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CONTENTS

INTRODUCTION XVI

Alison Clark-Wilson and Christian Bokhove

ICTMT17 ORGANISATION XVIII

SECTION 1 INVITED SPEAKERS AND PLENARY SESSIONS XX

INTENTIONAL INNOVATION: REIMAGINING TEACHER LEARNING AND MATH INSTRUCTION WITH AI XX

Yasemin Copur-Gencturk

ONE MATHEMATICAL TECHNOLOGY – THREE RESEARCH PERSPECTIVES (PANEL DISCUSSION) XX

Nils Buchholtz, Karen Hollebrands, Maria Fahlgren

CO-CREATING DYNAMIC MATHS CLASSROOMS – THREE PERSPECTIVES XXI

Pip Huyton, David Poras, Sam Rogerson

SECTION 2: PEER-REVIEWED PAPERS (8 PAGES) 1

WHOLE-CLASS DISCUSSIONS WITH DYNAMICALLY LINKED MULTI-REPRESENTATION TOOLS: CASES OF DISTRACTORS FROM STRUCTURE EXPLICATION 3

Malina Abraham and Susanne Prediger

STUDENTS' INTERACTIONS IN THE MATHEMATICS CLASSROOM: USING AUGMENTED REALITY TO EXPLORE THE DERIVATIVE FUNCTION 11

Valeria Andriano and Giulia Ferrari

CONVERTING STATIC GEOMETRY TASKS INTO DYNAMIC TASKS: TEACHERS' PERSPECTIVES 19

Hassan Ayoob, Osama Swidan

A MULTIMODAL INVESTIGATION OF SECOND-ORDER COVARIATIONAL REASONING 27

Sara Bagossi, Osama Swidan

THE MEME IS THE MESSAGE: HOW DIGITAL TECHNOLOGIES TRANSFORM PARTICIPATION IN THE MATHEMATICS CLASSROOM 35

Giulia Bini, Sara Gagliani Caputo, Marta Crippa

TECHNOLOGY USE IN MATHEMATICS CLASSROOMS IN JAPAN AND THE UNITED KINGDOM: AN ANALYSIS OF PISA DATA 43

Christian Bokhove, Kotaro Komatsu, Katsuyuki Koishizawa, Toshio Kondo, Nobuhiko Shinomiya

SCAFFOLDING INSTRUMENTAL GENESIS: HOW CONVERSIONS BETWEEN SEMIOTIC REGISTERS FOSTERED GEOMETRIC REASONING IN A DYNAMIC ENVIRONMENTC 51

Roberto Capone, Eleonora Faggiano, Ludovica Galiano, Federica Troilo

THE DATABASE GESTINV AS A TOOL TO DEVELOP MATHEMATICS TEACHERS' HERMENEUTICAL COMPETENCE 59

Maria Chiara Cibien, Federica Ferretti, Camilla Spagnolo

UNSTABLE INVARIANCE: INVESTIGATING THE DEVELOPMENT OF UTILISATION SCHEMES IN GEN-AI MEDIATED PROBLEM SOLVING 67

Francesco Contel, Annalisa Cusi

DO ARTIFICIAL INTELLIGENCE TOOLS HELP ENGINEERING STUDENTS TO LEARN ABOUT MULTIPLE INTEGRALS? 75

Maria Cristina Costa

ORCHESTRATING ARTEFACTS ACROSS LEARNING ENVIRONMENTS: A TEACHING EXPERIMENT ON SUN AND SHADOWS 83

Daniele De Giorgi

SUPPORTING STUDENTS IN COMPLETING MATHEMATICAL REFLECTION WORKSHEETS THROUGH AN AI-BASED APPLICATION 91

Chiara Marialuisa De Santis, Silvia Baccaro, Weronika Seniawska, Ilhiane Zarouri , Robin Short, Leonardo Guidoni

