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Reducing students learning gap in multicultural classrooms through mathematics teacher training: an Italian case study

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Abstract: This paper examines how mathematics teacher training can reduce the learning gap experienced by students from diverse cultural backgrounds in Italian multicultural classrooms. Drawing on a reinterpretation of learning loss through a cultural lens, we argue that students' mathematical knowledge is not lost but rather unrecognized within the dominant school culture. Survey data from 560 in-service teachers enrolled in the professional development course "Cultures Count" (2025-2026) reveal significant gaps in preparation for plurilingual and multicultural teaching contexts. An inductive content analysis of teachers' conceptions of mathematics further highlights prevalent epistemological positions. In the final part of the article, a section of the teacher training course phase is presented, aimed at discussing a didactic design from an intercultural perspective. Building on Villegas and Lucas's framework of culturally responsive teaching, the paper presents a co-designed planning scheme as a practical tool for developing teachers' roles as cultural brokers, capable of recognizing and valuing students' diverse mathematical knowledge as a resource rather than a deficit.

2020 Mathematics Subject Classification: Primary 97B50; Secondary 97C50.

Keywords: learning gap; multicultural classrooms; mathematics teacher education; teacher training course; intercultural competence.

1. Introduction

The phenomenon of multiculturalism in education has been studied for several years from pedagogical, psychological, and general didactic perspectives. Few works, however, address the

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issues of subject-specific teaching and learning in non-monocultural contexts. Even fewer are the studies in mathematics, both nationally and internationally. The topic discussed here falls within the field of research in mathematics education and may also be of interest to other areas in dialogue with it. The article, in discussing the theme, frames in its second section the issue of multiculturalism and multilingualism as a new challenge for teachers. In this section, examples are provided of different processes enacted by students from "other" cultures, which are often complex for teachers to analyze. Subsequently, the reported TALIS and OECD data highlight a gap in teacher training on these issues, thereby giving greater meaning to the teacher training innovation work we propose. The following sections discuss the theoretical framework (Section 3), the methodological aspects (Section 4), and the results (Sections 5 and 6) of the research described here. We believe that the article may be of interest to the research community in mathematics education, but not only there, also because we propose a shift in perspective in framing the phenomenon of *learning loss* from a cultural standpoint, such that it should not be interpreted merely as an effect of a temporal gap, but rather as a consequence of a change in the implicit or explicit frame of reference. This particular aspect is described in the section on theoretical frameworks.

2. Teaching mathematics in multicultural contexts: a "new" challenge for teachers

In contemporary educational research, the persistence of social and economic disparities among groups within the same context has long been one of the most widely debated issues. The social and cultural gap is often experienced on a daily basis as a form of "dissonance" that unfolds within school environments. Research shows that this gap develops along three main dimensions: the epistemology of the discipline, language (or discourse), and teachers' expectations, and that this cultural distance frequently manifests itself in learning contexts [1, 2]. Below, we recall some examples related to these three dimensions in order to prompt a didactic reflection.

In [3], examining the difficulties faced by Ukrainian refugee students in the UK, several challenges are identified that stem from differences in symbolic systems (digits, decimal point, multiplication and division signs), syntactic aspects of mathematical language (such as parentheses), and the algorithms used for computation and for solving quadratic equations and linear systems, which are often not aligned with those commonly used in the UK. The implication is clear: what was valid and meaningful for a Ukrainian student up until a few weeks before arriving in the UK becomes something to be "set aside", as it is no longer readily understood or easily assessed by teachers in the new context.

In [4], starting from a different setting—namely, two multicultural classes totaling 50 first-year technical high school students (25 from Italian families and 25 from non-Italian families)—the author describes several forms of "distance" emerging in relation to epistemological aspects and the use of more structured algorithms, such as those for division. The context outlined in the study is highly diverse: among the students with non-Italian family backgrounds, nine had arrived in Italy less than three years earlier. Figure 1 presents two division algorithms discussed in the study that differ from those typically used in Italy. According to the author, in many educational settings these alternative algorithms are not adequately recognized or valued and are sometimes even "dismissed" by teachers, as they are not aligned with the institutionalized "standard" knowledge of the classroom—that is, the knowledge associated with the dominant culture. [4] examines this issue also through a historical lens, which helps explain the origins and rationale behind these algorithms, suggesting that the ability to recognize and flexibly engage with multiple approaches can foster greater pedagogical "openness" and support a broader, more multidimensional understanding of the discipline (historically, critically and geographically flexible).

From the two contributions discussed above, it clearly emerges that the issue at stake con-

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Figure 1. Examples of spontaneous algorithms taken from figure 2 in [4].

cerns both the student and their way of learning mathematics in the classroom, as well as the teacher, who is embedded in a personal and often deeply ingrained frame of reference that is difficult to move beyond [5], despite the strong demands posed by multicultural educational contexts. *When confronted with bodies of knowledge that may be culturally "distant" from one another, how should they be addressed? How can the distance between them be reduced? What happens, at both a cognitive and affective level, to a student who, when placed in a different context, "distances" themselves from an algorithm or from knowledge that is part of their own (culturally grounded) background? Is this knowledge lost? Can this be considered a case of learning loss?*

Providing definitive answers to these questions is complex; however, with regard to the last question, we argue that the answer is "no". In our view, this is not a matter of "forgetting," but rather of "setting aside," thereby creating a space of *learning gap* between a "before" and an "after"—a distance between prior knowledge and what one is now required to learn. For this reason, in the present paper, we will conceptually reframe the notion of learning gap with an empirical and design-oriented account of teacher education in multicultural mathematics classrooms. In the landscape of multicultural literature, our work, due to this hybrid nature between theoretical and practical, represents a novel element. In the next section we set the research problem of learning gap in multicultural context and in section 3 we address this problem through different complementary lenses.

