficulties of students in the INVALSI questions; how teachers interpret students' responses and errors; how much teachers consider the INVALSI questions useful and how they use them in teaching practices (Arzarello and Ferretti, 2021).

Also in this case, a future research project line can be defined aimed at overcoming the identified conflict through a clearer understanding of its nature and an explanation of its components in order to obtain a real improvement of practices relating to the use of the INVALSI tests in schools.

The second thematic analysis path, relating to the teachers' attitude towards the formative assessment or the ideology of natural gifts, focused on the analysis of the data emerging from the attitude scale present in section two of the questionnaire, which measures the teacher's propensity to implement training assessment strategies, diagnosing errors in order to implement recovery strategies.

The scale refers to an attitude of the teacher oriented to analytically understanding the learning path carried out by the student, in order to control and self-regulate the didactic action in view of the students' specific cognitive needs. It is a conception of evaluation that aims at equity in learning outcomes and which strongly contrasts (in theoretical terms) the ideology of natural gifts, i.e., the belief that teaching is powerless in recovering the shortcomings in "certain" students (Truffelli and Vannini, 2021).

The results obtained will be presented and discussed in more detail in the following section, as they also serve to introduce the further analyses which are the subject of this chapter.

4. Analytic summary of evidence already obtained from this project about attitudes and use on INVALSI test in a formative perspective

In light of the overall picture outlined so far, in this chapter we have focused on blocks of variables relating to attitudes and beliefs on the formative function of assessment, on the INVALSI tests and their validity and on the declarations of use of the tests themselves in class, offering an analysis and interpretation of the connections that emerged on a correlational basis between the blocks of variables indicated. The general purpose of this work is mainly aimed at analysing the factors that influence the use practices of the INVALSI test in the classroom by primary school mathematics teachers. We asked ourselves if it is possible to trace a link between teachers' beliefs and attitudes towards assessment and towards the INVALSI tests and how the tests are used in the classroom, and lastly whether those beliefs and attitudes are related to specific practices of using the INVALSI tests.

Regarding these practices, we also asked what use teachers make of these tests. Do they use these tools to promote didactics that develop and strengthen students' skills? Or do they focus their use on results and performance to train their students on the mere passing of these tests?

A first study (Truffelli and Vannini, 2021) conducted as part of this survey investigated these aspects, exploring them through second-level analyses. We will briefly present the results to then introduce the further analyses which are

the subject of this contribution, given the close connection between the former and the latter. Two sets of questions, one relating to the perceived usefulness of the INVALSI questions by teachers and the other relating to the type of use of the questions in classroom teaching, were subjected to factor analyses of the main components. We defined the two components that emerged regarding the perception of use as a) usefulness of the INVALSI tests to analyse, reflect on and plan teaching; b) usefulness of "training" for the INVALSI tests. These components reveal two distinct orientations underlying the use of the tests, one aimed at planning actions such as the definition and redefinition of ad hoc didactic objectives for the class, the other aimed at teaching-to-test to prepare students to pass the system assessment tests. The components resulting from the same analyses conducted on the set concerning the type of use of the INVALSI tests in class are: a) use of the INVALSI tests to favour the development of students' skills; b) use of the INVALSI tests for training. Different uses are therefore made of the items taken from these tests: in some cases oriented to the process of building competence, favouring an argumentative exchange with the teacher and among students and the development of critical thinking; in other cases it is more focused on performance, technical aspects and faster resolution strategies.