HATTIE&TIMPERLAI: IMPROVING FORMATIVE FEEDBACK THROUGH A RESEARCH DRIVEN TEACHER COACH 99

Del Zozzo Agnese, Funghi Silvia, Montresor Alberto, Valentini Marta

TOWARDS A THEORETICAL FRAMEWORK FOR LEARNING DEVELOPMENT SYSTEMS: THE CASE OF CHUNK LEARNING 107

Helena Dell'Anna, Domenico Brunetto, Ralucca Gera

TOWARDS A FRAMEWORK FOR THE DESIGN FOR SCRATCH-BASED ACTIVITIES: EMERGING INSIGHTS FROM NORWEGIAN TEACHERS 115

Magnus Eggen

PAPER AND SCREEN IN INTRODUCING DIGITAL MATHEMATICS ITEMS: A STUDY OF COMPUTER-BASED MATHEMATICS ASSESSMENT IN THE FIFTH GRADE 123

Francesca Ferrara, Laura Montagnoli

THE IMPACT OF GENERATIVE AI ON STUDENT LEARNING ACHIEVEMENT IN SECONDARY STEM EDUCATION: A META-ANALYSIS 131

Alissa Fock, Hans-Stefan Siller

ORCHESTRATING ASYNCHRONOUS MATHEMATICAL DISCUSSIONS: TEACHER ROLES AND THE EMERGENCE OF INDIVIDUAL-GROUP DYNAMICS 139

Sara Gagliani Caputo, Annalisa Cusi, Laura Branchetti

CRAFTING EMBODIED MATH: A DESIGN GRAMMAR FOR GEOGEBRA PLUS APPLETS 147

Andrea Ghersi, Marzia Garzetti, Ornella Robutti

DANCING ANGLES: MAKING SENSE OF ANGLES THROUGH MATERIALLY GROUNDED ENACTIVE METAPHORS 155

Christina Gkreka, Myrto Karavakou

WHO BENEFITS FROM INTELLIGENT TUTORING SYSTEMS? STATISTICAL EVIDENCE OF THE DIGITAL DIVIDE IN AUSTRALIAN HIGH SCHOOL MATHEMATICS EDUCATION 163

Brody Hannan

THE USE OF TECHNOLOGY FOR EVIDENCE-USE IN PRE-SERVICE MATHEMATICS TEACHER EDUCATION 171

Rosalyn Hyde, Christian Bokhove, Lucy Hoyes

VISUALIZING PATTERNS IN STUDENT WORK: USING CARTESIAN REPRESENTATIONS IN EXAMPLE-ELICITING FRACTION TASKS 179

Amal Kadan-Tabaja, Michal Yerushalmy, Daniel Chazan

PROPORTION DANCING FOR MATERIALLY ENACTED COVARIATIONAL REASONING 187

Myrto Karavakou

CODING MODELING AND 3D PRINTING TO ACHIEVE INSCRIBABILITY: AN EMBODIED MATHEMATICAL EXPERIENCE WITHIN A NEW CONCEPTUAL FIEL- 195

Charikleia Korompli, Chronis Kynigos

A GEOMETRIC INTERPRETATION OF THE NEWTON LEIBNIZ FORMULA AND ITS ANIMATION IN JAVASCRIPT 3D GRAPHICS 203

Maria Antonietta Lepellere, Fabrizio Masullo

CONSTRUCT OR COMMAND? PEDAGOGICAL DECISION MAKING IN GEOGEBRA CREATED VERSUS AI-GENERATED DYNAMIC APPLETS 211

Donglin Li, Alison Clark-Wilson, Nicola Bretscher

LEARNING SPATIAL ORIENTATION WITH THE USE OF A VIRTUAL CITY 219

Sabrina Matri, Sylvia Coutat, Jean-Luc Dorier

FOSTERING FIGURAL-CONCEPTUAL COVARIATION: HOW GEOGEBRA TRANSFORMS UNDERSTANDING IN EUCLIDEAN-TAXICAB GEOMETRIC TRANSITIONS 227