This complex situation requires teachers—who are called to educate in the broadest sense within such contexts—to adopt an open, dialogic approach. In multicultural educational settings, this complexity is further intensified by linguistic and social dissonances. For this reason, it appears promising to approach the issue not primarily from the perspective of the individual student and their knowledge (acquired and then lost), as in the case of learning loss, but rather from the perspective of the environment in which the student is situated. This involves examining the relationship between what the student knows and what, within the dominant culture of the host classroom, they are normatively expected to know.

Within this second set of dimensions—more appropriately framed in terms of the learning gap—it becomes possible to disentangle and analyze structural inequalities. In this context, mathematics can become a space for narration and for grounding knowledge in deep, lived experiences. Viewing mathematics as a bridge between different bodies of knowledge—distinct yet connected to diverse cultural references—rests on a pluralistic stance: cultural and linguistic differences, as they emerge in mathematical practice, are not only accepted and supported, but actively sought as resources for the construction of richer, shared knowledge.

From this perspective, a relativistic stance—free from hierarchical value judgments about different forms of knowledge—becomes a necessary condition for genuine inclusion, grounded in concrete diversity. This allows for moving beyond a naïve and rhetorical notion of equality

toward an equity-oriented perspective: we are different, yet we have equal value and equal rights. It is therefore essential to begin with differences, to understand them, and to engage with them relationally. Culture, in this sense, becomes a lens through which we interpret and act in the world—an opportunity rather than a fixed inheritance or a burden tied to an immutable tradition [5, 6].

Data from TALIS (2018) indicate that engaging in these issues constitutes, in many cases, a clear professional development need for teachers [7]. Only 26.3% of lower secondary teachers report that elements of "teaching in plurilingual and multicultural contexts" were included in their formal education or training, compared to an average of 38.5% across TALIS countries (see Table 2.a in TALIS 2018). Furthermore, only 18.7% consider themselves "well prepared" or "very well prepared" in this area, compared to an international average of 31.4% (see Table 2.b in TALIS 2018). Figure 2 presents data from TALIS 2018 regarding the "high level of need for professional development in the area of teaching in a multicultural or multilingual setting" among lower secondary teachers: within this international framework, Italy ranks third, after Mexico and Brazil².

Figure 2. Teachers' needs for professional development for teaching in a multicultural setting

Percentage of lower secondary teachers who indicated that they have a high level of need for professional development in the area of teaching in a multicultural or multilingual setting

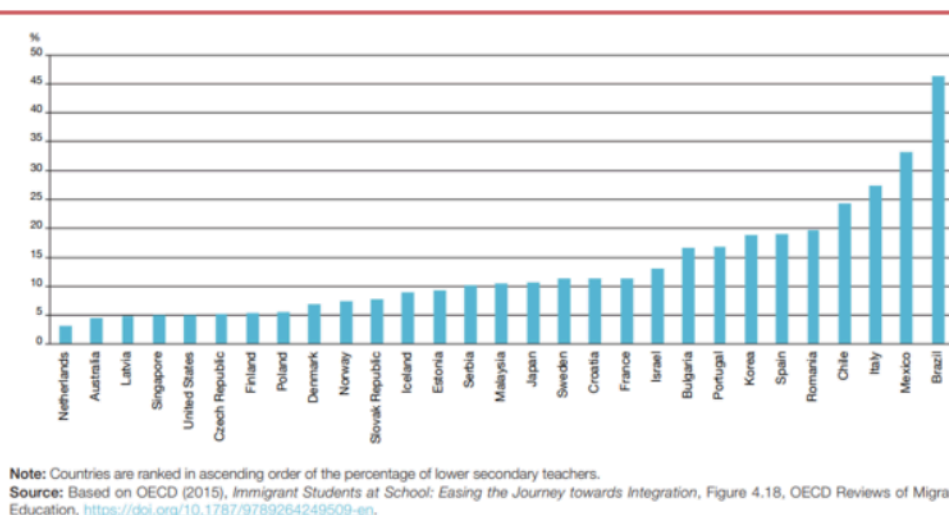


Figure 2. TALIS 2018 regarding "high level of need for professional development in the area of teaching in a multicultural or multilingual setting" among lower secondary teachers.

In the most recent TALIS 2024 survey [8], the data show slight improvement but, in our view, still remain "below threshold": 35.7% of Italian teachers identify teaching in a multicultural or multilingual setting as a component of their professional learning activities (see Table 4.22 in [8]), while 39.6% consider themselves prepared in this area (see Table 4.5 in [8]).