To give a further answer to the first questions mentioned above, Truffelli and Vannini (2021) developed an exploratory regression model. The model investigated beliefs and attitudes that can favour teachers' propensity for didactic choices consistent with a formative perspective. The exploratory regression was conducted on a summary index relating to the statements about the use of the INVALSI questions which we called "Systematic use of INVALSI tests to promote skills". The analysis in question identified three elements that significantly regress on the dependent variable: the factor that reveals an attitude about the usefulness of the INVALSI tests for analysing, reflecting and planning didactics (beta = .401); the "Engaged teachers" index (beta = .236) which identifies those who have particular roles related to assessment within their own school and have been specifically trained in mathematics assessment and teaching; the scores on the scale that measures the propensity towards a diagnostic-formative use of the assessment (beta = .188) (Ciani and Vannini, 2017). As the authors conclude, «We can affirm that the propensity to act in a formative perspective is greater in teachers who study and are involved in relation to the themes of didactics and assessment, who have the ability to recognise and use the formative function of assessment and above all interpret the INVALSI tests as a tool and occasion for error analysis and enhancement» (Truffelli and Vannini, 2021, p. 391).

Starting from the hypothesis that attitudes and beliefs can influence the practices that teachers implement in their professional action, we focused our

attention on further aspects, more specifically an analysis and interpretation of the links that emerged starting from statistical correlations between three elements: a) teachers' beliefs about the type of knowledge and skills detected by the INVALSI test; b) its validity; c) statements regarding the teaching practices connected with the use of the INVALSI test in the classroom.

5. Use of INVALSI questions at the microsystem level

The analyses presented in this section, carried out on the database taken from the administration of the questionnaire to over 500 primary school mathematics teachers, allowed us to develop some reflections regarding the use made of this nationally administered learning survey by teachers in the micro-contexts to which they belong. We focused in particular on the correlations between two indices constructed in a first phase of the research starting from specific questions of the questionnaire and one of the factors that emerged in the factor analyses.

The first index measures the extent to which teachers believe INVALSI items are suitable for assessing students' learning. In fact, the questionnaire included seven INVALSI mathematics items that were released after their use for the national testing and the following question was asked for each of them: "On a scale from 1 to 4, how well do you think this question is suitable for assessing your students' learning in the fifth year of Primary School?". The scores were indexed in a single variable.

The second index measures how often teachers use INVALSI questions to develop students' skills. We selected and included in the index three specific items that were particularly relevant to the topic (see Tab. 5) from the set of questions: "Please indicate how frequently you use the following practices in class in reference to each of the following statements. In my classroom practices...: (omitted)".

Tab. 5 – Items included in the index

	Items included in the index
1	I draw inspiration from the INVALSI tests for activities related to argumentation in mathematics
2	I draw inspiration from the INVALSI tests for activities related to problem solving
3	I draw inspiration from the INVALSI tests for activities related to justifying one's answers

Tab. 6 – Correlations under analysis

		INVALSI test usefulness for analysing, reflecting and planning	*Use of the INVALSI test to enhance math skills*	*INVALSI test validity*
INVALSI test usefulness for analysing, reflecting and planning	Pearson Correlation	1**	,515**	,331**
	Sig. (2-tailed)		,000	,000
	N	463	463	463
Use of the INVALSI test to enhance mathematical skills	Pearson Correlation	,515**	1**	,310**
	Sig. (2-tailed)	,000		,000
	N	463	463	463
INVALSI test validity	Pearson Correlation	,331**	,310**	1**
	Sig. (2-tailed)	,000	,000	
	N	463	463	463

** Correlation is significant at the 0.01 level

Finally the third factor concerning the teachers' attitudes towards the usefulness of the INVALSI tests to analyse, reflect and plan didactics was found to correlate consistently and significantly with both indices, in particular with the second.

The highest correlation reported in the last column puts in evidence a positive and statistically significant link[3] between recognition of the validity of the INVALSI test to measure and assess mathematical skills and the usefulness (perceived by teachers) of the items for analysing, reflecting and planning their own didactics (.331**) (Tab. 6).

This correlation shows that those who consider the measures obtained from this test as non-random, reliable and referable to a clear conceptual framework, are inclined to consider the test itself as a useful tool capable of providing a solid foundation of data. They attribute a diagnostic assessment function to the test (Vertecchi, 2003; Domenici, 2003), able to highlight the skill levels of each student. Starting from these data, these teachers can reflect on their own didactics, on the needs that emerged in their class and on the opportunity to plan work paths that give specific answers with respect to the picture that emerged from the analysis of the test results.