Annamaria Miranda

BRIDGING VISUAL AND VERBAL DATA: AI-AUGMENTED LEARNING ANALYTICS FOR FORMATIVE ASSESSMENT IN MATHEMATICS EDUCATION 235

Kholod Moed-Abu Raya, Shai Olsher

THE ROLE OF A DYNAMIC GEOMETRY ENVIRONMENT IN SECONDARY STUDENTS' ARGUMENTATION WHILE ENGAGING WITH A EUCLIDEAN GEOMETRY TASK 243

Gemma F. Mojica, Karen Hollebrands, Michael Hoyes, Ruby Ellis, & Kayla Chandler

THE DATABASE GESTINV AS A TOOL TO DEVELOP MATHEMATICS TEACHERS' HERMENEUTICAL COMPETENCE

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This study explores how interaction with the Gestinv database, which contains data from Italian Large-Scale Assessments (LSAs), can impact on teachers' competence in identifying and interpreting students' mathematical errors, understood as hermeneutical competence. It builds on the widespread difficulties emerged among mathematics teachers across different school levels in a previous research questionnaire. This research presents a case study involving a lower secondary school teacher during a semi-structured qualitative interview focused on analysing an item from the national LSAs mathematics tests. The interview was conducted using the Gestinv database technology tool and an increase in hermeneutical competence seems to have been detected.

Keywords: Teacher education, Large-Scale Assessments (LSAs), Gestinv, Hermeneutical competence

INTRODUCTION

The role of errors in mathematics learning and teaching has long been a central topic in mathematics education. Many studies have explored the nature of errors, the roles they can play in students' mathematical learning, and how they can be effectively used within a teaching and learning domain (Borasi, 1987). More recently, interest in this field has been also focusing within the context of teacher education (Hoth et al., 2022). In this regard, the aim is to investigate whether mathematics teachers are aware of students' errors and how these errors are interpreted considering teachers' knowledge, beliefs, and experiences. Our study aligns with this strand of thoughts, as the main objective is to investigate the competence of Italian mathematics teachers in identifying and interpreting students' errors. More specifically, it is embedded within the broader national research project "*Mathematics Standardized Assessment as a Tool for Teachers' Professional Development*", which aims to develop a new model for teachers' professional development, that integrates both theoretical and operational tools, starting from the results collected from the Italian Large-Scale Assessments (LSAs). In Italy, national LSAs are managed by INVALSI (www.invalsi.it), the public research institute responsible for systematically monitoring student learning and the quality of educational system. The INVALSI mathematics assessments are based on theoretical frameworks consistent with the National Curriculum Guidelines and educational research, providing valuable data for investigating teaching and learning nationwide (for theoretical framework https://invalsi-areaprove.cineca.it/docs/file/QdR_MATEMATICA.pdf). Analyses of these data have contributed to a deeper understanding of internationally recognized constructs of mathematics education (Bolondi & Ferretti, 2021) and have led to the identification of new phenomena (Ferretti & Bolondi, 2019). When effectively and thoughtfully integrated into teacher education, these findings can enhance both disciplinary and pedagogical knowledge, supporting the professional development of mathematics teachers (Campbell & Levin, 2009). In order to design the aforementioned model, a research questionnaire was administered to explore knowledge, beliefs and educational needs of Italian mathematics teachers. Specifically, the questionnaire included a selection of past INVALSI items and teachers were asked to reflect on various aspects of them: what the items assess, the level of difficulty for students, which incorrect answer