3. Theoretical frameworks

The phenomenon discussed here is very complex from a didactic point of view and therefore requires multiple lenses of analysis. For us, a possible perspective, albeit an initial one, has referred to the possibility of identifying a gap in knowledge related to student learning in multicultural classrooms that is very difficult to detect, analyze, and interpret. In this work, we attempt to establish a connection between the construct of *learning loss* and that of *learning gap*, the latter being more widely discussed in literature. The learning gap is mentioned in this

²https://www.oecd.org/content/dam/oecd/en/publications/reports/2019/02/how-education-systems-respond-to-cultural-diversity-in-schools_3359b650/1baa285c-en.pdf

sense as an initial step and an opportunity for developing a teaching practice attentive to students' needs, in terms of "recovering" and valuing their knowledge, from a perspective of inclusion and cultural transposition. The theoretical framework described here further focuses on the role of the teacher working within these classrooms, referring to the teacher as a *cultural broker*. The theoretical framework, shifting the focus from the student to the context and finally to the teacher, discusses the relationship among these constructs (the triad of learning loss, learning gap, and "teaching gap"), which finds its natural application in the design of the training course (Section 5) and in the analysis of the data collected from the teachers (Section 6).

In recent years, numerous studies have examined the phenomenon of *learning loss*. These studies primarily analyze the relationship between the level of a given competence (expressed through measures such as degree of mastery or speed of use), periods of inactivity related to specific mathematical content, or changes in the learning context. Typically, research focuses on the effects of summer breaks (or exceptional disruptions such as the pandemic [9], as well as on phases in which, within a spiral curriculum, certain topics are revisited and reworked in new ways.

From this perspective, learning loss can be understood less as the effect of a temporal interruption (before vs. after a break) and more as the consequence of a (prolonged) change in context (school vs. out-of-school). Framed more broadly, if a piece of knowledge (a competence, a concept, or even simple information) holds meaning only within the teacher's cultural framework but not within the student's, the likelihood that it will leave no lasting trace is very high. There is, in fact, a strong relationship between what remains in our minds—what becomes permanently "ours," even beyond schooling—and what is meaningful to us, that is, what makes sense within our cultural framework [10]. Positioning itself within this line of research, the present contribution proposes a broader interpretation of learning loss by opening it up to a cultural perspective. Within this framework, we connect the phenomenon of learning loss to the broader concept of learning gap.

The concept of *learning gap* is often mistakenly interpreted solely through a "deficit model," which attributes failure to intrinsic shortcomings of students or their families [11]. However, research has repeatedly shown that this gap is more accurately understood as the result of a lack of "alignment" between the learner's culture of origin and the cultural context of schooling, with culture understood in a broad sense. In line with [11], the key shift involves moving away from a deficit-oriented view—where the student is seen as lacking—toward a culturally responsive approach that treats students' cultural backgrounds and prior knowledge as "cognitive hooks" for expanding their intellectual capacity [12].

In the educational field, [13] further emphasize that the learning gap is a multidimensional phenomenon arising from the interaction between a school system that is often rigid and hegemonic and a culturally diverse student population. Along similar lines, [14] highlights a certain "predictability" of failure based on intersecting demographic variables such as gender, class, and language. From this broader cultural perspective, the gap is not merely a difference in performance or scores—a simple learning loss—but rather an *opportunity gap*, from the very beginning of the learning trajectory, within school systems embedded in a dominant culture [15]. In many educational contexts, as noted by [16], a systematic gap can be observed between an increasingly diverse, multiethnic, multicultural, and multilingual student population and a teaching body that often remains anchored in homogeneous, outdated, and "Eurocentric" pedagogical models, far removed from the actual needs of the classroom.

Within classroom practice, this translates into several recurring dynamics:

- Implicit bias. Teachers may unintentionally hold lower expectations for students from certain minority groups, a phenomenon described as part of the "social construction

of failure" [17]. By neglecting the temporal dimension in which learning unfolds, and by confining students' mathematical competences—even future ones—to a fixed cultural identity, mathematics becomes a gatekeeper, also for subsequent career choices [18].

- **Cultural invisibility.** When mathematical problems are framed in contexts that are unfamiliar to students, cognitive load increases—not because of computational difficulty, but because of the unfamiliarity of the situation. The lack of coherence between the cultural backgrounds—understood in a broad sense as family culture or students' socio-economic background—of students and those of teachers and institutions can lead teachers to partially misinterpret students' modeling choices, for example in problem-solving contexts: real-life problems are not necessarily inclusive [19].

In addressing issues of equity, the goal should not be to provide identical treatment to all students (equality), but rather to ensure that each student has access to the resources necessary to achieve shared goals (equity), with attention to the learning process itself. In this sense, [17] advocates for a culturally grounded approach to equity that can have a transversal impact on the learning gap experienced by students. However, this would require a substantial restructuring of the educational system—particularly in terms of teacher education—so as to include intervention models that build upon and diverse values rather than marginalizing them.

The research question guiding this contribution is therefore the following: *how can the learning gap experienced by students from different cultural backgrounds in Italian classrooms be reduced through teacher education?* In the following sections, we explore what we consider to be key moments (initial questionnaire and collaborative planning) within an in-service teacher training course that the authors have organized over the past three years (here we refer to the 2025-2026 edition). In our view—supported by the data presented in Sections 3 and 4—the issue brought by the research question has a structural nature that requires a strong shift in awareness, starting from reflection on the symptom or effect (the student's learning gap) and grounding itself in its underlying cause: the open, complex, and dialogic relationship between teacher and learner in contexts marked by significant cultural distance, as is often the case in multicultural classrooms.