A second interesting correlation is the one that highlights a positive and significant link between the recognition of the validity of the INVALSI test and the statement of use of the test (in teaching practicies) to enhance their mathematical skills (r = 0.310**) (Tab. 6). Our analyses led us to consider that those teachers, who consider the INVALSI test as a useful tool for assessment, not only recognise the diagnostic potential to exploit upstream of the didactic action, but also appreciate the reinforcing potential, which can strengthen learning downstream or during explanations, consolidating the message through operational practices. According to our interpretation, recognising and giving value to the theoretical construct that underlies the INVALSI test represents a non-obvious element: this element represents a necessary condition for the attribution of validity by teachers to each of the items released and available for didactic use, including the microsystem level evaluation function in the classroom context.

A third high correlation indicates a marked covariation between the use of INVALSI questions to analyse, reflect and plan didactics, and the habit of using INVALSI items to work with students to enhance their mathematical skills (.515**) (Tab. 6). Some teachers consider the INVALSI questions as a

[3] The correlations were calculated with Pearson's r and the strength is reported in parentheses, with the level of significance with asterisks in the contribution for each, according to conventional standards recognised in the scientific community.

valid basis for structuring and restructuring teacher interventions in a targeted and individualized way based on the needs of the students. We interpreted that belief as a prerequisite for teaching practices don't oriented as much to train students to pass the INVALSI test, but rather to help students in developing those specific mathematical skills involved in their resolution.

6. Reflections based on the data

What do the correlations that we have analysed in this contribution indicate as a whole? Undoubtedly, they are revealed as being strongly interconnected. This first observation makes us understand something of interesting. The three summary variables constructed, 1) the recognition of the validity of the INVALSI test to assess students'skills, 2) the use of INVALSI questions in the classroom context to develop students' skills, 3) the recognition of the usefulness of the INVALSI tests for analysing, reflecting and planning didactics, are linked by a common ground. We can trace a convergence in them towards certain convictions and attitudes relating to the teaching-learning process: it is intended above all as the result of a work that requires specific interpretations of the context supported by diagnostic assessments. The teacher who emerges from this vision is therefore the same person responsible for the process. Furthermore, the emerging vision of the teaching-learning process shows strong connections with specific professional skills: 1) teachers' reflective and analytical capabilities 2) teachers' ability of planning the didactic activities according to a medium and long-range perspective 3) teachers' skills in carry out what planned. In this sense, the teacher assumes the responsibility of a programmatic vision of the work in the classroom and manages its direction. Moreover, the vision of the teaching-learning process, that is outlined starting from the correlations discussed, testifies to a conception of learning that is far from an innate vision, which considers the act of learning as an almost exclusive result of natural gifts the students already have. Rather, it appears to be conceived as the result of a positive, intentional and guided interaction with the notion that skills can be acquired, trained and developed, an interaction that enhances the use of valid tools to work on strengthening students, also in a targeted way.

These correlations show that their beliefs have influence teachers' didactic choices and actions. Recognising the validity of the INVALSI tests, in relation to the skills they demand of students on the one hand, and their usefulness for analysing, reflecting and planning didactics on the other, affect the type of prevalent use they make of the test in the classroom context:

a use mainly aimed at developing skills and less oriented towards teaching-to-test. The teachers with high scores on the indices and factors used for these second-level analyses, interpret themselves as professionals who do not act merely by their simple vocation and believe that learning can and should be constructed. They develop reflections to improve and adapt their didactic proposal to students and help them enhance their mathematical skills. In summary, among the respondents, we can trace the figure of a teacher who works on two fronts: the first direction is oriented to build a stimulating learning environment; the second direction aims to strengthen students' skills for encouraging them to approach their learning path in a critical and reflective way. It is a type of teacher who recognises the validity of the INVALSI test constructs and is therefore inclined to identify them as useful tools for analysing their teaching action, reflect on it and redesign it in a manner which is functional to the learning objectives, and to use the items derived from the INVALSI tests in classroom assessment practises more frequently.