is most likely to be chosen and how the items might be used in the classroom. Analysis of the responses revealed a wide range of teacher knowledge and beliefs (Viola et al., 2024), and in particular, highlighted difficulties in identifying the most common students' errors at the national level (Cibien, 2025). The present study aims to further investigate this issue by exploring, through the use of the Gestinv database (www.gestinv.it), teachers' competence in identifying and interpreting students' errors, which led to the delineation of the new construct of *hermeneutical competence*. The Gestinv database provides access to extensive data from previous INVALSI LSAs. The availability of such detailed and structured information allows it to be used as a tool for examining how teachers reason about students' errors: whether they are able to identify them, how they interpret them, and the extent to which these interpretations are shaped by their prior knowledge, beliefs, and professional experience. In this sense, Gestinv acts as a bridge between the research community and the teaching community (Ferretti et al, 2020). From this perspective, the technology provided by the database is not merely a support tool, but a key element for investigating hermeneutical competence. Thus, the research question this study seeks to address is: *How can the Gestinv database contribute to the development of mathematics teachers' hermeneutical competence?* To address the research question, semi-structured interviews were conducted with lower secondary school teachers who had previously completed the questionnaire. The following sections present the analysis of one of these interviews, selected for its particular relevance in illustrating a meaningful development in the hermeneutical competence of the interviewed teacher. Beyond the Italian context, while the present study is grounded in the national setting and makes use of LSAs and related resources, its implications are not limited to this case. At the same time, it also aims to contribute to a broader international framework, situated within a strand of studies highlighting how teachers' knowledge and beliefs influence the ways in which they manage students' errors (Bray, 2011). From this perspective, national LSAs such as INVALSI represent just one possible source of evidence: comparable results from LSAs in other countries may equally serve to pursue the same goal within their specific educational contexts, as already emphasized by Williams and Ryan (1999).

THE HERMENEUTICAL COMPETENCE

The conceptualization of *hermeneutical competence* is grounded in a networking of theoretical perspectives, drawing on the frameworks of *diagnostic competence* (Schrader, 2011) and *interpretative knowledge* (Ribeiro et al., 2013). This integration follows the networking approach proposed by Prediger et al. (2008), who argue that linking different theoretical perspectives enriches the analysis of complex educational processes. Diagnostic competence refers to the set of knowledge, skills, and beliefs teachers mobilize when engaging in diagnostic activities (Schrader, 2011). These activities involve collecting and interpreting information about learning conditions, processes, and outcomes through tools such as tests, observations, student work, or interviews. An example of diagnostic activity is the identification and interpretation of students' errors (Hoth et al., 2016), both in relation to subject-specific content (*content-related diagnosis*) and to broader aspects such as motivation and behaviour (*student-related* or *action-related diagnosis*). The primary aim of such practices is to gather reliable and meaningful information about individual learners or the class as a whole, in order to guide targeted and effective instructional strategies, particularly for addressing and overcoming students' errors. In this regard, Heinrichs and Kaiser (2018) define *diagnostic competence in error situations* as the teachers' ability to interpret students' errors without necessarily focusing on subsequent corrective actions. On the other hand, interpretative knowledge (Ribeiro et al., 2013) refers to the knowledge teachers need to make sense of students' solutions, whether incorrect or correct but based on flawed reasoning. It is involved not only in interpreting students' thinking but also in using such interpretations to support learning: in this regard, it can be seen as analogous to the corrective dimension

following diagnostic activities within the framework of diagnostic competence. Grounded in core features of the two constructs previously discussed, the notion of *hermeneutical competence* was developed, also with specific reference to students' errors. Hermeneutical competence is defined as the practice-related competence of a mathematics teacher, necessary for identifying and interpreting students' errors on the basis of texts (verbal, graphical, or written). It is considered practice-related because, in everyday teaching practice, teachers work directly with such texts, which thus become hermeneutical objects, in the sense described by Figal (2022). Moreover, this work is dynamic in nature, as it must account for a wide range of classroom situations in which these hermeneutical objects maintain a fundamentally subjective relationship with the objective content of the mathematical item. In this study, hermeneutical objects are represented by items from LSAs: their formal characteristics help prevent conflating the hermeneutical object with the interpretative process (Figal, 2022), while their alignment with curriculum guidelines and mathematics education research enables the identification of macro-phenomena in LSAs data. As such, these hermeneutical objects allow for a reliable measurement of the competence under investigation. Possessing a solid hermeneutical competence means being able to analyse and interpret a LSAs item to identify the conceptual difficulties it may entail and, consequently, the most likely errors a student might make. It also involves interpreting such errors by reflecting on the cognitive processes and reasoning that may have led the student to them. To explore the hermeneutical competence of the teachers involved in this study, we made use of the Gestinv database, which collects mathematics items from the INVALSI national assessments administered since 2008. Designed to support teacher education, Gestinv enables in-depth analysis of items through multiple search criteria, including learning objectives (as defined by the National Curriculum Guidelines), keywords within the item, question type, underlying cognitive processes, grade level, disciplinary domain, and year of administration. Gestinv works as an interactive technological resource of particular relevance in teachers' professional development, as it provides access to a wide range of information offering insights into both teaching and learning processes (Ferretti et al., 2020). Within the context of this study, the data available through the database were used to prompt structured reflection with teachers on potential student errors related to specific mathematical items and topics.