In our view, the central pillar for reducing the cultural learning gap necessarily lies in teacher education. This means preparing teachers who are not only subject-matter experts, but also "cultural mediators," capable of challenging the hegemonic roots of traditional education. Within this framework, the teacher's role is that of a *cultural broker*, who does not conceive knowledge as a static entity to be transmitted, but as a mediated construct [20]. As argued by Villegas and Lucas [20], teachers should act as bridges, helping students interpret the codes of the dominant school culture without requiring them to renounce their own identities. It is therefore not sufficient to simply add a module on diversity to teacher education programs (which, moreover, is often absent in the Italian context). What is needed is a comprehensive restructuring of the curriculum in order to prepare culturally responsive teachers [20], capable of:

1. Developing *sociocultural awareness*: understanding that one's own ways of thinking and acting are culturally shaped, and that multiple worldviews exist.
2. Adopting an *affirming stance*: viewing diversity as a resource rather than as a problem to be solved.
3. Acting as an *agent of change* within the educational context: taking responsibility for fostering a more equitable school system and addressing structural injustices.
4. Fostering a *constructivist orientation*: understanding how students build knowledge based on their prior experiences.
5. *Knowing students' lives*, interests, and the traditions of their communities.
6. Designing *inclusive practices* that build bridges between what students previously knew,

what they currently know, and what they are expected to learn.

Without such awareness and preparation, there is a significant risk that teachers will unintentionally reproduce "pedagogies, curricula, and assessment practices that better serve a homogeneous, dominant group within the context rather than a diverse and heterogeneous student population composed of minorities" [16]. The choice to refer to the theoretical framework described here is consistent with what has been discussed in the literature on the same subject, as it is capable of linking the design of the training course to the methodological aspects of data collection and interpretation, as well as to the outputs related to the training needs of teachers.

Clearly, implementing such an approach is complex. In the absence of top-down, centralized, and well-structured initiatives—unfortunately a characteristic of the Italian context—our approach is to work alongside teachers, fostering an intercultural sensitivity toward the ideas, perspectives, and language of those who come from different contexts and bring with them backgrounds that are often perceived as "distant." Within this perspective, the aim is to promote a form of intercultural competence among teachers that does not consist in knowing the language of newly arrived students, nor in mastering their specific cultures. Rather, it is a transversal capacity: the ability to remain open, to learn from one's students, and to value their out-of-school cultural knowledge [5]. Cultural Transposition—working on disciplinary and epistemological aspects—and culturally responsive teaching—working on a broader pedagogical direction—become complementary, as we will see when analysing the data in Sections 5 and 6.

4. Methods

The overall limited preparation—and the resulting perception of low competence—mentioned regarding teaching in plurilingual and multicultural contexts is consistent with the data collected by the authors in relation to the teacher training course "Cultures Count", launched in winter 2026. The program involved more than 500 in-service mathematics teachers from across Italy, spanning educational levels from kindergarten education to adult education ($N = 560$), and consisted of 24 hours of online training distributed over three months. Teachers voluntarily participated in this teacher training course by completing an online form distributed nationwide in the weeks before the start of the course. Participants also agreed to videorecord each meeting, complete the questionnaires, and allow the data to be used for research purposes, as long as they were appropriately anonymized. In the present section we quantitatively analyse the data that emerged during registration for the teacher training course; in the next section, using an inductive content analysis, we refer to the first two meetings of the course.

During registration teachers were asked: *"Have you ever addressed, during your studies or through professional development activities, the topic of teaching in plurilingual and multicultural contexts?"* The 560 responses were as follows: 50.4% answered "no," 37.7% answered "yes, but without a focus on mathematics," and only 12.0% answered "yes, with a focus on mathematics." Even though the majority of teachers were interested in the topic, only a small part of them were already competent or trained, which is natural for those attending a teacher training course. Due to the voluntary participation, this makes the sample not representative of all Italian teachers, but only of a small minority of teachers who are sensitive and interested, yet not yet trained.

These data points in several directions:

Practical level. Among the variables collected—teaching level (kindergarten, primary school, lower secondary school, upper secondary school, adult education center, other), role (mathematics teacher, support teacher, other subjects), and years of service (1–5, 5–10, 10–20, over 20)—the only variable significantly correlated with the question above is the school level ($\chi^2 = 46.66$, $p < .001$, Cramér's $V = .204$, small-to-medium effect) (Figure 4). The pattern is clear: lower