7. Conclusions and prospects

In conclusion, the study that was carried out intercepted a current and interesting topic and provided significant results. It allowed us to shed light on the potential ways of improving mathematics teaching thanks to the monitoring offered by the INVALSI tests.

The relationship between teaching practices and tests, as emerging from the data, still needs to be explored and deepened from many points of view. It however seems to be a crucial link to confirm the importance of recognizing and enhancing the professionalism of teachers. Their key role consists in giving an interpretation of the INVALSI tests results and in drawing inspiration from them to implement processes capable of raising the quality level of teaching. The highlighted elements contribute to outlining a rich picture, which may, however, be further confirmed and clarified by the collection of wider range of data, both in terms of the representativeness of the sample and in terms of depth of the analysis. For example:

– the preparatory activities in view of the administration of tests could be also explored;
– the processes of design and implementation of educational interventions suggested in some way by the tests could be analyzed;
– dynamics relating to the return of the information collected and its exploitation may be studied in order to improve the quality of teaching.

The results set out above also encourage to explore the logical-pragmatic patterns in order to describe and validate "good practices" of teaching mathematics as favoured by the INVALSI tests. Such dynamics can be considered as "habits" of professional activity. They do not always give rise to processes of mentalization and speech and may, have a "pre-semantic" nature. A possible development of this study could therefore go in the direction of deepening their knowledge and understanding with a set of ad hoc tools, hopefully capable of also reaching the practices actually implemented. The aim is to focus on elements of educational quality that may be exported as part of training and accompanying initiatives to enhance the INVALSI tests as potential tools for improving teaching and learning processes. Furthermore, these are 'ways' of interpreting class work that are constructed during the activity itself also on the basis of the relationships that the teacher maintains with students as the literature suggests. This may suggest an effort to rebuild the context and ways of participating in the communities of professional practices that have generated certain approaches to teaching from tests. On the other hand, precisely the emergence from the data of distinctive dynamics potentially capable of bringing "added value" to the use of INVALSI tests in the classroom recommends not to neglect different professional interpretations, characterised by greater misalignment between the use of tests and classroom teaching practices. It would be the subject of analysis in a pro-active and improving key, possibly also "in" and "with" the teacher communities. This, in the wider dialogue framework of the relationships between INVALSI tests and didactic-evaluation processes, to be explored, in perspective, also in the development of innovative methods and strategies for conducting the class.

On a methodological level, the study contributes to confirming the importance of promoting collaborative dialogue between researchers and teachers. This strategic synergy could create the conditions so that "experiential knowledge" and formalized knowledge about teaching can find basis for discussion. Practical and theoretical problems on how to promote the best learning by each student, indeed, can find a ground for mutual clarification and for progressive synthesis. In this way it is possible to give life to forms of knowledge that are increasingly responsive to the professional action of teachers, promoting operational choices that are based on cognitive foundations.

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Education is a crucial issue for the economic, cultural and social development of all countries. International empirical evidence has actually highlighted the close correlation between school learning and the economic growth of a country, reaffirming the value of education as a central development lever. INVALSI data, therefore, in addition with other data sources – such as the ones of the Ministry of Education and Merit – may be precious in order to know, better understand, and deepen school processes. INVALSI tests, in particular, provide both educational institutions and policy makers with a wide range of useful and important information to respond to different school needs.

This volume collects some research papers presented at the sixth edition of the Seminar "INVALSI data: a tool for research and teaching" (held in Rome from 25th to 28th November 2021) aimed to explore this topic.

As the Statistical Service, we hope that these examples of the use of INVALSI data, either alone or integrated with other databases, will reinforce the belief that a proper use of data can make an important and crucial contribution to decision-making processes and be a determining factor in making worthy and strong decisions.

Patrizia Falzetti, Technologist Director, 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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