METHODOLOGY

This study adopted a *mixed-methods* approach (Johnson & Onwuegbuzie, 2004). The quantitative component drew on an anonymous online questionnaire administered via Google Forms to 456 Italian mathematics teachers, categorized by school level and teaching experience (in-service and pre-service). Among them, 81 were lower secondary school teachers (56 in-service and 25 pre-service) from various schools and universities across Italy. Questionnaire data were analysed using Grounded Theory methodology (Charmaz, 1983), inductively deriving analytic categories from the responses. The questionnaire included three INVALSI items from past LSAs. For each item, teachers responded to guiding questions designed to investigate their hermeneutical competence, including (Q1) "*In your opinion, what does this item primarily assess?*" and (Q2) "*The correct option is X. In your opinion, which incorrect option was most frequently selected nationwide, and why?*". Q1 explored which mathematical knowledge and skills teachers considered essential for solving the item correctly, and whether they are able to identify potential conceptual difficulties. Q2 assessed their ability to recognize most common national errors and interpret the reasoning behind them. Results showed that many teachers struggled with both tasks (Cibien, 2025), prompting further qualitative exploration. This led to the need for deeper qualitative exploration, which was conducted through semi-structured interviews with participants who had expressed willingness to be contacted for further research after the questionnaire administration. Interviews were conducted online, following Patton's *interview guide approach* (Patton, 1980), thus were informed by the data collected through the questionnaire. The interviews were analysed using both the available transcripts and the researchers' notes

taken during the sessions, with attention to moments where changes in hermeneutical competence emerged, such as reinterpreting errors initially seen as unpredictable. During interviews, the same INVALSI items were reintroduced, and teachers were asked to elaborate on their reasoning, particularly regarding the distractors they had selected answering Q2 and how they interpreted them. In a subsequent phase, we presented teachers with anonymized examples of incorrect student responses, during which the data available in the Gestinv database were jointly examined and discussed with the interviewee. Specifically, the relevant database section for each item was shown, including the national distribution of responses (correct/incorrect and by distractor), references to the National Curriculum Guidelines, the disciplinary domain, the cognitive processes involved, psychometric analyses, item characteristic curves (which display the probability of selecting a given option based on student ability), and any associated didactic or disciplinary commentary. The discussion of this data with the participants aimed to explore which information teachers prioritized when interpreting student errors, and how such engagement could impact their hermeneutical competence. In particular, this contribution will present the data collected from the questionnaire and an interview regarding reflections from lower secondary school teachers on the item 6 from the 2012 INVALSI test, administered to Grade 8 students (third year of lower secondary school in Italy), shown in Fig. 1a.

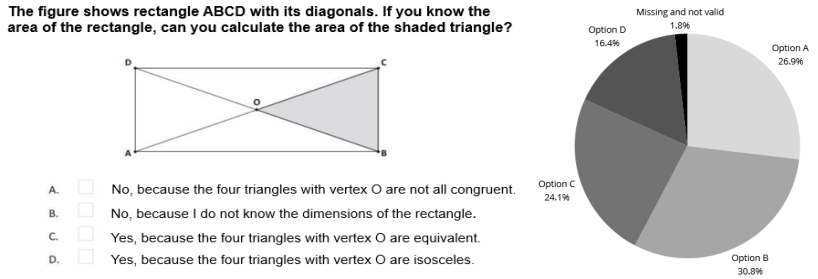


Fig. 1. a) On the left, item 6 of 2012 INVALSI test for grade 8 (translation by the authors); b) on the right, percentage distribution of response options for the item.