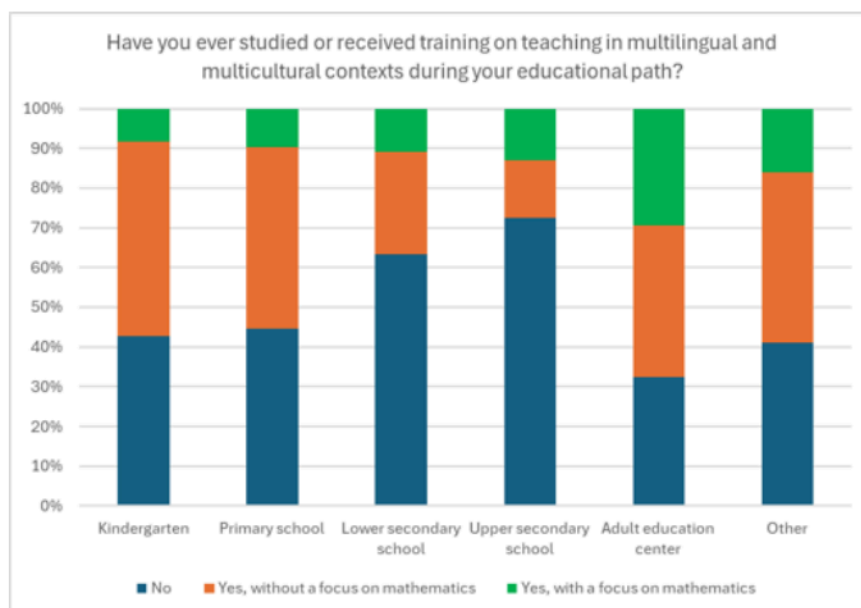


Figure 3. Responses from the 560 teachers to the question: "Have you ever addressed, during your studies or through professional development activities, the topic of teaching in plurilingual and multicultural contexts?"

and upper secondary school teachers are the least trained (63% and 73%, respectively), while adult education centers, kindergartens, and primary school teachers show the highest levels of training. The adult education center stands out in particular for its focus on mathematics (29%), nearly three times higher than in other school levels. There is no evident generational divide (experienced vs. novice teachers). In other words, there is no significant in-service training trajectory leading to a linear increase in competence with experience, nor is there evidence of systematic improvement over time due to top-down initiatives. This suggests weak long-term planning and a general lack of change in approach over recent decades, despite the fact that the issue has become structurally significant at the statistical level [7].

Theoretical level. Teachers report a lack specifically related to the articulation of teaching practices for mathematics within plurilingual and multicultural contexts. This gap is not only pedagogical and related to training, but also theoretical. At both national and European levels, there is a noticeable difficulty—if not an outright inability—to integrate an intercultural perspective into disciplinary teaching, despite it being formally promoted as a flexible and transdisciplinary approach for effective education in such contexts. As a result, intercultural pedagogy remains misaligned with mathematics education, in contrast with European policy documents that emphasize the importance of valuing students' linguistic and cultural backgrounds, particularly those rooted in family contexts [21]. This theoretical gap, in turn, generates a corresponding didactic gap.

This analysis can be further refined by considering additional variables: the weight of plurilingual and multicultural educational contexts—as suggested by the adult education center data in our sample—and the educational background of teachers, whether oriented toward mathematics (upper secondary), science (lower secondary and adult education center), or more pedagogically grounded approaches (kindergarten and primary education). This preliminary overview of teachers' perceptions and beliefs helped us refine our teacher training course.

Given the need for an opening introductory training, in the first phase of the teacher training course, a general framework was provided across four sessions, with particular attention to cultural and linguistic dimensions, aiming to highlight, explore, and problematize key issues in teaching and learning mathematics with students from diverse linguistic and cultural

backgrounds. This was followed by five hands-on workshops organized by broad educational groupings—students aged 3–11 (kindergarten and primary), 12–19 (lower and upper secondary), and adults—with the goal of developing synergistic and concrete approaches to lesson design, in line with [7]. The final two sessions focused on sharing lesson plans, challenges, and open questions, thereby strengthening the community of teachers and researchers (see Figure 3).



Figure 4. Roadmap of the teacher training course.

5. Results: teachers' conceptions and learning gaps

A fundamental obstacle to reducing the learning gap observed among students often lies in teachers' own conception of mathematics. In this regard, [22] highlights how, in some cases, teachers view mathematics as a single, unified body of knowledge, characterized by an ideology of an objectivist epistemology and a logic of certainty. While already problematic in itself, this view, when applied in multicultural contexts, leads to a form of "culturally decontextualized" instruction that tends to alienate students whose backgrounds do not align with the dominant culture of the classroom. To overcome this limitation, recent research has proposed reconceptualizing mathematics as a "system of fluid and interacting bodies of knowledge" [23, 6]. In line with [24], it becomes desirable to shift mathematics from a "monologue of universal truths" to a "dialogue of human practices," emphasizing the discursive nature of school mathematical activity and decentering the teacher from their own system of reference and perceived certainties [25, 26].

Within this perspective, we report findings from an inductive content analysis of responses provided by in-service mathematics teachers participating in the training program "Cultures Count" (school year 2025–2026), which will be described in the next section. The analysis focused on two questions: "*Is mathematics universal?*" and "*What are the two most significant difficulties in teaching students with a migrant background?*" The categorization was carried out by identifying keywords (e.g., "algorithm") and grouping them into higher-order themes (e.g., "Didactic"). This approach preserves the participants' voices while enabling a structured, quantitative overview of qualitative data.