The item was selected because it is representative of a macro-phenomenon emerged at national level: it is characterized by a low percentage of correct responses (24.1%) and its distractors can be easily framed with mathematics education research constructs. Their interpretation is particularly meaningful within the framework of the didactical contract (Brousseau, 1986): distractors B and D may be read as manifestations of the *formal justification clause*, according to which a mathematical solution appears incomplete in the absence of traditional calculations. Students selecting B seem disoriented by the lack of explicit computation, while those who choose D adopt a formally coherent reasoning that remains inadequate to fully address the problem. Distractor A, in contrast, may reflect a geometrical misconception tied to confusion between equivalence and congruence. Through the research instruments, the study aimed to explore whether the teachers' interpretations of the errors described by these distractors were consistent with the main findings in mathematics education research.

RESULTS AND DISCUSSION

This section presents the case of a lower secondary school teacher with extensive classroom experience, whose hermeneutical competence appears to have developed further as a result of her engagement with the Gestinv database. The episode reported here concerns this teacher's reflection on the INVALSI item shown in Fig. 1a during the semi-structured interview. With reference to this item, questionnaire analysis revealed that, although option B was most frequently selected by students nationally, 54% of the responding teachers (44 out of 81, of which 33 were in-service and 11 pre-service) identified option A as the most

commonly chosen distractor. Teachers justifying this choice cited students' difficulty distinguishing between equivalence and congruence, as well as challenges in manipulating the geometric figure. In contrast, those selecting B (34% of the total, corresponding to 22 in-service teachers and 8 pre-service teachers) tended (implicitly) to reference aspects of the didactical contract. Regarding (Q1), most teachers referred to the principle of equi-decomposability. Some offered more general explanations, emphasizing area equivalence, while others cited broader geometric competencies without engaging with the item's specific content. No clear correlation emerged between responses to the two questionnaire prompts, in the sense that the interpretation provided of the hypothesized errors often did not refer to the specific topic that the item was intended to assess, according to their point of view. Overall, there was a noticeable lack of awareness regarding the most frequent student errors and the underlying reasons. The teacher featured in our case study, like many others who incorrectly identified the most common distractor, answered succinctly in the questionnaire: she selected A without providing justification and assumed the item simply assessed equi-decomposability. During the interview, she was invited to elaborate on her responses. Regarding the most likely distractor, she remarked (we indicate with R the researcher conducting the interview—one of the authors of this paper—and with T the interviewed teacher):

> T: "Option A, because in my experience there is considerable difficulty in observation, not just manipulation of the figure. So, as students, the first thing they would likely have done is look at the heights and the bases. […] They would have struggled more to observe the figure and to attempt work on it. That's why I chose that option."

This response reveals a strong anchoring in personal teaching experience and limited exposure to theoretical constructs in mathematics education, as no explicit reference was made to existing literature or other established research sources. Subsequently, the teacher was shown several Grade 8 student response protocols for options A, B, and D. These protocols were collected via an open-ended version of the item, which required students to articulate their reasoning. Reviewing these protocols did not significantly alter the teacher's hermeneutical competence, as she continued to regard option A as the most plausible frequent error. The second part of the interview focused on engaging with the Gestinv database. Already familiar with and using the database in her teaching practice, the teacher immediately requested to see the statistical data showing the percentages of the item's response options to compare them with her personal assumptions. She anticipated that the item would yield a relatively high error rate but expected the proportion of incorrect responses to be below 60%, whereas the actual rate was 74.1%. Although she did not elaborate fully, her position shifted radically after observing the distractor distribution (Fig. 1b):

> R: "[Displaying the percentages] Did you expect this distribution among the distractors?"
> T: "It is important to note the variance among the distractors. […] in the end, perhaps the formula-based error was more plausible than the… In my view, it's plausible because I perceive a certain rigidity in students' approaches to geometry overall."
> R: "And did you expect the selection of distractor D?"
> T: "I'm somewhat surprised by D. In other words, in the area calculation, the triangle classification doesn't carry such predominance. Honestly, I expected the first two distractors would have been more frequent."

The database interaction enabled the teacher not only to reevaluate B as the most frequent distractor, but also to consider D, an option she initially excluded. Though concise in her responses, she demonstrates a reinterpretation of her prior assumptions: while she does not reference theoretical constructs explicitly, her interpretation of students' errors appears to have become more refined. This shift suggests a development in her hermeneutical, resulting in an interpretation of the situation that is more consistent with the results

observed at the national level. Finally, the teacher was explicitly asked which of the two resources (student protocols or the Gestinv database) had a greater impact on her reflection:

> R: "What helped you most to become aware of perspectives you hadn't previously considered: working with the student protocols or with the Gestinv database?"
> T: "Between the two, definitely Gestinv. In particular, the percentages help me because sometimes I struggle to interpret. The statistical data is interpretable up to a point, while a student's reflection is not always guaranteed to be interpreted correctly by me. So, I relied more on the statistical data provided."

Despite her familiarity with the Gestinv database, the teacher had not fully explored its potential as a professional reflective resource. However, the guided interaction during the interview prompted her to reconsider and broaden her initial interpretations, fostering a more grounded reading of student errors. The visualization of national response percentages available in Gestinv prompted discussions about unexpected student errors that she had not previously taken into consideration. It was precisely through the integration of the Gestinv database into the interview process that a significant development in the teacher's hermeneutical competence became evident. In this context, technology functioned not merely as a supportive tool but as a *determining factor* in the transformation of teachers' competence. Overall, this case study shows how intentional and structured engagement with technological resources such as Gestinv can activate reflective processes that substantially enhance teachers' hermeneutical competence.

CONCLUSION

INVALSI LSAs represent a potentially powerful tool for investigating teachers' ability to identify and interpret students' errors. The availability of nationally representative data, combined with the interactive functions of the Gestinv database, enables mathematics teachers to reflect critically on a central aspect of their professional expertise: hermeneutical competence. By collecting and organizing publicly available INVALSI data, Gestinv acts as a bridge between educational research and classroom practice (Ferretti et al., 2020) and can support the development of teachers' professional knowledge (Viola et al., 2024). Hermeneutical competence can be developed through reflective interaction with these data. Previous studies reveal that teachers often struggle with this task (Cibien, 2025), suggesting limited hermeneutical competence. This contribution shows that engaging with the data contained in Gestinv can foster the development of this competence. The case study presented illustrates how one teacher, after interacting with Gestinv, revised her assumptions about students' most frequent errors, explicitly acknowledging a shift in her perception. This case does not stand alone. Preliminary findings from ongoing interviews confirm this pattern: teachers' engagement with Gestinv is consistently linked to changes in hermeneutical competence. At the same time, this study represents a first step toward a broader investigation. Future developments will extend the investigation of hermeneutical competence to a wider variety of LSAs items (not only multiple-choice items) and will explore in greater depth factors that have been only marginally addressed here, such as teachers' attitudes toward standardized assessments and how these attitudes influence their interpretation of students' errors. Further research is also needed to examine how teachers navigate Gestinv in more complex, authentic analytical scenarios and which data features they privilege when constructing interpretations. These insights open promising directions for future research into how LSAs data can meaningfully support teachers' professional development at all school levels. Extending this perspective, the study also carries potential relevance beyond the Italian context: international LSA results, when appropriately leveraged and accompanied by technological tools that facilitate their dissemination among mathematics teachers, may likewise serve as a resource for investigating and fostering teachers' hermeneutical competence across diverse educational systems.

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REFERENCES

Bolondi, G., & Ferretti, F. (2021). Quantifying solid findings in mathematics education: loss of meaning for algebraic symbols. *International Journal of Innovation in Science and Mathematics Education*, *29*(1), 1–15. https://doi.org/10.30722/IJISME.29.01.001

Borasi, R. (1987). Exploring mathematics through the analysis of errors. *For the learning of Mathematics*, 7(3), 2–8.