Regarding the first question (Table 1), 114 in-service teachers replied. The results show a clear distribution: the majority of teachers are divided between an absolutist, Platonist view of mathematics (47.8%)—"mathematics is universal"—and a more nuanced universalist view (46.9%)—"mathematics is universal in its results but particular in its practices." In the latter case, teachers demonstrate a clear awareness that mathematical practices vary significantly across cultural contexts (Table 1). Only a small minority adopts a fully relativist perspective,

Table 1. "Is mathematics universal?" Responses from 114 in-service teachers.

Category	Weight (%)	Justification
Culturally mediated universal	47.8%	Responses acknowledging that while logic is universal, the methods, approaches, teaching styles, and algorithms are culture-bound.
Absolutist	46.9%	Responses viewing math as a "universal language" or "unquestionable logic" that transcends human culture.
Relativist	4.4%	Responses defining math as a purely human/cultural construct or a social product.
Other	0.9%	Ambiguous or incomplete responses.

in which culture plays a primary role. This emerging awareness aligns with the ethnomathematical perspective advanced by Ubiratan D'Ambrosio [27], according to which each educational community develops its own mathematical knowledge within its specific context. Such knowledge is not merely a subset of academic mathematics (the "knowledge to be taught") recognized within a given national system, but rather a set of themes, concepts, procedures, and practices that are locally meaningful—and not always recognized as valid by other communities, including those that produce academic mathematics. Thus, one classroom may favor problem-solving procedures that another does not recognize, and such differences frequently emerge across schools operating in different social, geographical, or educational contexts.

Table 2. "What are the two most significant difficulties in teaching students with a migrant background?" Responses from 137 in-service teachers.

Category	Mentions (%)	Justification
Language barriers	61.3%	Explicit mentions of lack of Italian proficiency, communication gaps, and second language learning difficulties.
Cultural differences	19.7%	Mentions of different worldviews, cultural practices, or classroom behavioral norms.
Didactic issues	13.1%	Issues with different algorithms, varying levels of prior schooling, and difficulty in individualization.
Institutional and resource constraints	8.8%	Lack of time, lack of linguistic mediators, and classroom management pressure.
Lack of family involvement	5.8%	Difficulty in establishing a "pact" with families or lack of support at home.

In the second question (Table 2), we see the replies by the 137 in-service teachers. A particularly strong cross-cutting theme concerns language: more than half of the teachers (61.3%)

identify it as a key issue for effective teaching in multicultural contexts. Linguistic difficulties are therefore seen as a *gatekeeper* for the inclusion of all students. Some teachers also explicitly refer to the specialized language of the discipline. Slightly more than 10% highlight more strictly disciplinary dimensions—curricular, epistemological (e.g., algorithms), and cognitive (e.g., logical structures)—related to how mathematics is learned. Finally, another group of responses points to the importance of both the classroom context (motivation, participation, peer interaction) and the out-of-school environment (family). In the following section, we outline—more schematically—the structure of the teacher training program designed on the basis of these questions and the corresponding responses.

6. Designing a planning scheme to reduce the learning gap: a dialogic process

In this section we present a synthesis of the co-design process of a planning scheme, developed through the interaction between teachers and one of the article's authors, an upper secondary school teacher acting as a teacher training facilitator within the "Cultures Count" training course, during a workshop session. The figure shows the scheme produced after approximately 40 minutes of dialogue with around 70 lower and upper secondary school teachers connected online. This initial phase was followed by 30 minutes of small-group design work. What follows is a discursive reconstruction of the key moments in the development of the shared planning scheme, organized by macro-themes (Figure 5) and highlighting the roles played by both teachers and the facilitator. The different phases are interpreted through the six dimensions identified by Villegas and Lucas [20], introduced in Section 3, which characterize the development of teachers' awareness of their role as cultural brokers operating at the intersection of disciplinary knowledge and the heterogeneous, plural contexts of multicultural classrooms. In this sense, the dialogue reported here can be understood both as a moment of rupture and as a step toward the emergence of a collective and critical awareness of the discipline and its teaching.

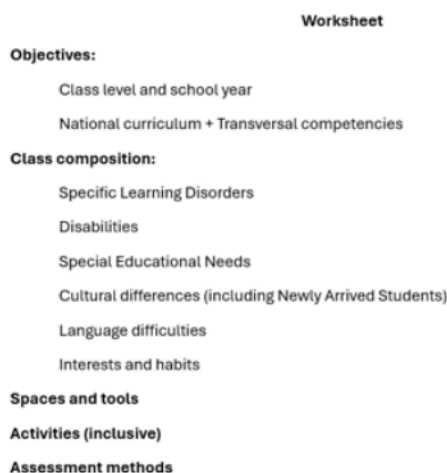


Figure 5. Shared planning scheme for lower and upper secondary school teachers.

Selection of objectives

After defining the class level and school year and aligning with the core thematic areas of the *national curriculum*—with particular attention to vertical coherence—participants, following a suggestion from one teacher, emphasizing the importance of *transversal competences* applied to mathematics.

Class composition

The discussion then moved to issues central to the course. Teacher A remarked: "We also need to consider the students—what they are like, how many have *special educational needs*, how many have *disabilities*, and so on." The facilitator summarized: "So, let's include *specific learning disorders*, possible disabilities—and what else?" Teacher A added: "Foreign students, *newly arrived* students." The facilitator proposed: "Let's include *cultural differences*." Another teacher, B, suggested: "General *special educational needs* categories?" The facilitator responded by noting that while useful, such broad categories risk obscuring important distinctions. Other participants refined the categories (e.g., *linguistic special educational needs*, *language difficulties*, dysgraphia). Ultimately, the facilitator emphasized the importance of explicitly identifying the issues: "So, in this context I would first give a brief overview of what we are talking about: difficulties, cultural differences—*cultural differences* in a broad sense, including also *newly arrived* students".

The inclusion of students' *interests and habits* was also proposed. This aspect emerged as crucial both for understanding the class and for fostering mutual knowledge among students. It was framed in multiple ways: formal entry assessments, small-group work, and especially informal whole-class discussions, which were considered preferable—particularly for students with difficulties—over static, normative documentation inherited from previous schooling. To gain deeper insight into each student, teachers suggested assigning a reflective text on "one's relationship with mathematics and with school," to be revisited during the year. Teacher C noted that revisiting such reflections often reveals meaningful developments and helps reopen a dialogue: "Then perhaps we revisit it halfway through the year, go over it again, and then return to it once more at the end of the year—it really depends on how the situation develops. Very interesting insights always emerge. It's usually the primary school teacher who made them hate mathematics, so from there we need to find a way to establish a channel of communication".

This multiplicity of perspectives led to flexible uses of this component during lesson planning in groups, often tailored to specific classes. These elements align with Dimension 5—*Knowing students' lives*—of [20].

Affective dimensions

Taking emotional aspects into consideration, the facilitator explicitly opened this line of inquiry: "Let me take this opportunity—why do you think mathematics teachers sometimes lead students to dislike mathematics? I know this is not directly related to the workshop, but I'd really like to hear your thoughts, because I have my own answer." Teacher D responded: "In my opinion, it's quite simply because students have different learning speeds. I have a student now in third year who told me that between fourth and fifth grade [primary] she was placed in a small group with newly arrived students and others with significant difficulties because she was slower in mathematics. She was separated from the rest [of the class], and she began to feel different, unable to keep up, and eventually to dislike the subject."

As the discussion evolved, Teacher E added: "The first question I always ask in class is: how were you in mathematics? Who is afraid of mathematics? And I always say: I don't know whether I will be able to teach it well, whether you will learn it, understand it, or even like it—but what I do not want is for you to be afraid of mathematics. Face it without fear. Make mistakes as many times as you need, but do it without fear."

This awareness—that students' complex relationship with mathematics often originates in their interactions with previous teachers—leads to a sense of responsibility on the part of the current teacher, who becomes a mediator of knowledge to be rediscovered and reconstructed, and thus an *agent of change* (Dimension 3 of [20]).

Spaces, structures, materials, tools

This dimension emerged collectively as a key necessity. Teacher F stated: "Based on the spaces, structures, and tools available, our way of acting follows—how we manage the teaching activity, how we design and propose activities, as was mentioned earlier, that are engaging and grounded in students' real contexts, especially not only in cases of difficulty but also in situations of cultural difference."

The context thus shapes educational possibilities from the ground up, particularly where classroom diversity does not allow for rigid, pre-defined planning. An *affirming stance* (Dimension 2 of [20]) encourages teachers to work from within the given context, promoting and valuing diversity as a resource.

Misconceptions

Teacher G observed: "In my opinion, in primary school they focus too much on formulas—too many formulas—so students retain mostly memorized notions that they then struggle to apply. We need to deconstruct those memorized learnings and then apply them concretely, whether to geometric figures or to real situations that can be modeled geometrically. Let me give a simple example: I always tell my students that to find an area, you multiply two perpendicular segments. Then we may call them base and height, or diagonals, depending on the figure—but they struggle, because sometimes they think: the area of a rectangle is base times height. I don't even call them base and height anymore, I call them the two dimensions of the rectangle. But they still struggle." The facilitator added: "For example, when a student arrives from another educational system and performs operations using different algorithms, some teachers do not accept those procedures simply because they are written or structured differently."

This reflection—rooted within the discipline itself—on typical misconceptions (e.g., base vs. height, verticality/horizontality, perpendicularity) opened up both disciplinary and cultural perspectives, in line with the development of *sociocultural awareness* (Dimension 1 of [20]).

Inclusive activities and assessment methods

Teachers referred to dialogic, interdisciplinary, playful, laboratory-based, and experiential elements, as well as to the possibility of co-designing activities with students, as key components to be integrated into classroom practice.

The practical and engaging dimension emerged as fundamental (*constructivist orientation*, Dimension 4 of [20]), although it must be carefully adapted to account for the plurality of students' "experiences"—for instance, in the design of real-world problems [19]. Finally, different forms of assessment were discussed, variably interpreted and implemented by teachers within their own planning practices.

The meaning of planning

The facilitator concluded the co-design session with the following reflection: "The real planning that happens in the classroom actually emerges in the classroom. The written plan we prepared at the beginning of the year—I don't know if this happens to you, but it often happens to me—I end up forgetting it. What really determines what we do and how far we go is what happens in the classroom. The issue is that the system still requires certain outcomes and targets, quite rightly. So we return to the usual tension between the two aims of schooling: on the one hand, educating a citizen who has the competencies to make informed choices—so someone who knows enough mathematics to participate, for example, in civic life—and on the other hand, the technical school, which has the function of providing skills that can be used later [work]. These are two important and complementary functions, but without critical reflection we risk losing our way."