Bray, W. S. (2011). A Collective Case Study of the Influence of Teachers' Beliefs and Knowledge on Error-Handling Practices During Class Discussion of Mathematics. Journal for Research in Mathematics Education JRME, 42(1), 2-38. https://doi.org/10.5951/jresematheduc.42.1.0002

Brousseau, G. (1986). Fondements et méthodes de la didactique des mathématiques. *Recherches en didactique des mathématiques (Revue)*, *7*(2), 33–115.

Campbell, C., & Levin, B. (2009). Using data to support educational improvement. *Educational Assessment, Evaluation and Accountability, 21*(1), 47–65. https://doi.org/10.1007/s11092-008-9063-x

Charmaz, K. (1983). The grounded theory method: An explication and interpretation. Contemporary field research, 109-126.

Cibien, M. C. (2025). Pre-service teachers' professional development and mathematics Large-Scale Assessment. In M. Bosh, S. Carreira, G.Bolondi, M. Gaidoschik & C. Spagnolo (Eds.), *Proceedings of CERME14.* ERME / Free University of Bozen-Bolzano.

Ferretti, F., & Bolondi, G. (2019). This cannot be the result! The didactic phenomenon "the Age of the Earth". *International Journal of Mathematical Education in Science and Technology. 52*(2), 194–207. https://doi.org/10.1080/0020739X.2019.1670366

Ferretti, F., Gambini, A., & Santi, G. (2020). The Gestinv Database: A Tool for Enhancing Teachers Professional Development within a Community of Inquiry. In H. Borko and D. Potari (Eds.), *Proceedings of the Twenty-fifth ICMI Study School Teachers of mathematics working and learning in collaborative groups* (pp.621–628). Portugal: University of Lisbon.

Figal, G. (2022). The Task of Hermeneutics. Critical Hermeneutics, 6(2), 17–33. https://doi.org/10.13125/CH/5433

Heinrichs, H., & Kaiser, G. (2018). Diagnostic competence for dealing with students' errors: Fostering diagnostic competence in error situations. In T. Leuders, K. Philipp, & J. Leuders (Eds.), *Diagnostic competence of mathematics teachers: Unpacking a complex construct in teacher education and teacher practice* (Vol. 11, pp. 79–94). Springer. https://doi.org/10.1007/978-3-319-66327-2_4

Hoth, J., Döhrmann, M., Kaiser, G., Busse, A., König, J., & Blömeke, S. (2016). Diagnostic competence of primary school mathematics teachers during classroom situations. *ZDM – Mathematics Education, 48*(1), 41–53. https://doi.org/10.1007/s11858-016-0759-y

Hoth, J., Larrain, M., & Kaiser, G. (2022). Identifying and dealing with student errors in the mathematics classroom: Cognitive and motivational requirements. *Frontiers in psychology*, *13*, 1057730. https://doi.org/10.3389/fpsyg.2022.1057730

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14–26. https://doi.org/10.3102/0013189X033007014

Patton, M. Q. (1980) Qualitative Evaluation Methods. Beverly Hills, CA: Sage.

Prediger, S., Bikner-Ahsbahs, A., & Arzarello, F. (2008). Networking strategies and methods for connecting theoretical approaches: First steps towards a conceptual framework. *ZDM – The International Journal on Mathematics Education, 40*(2), 165–178. https://doi.org/10.1007/s11858-008-0086-z

Ribeiro, C. M., Mellone, M., & Jakobsen, A. (2013). Characterizing prospective teachers' knowledge in/for interpreting students' solutions. In *Proceedings of the 37th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 4, pp. 89-96). PME.

Schrader, F. W. (2011). Lehrer als Diagnostiker. *Handbuch der Forschung zum Lehrerberuf*, 683-698.

Viola, G., Ferretti, F., Gambini, A., Francesca, M., & Spagnolo, C. (2024). In *Proceedings of the 47th International Group for the Psychology of Mathematics Education (*Vol. 1, pp. 223–224). PME

Williams, J., & Ryan, J. (2000). National Testing and the Improvement of Classroom Teaching: Can they coexist? *British Educational Research Journal, 26(1), 49–73. https://doi.org/10.1080/014119200109516*