This reflection points critically to the need for an open form of literacy, capable of avoiding

what [17] defines as the "social construction of failure," and of moving toward the more dynamic and intercultural direction described in Dimension 6 of [20]: designing *inclusive practices* that connect students' prior knowledge with new learning, creating shared meaning in the classroom without generating gaps.

7. Conclusions

Building on the wide range of heterogeneous situations already observed in multicultural classrooms, both in Italy and in other contexts (Section 1), we have argued that reframing the issue of teaching and learning mathematics in multicultural classrooms through the notion of a cultural learning gap offers a broader and more accurate lens for interpreting learning processes than the traditional concept of learning loss (Section 2). We prefer the learning gap perspective because, when a cultural distance exists between teacher and student, what is often interpreted as "missing knowledge" is not actually lost; rather, it remains unrecognized, culturally situated, and therefore not directly accessible to the teacher's interpretation.

Drawing on the idea of cultural transposition, which shifts attention toward the teacher's own unexamined assumptions through encounters with other disciplinary traditions—such as those emerging in the design dialogue discussed in Section 6 or through engagement with emerging algorithmic tools in Section 1—we have stressed the idea to reduce the students learning gap enacting to teachers training through a cultural lens. According to this perspective we think that the teacher has to become a cultural mediator, a bridge-builder, and a *cultural broker* of meanings and traditions [20]. In this view, the teacher has to be prepared not merely as a transmitter of content but someone who actively engages in intercultural communication, capable of recognizing, interpreting, and valuing mathematical knowledge even when it is produced in distant or unfamiliar contexts.

The evidence emerging from our training course "Cultures Count" (Sections 4 and 6) highlights, within the case study, both the inherent complexity of this process (Section 5) and the pressing need (Section 3) to co-design educational resources and practices collaboratively. These outcomes concern not only teaching materials but also more structured and sustainable pedagogical approaches. The training experience has thus supported a reflective process that begins with decentering—understood through the lens of cultural transposition—prompted by engagement with alternative mathematical traditions (Sections 1), with the goal of fostering intercultural awareness. In a world still marked by cultural conflict and, at times, irrational but persistent forms of violence, the teacher's role as mediator between home and school cultures, between institutional and informal knowledge systems, becomes particularly critical. It is around this role that the efforts of all stakeholders involved in students' educational trajectories should converge. The dialogical account of designing flexible teaching materials presented in Section 6 represents only an initial step, which must evolve into fully developed teaching designs and practices that can be collected, adapted, tested, and iteratively refined, in continuity with [7].

With the aim to reduce students learning gap in multicultural classrooms through mathematics teacher training, intercultural sensitivity, consistent with an understanding of interculture as a non-hierarchical space of dialogue and communication between cultural systems, has to naturally aligned with this bottom-up approach, which is deeply grounded in specific classroom realities [23, 28]. From this perspective, interculture can help bridge the gap between teacher and student cultures, particularly addressing teachers' difficulty in recognizing the reasoning processes underlying students' actions. The cases discussed in Section 1 are reinterpreted in Section 6 as opportunities for professional reflection and transformation for in-service teachers as (future) cultural brokers [20]. Reducing the distance between classroom and home cultures, or between dominant and subaltern (though not necessarily minority) cultures, requires the development of intercultural competence and the abandonment of a one-dimensional view of

mathematics education in which diversity is interpreted primarily as lack or deficiency relative to a fixed standard—whether that standard is in time (as in traditional notions of learning loss) or in context (as in comparisons between host-country schooling and educational practices from students' countries of origin).

What has been done with the teachers made it possible to respond to the needs of teachers highlighted by TALIS and OECD data, starting from the teachers' daily didactic problems, for example by asking them open-ended questions and using a strongly dialogic approach focused on cultural and linguistic considerations in the teaching of mathematics. The contents addressed and the methodological aspects appropriately chosen for this training course represent a novelty in the national and, in some ways, international context of teacher education. They explicitly contrast our 'Cultures Count' model with standard top-down professional development courses in Italy, highlighting how the collaborative negotiation between researchers and teachers represents a methodological innovation for culturally responsive education – a topic we will explore further in future publications. Secondly, thanks to the work we did with teachers during the training, rather than a simple "loss", multicultural classrooms were better understood as spaces where experiences are fragmented and communication is constrained by what is "common": not all linguistic expressions are available, not all algorithms are equally meaningful, and not all symbolic systems are equally accessible [28]. Of course, within such classrooms, power relations are always present, shaped by norms, habits, the didactic contract, curricular structures (both explicit and implicit), and textbooks. However, by reversing the analytical perspective it becomes possible to learn from students themselves, especially those with diverse educational and cultural trajectories. This shift places mathematical dialogue and lived classroom mathematics at the center of teaching practice. Ultimately, knowing, recognizing and valuing students' knowledge is fundamental to moving from a deficit-based interpretation of diversity (equality) toward one that understands and enacts diversity as a resource and an opportunity for learning (equity) [29].

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Conflict of interest

The authors declare that there are no conflicts of interest.

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