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TEACHING AND LEARNING MATH IN PRISON: A SYSTEMATIC REVIEW

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Teaching and Learning Math in Prison: A Systematic Review

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Abstract: *The paper presents the first results of a systematic review of the literature on mathematics teaching and learning in prison. The paper explores, through a systematic review based on the PRISMA method, the state of the art of mathematics teaching-learning in prisons, focusing on theoretical frameworks that identify good educational practices, the role of affective aspects, inclusiveness and accessibility. The study is part of the LeMP project, 'Learning Math in Prison', which aims at exploring the conditions of mathematics teaching-learning in a prison context.*
Keywords: *Mathematics education, prison, inclusion, Universal Design for Learning, beliefs*

Introduction

The *Learning Math in Prison* (LeMP) project stems from critical considerations regarding the urgency of producing pedagogical reflections to support the educational paths of persons in prison. It is a collaboration between researchers in mathematics education and pedagogical sciences from four Italian Universities and has the twofold objective of meeting the training needs of mathematics teachers in prison and of constructing teaching materials suited to the multi-complexity of the context in which they work.

The project starts from the awareness that education, in addition to being a right, is also the main way to initiate and consolidate paths of inclusion (CAST, 2011), self-determination and change for people in prison. Such pathways, in fact, do not only rely on the motivation and decision of detained persons – often discouraged and disheartened by the institution's discipline – but are also the responsibility of those in charge of education, of educational institutions and society.

An initial exploratory phase carried out with the teachers of the juvenile detention centre in Bologna (Maffia & Decembrotto, 2022) revealed an important lack of training opportunities and spaces for reflection on specific postures and tools to be adopted for teaching in a complex context such as prison. Among all subjects, in fact, mathematics emerges with its peculiar role: a challenging object of study with important educational potential (e.g., autonomous reflexive thinking, argumentation and proof) that is an essential requirement for future studies and scientific-technical job positions.

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The aim of the article is to investigate, in the body of research on mathematics education in prison, the state of the art of teaching-learning practices – in terms of cognition, emotions and inclusiveness – involving incarcerated students. In this scenario, it is urgent to reflect on the current state of research in mathematics education on this topic before designing any educational interventions. For this purpose, we set out to conduct a systematic review of research about mathematics education in prison. We are interested in investigating the complexity of teaching-learning processes in the special context of prison environments focussing on three intertwined dimensions. The first dimension, which we term as cognition, refers to the ways prison students encounter mathematical knowledge, driven by mediated activities with signs and artefacts. The second dimension, which we termed as emotions, refers to the role of students' attitudes as they are exposed to mathematical knowledge. The third dimension, which we termed as inclusiveness, refers to the opportunities offered by the teaching-learning environment to prison students so that they can express their specific cognitive styles and realize their project of life.

Rationale

To systematically review the literature present internationally on the pivotal topics of the LeMP project, the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) Statement methodology was chosen, which allows rigor and precision in the results (Moher et al., 2009). In regard to LeMP, the international literature review allowed us to probe how mathematics teaching-learning processes are implemented in the prison setting, pinpointing important reflections for the design of viable and replicable teaching proposals in Italian, as well as international, prison.

Method

The systematic review was accomplished by consulting the *EBSCO host platform*, with special reference to *ERIC, PsycInfo, MEDLINE, PubMed, Psychology and Behavioral Sciences, Collection, Springer Nature. Google Scholar* was used to investigate the grey literature. The last platform search was conducted on February 15th 2025, with the following string of words and Boolean indicators:

- prison
- mathematics (AND) education.

Research Questions

In order to investigate the state of the art of research on mathematics education in prison, we set out to answer the following research questions:

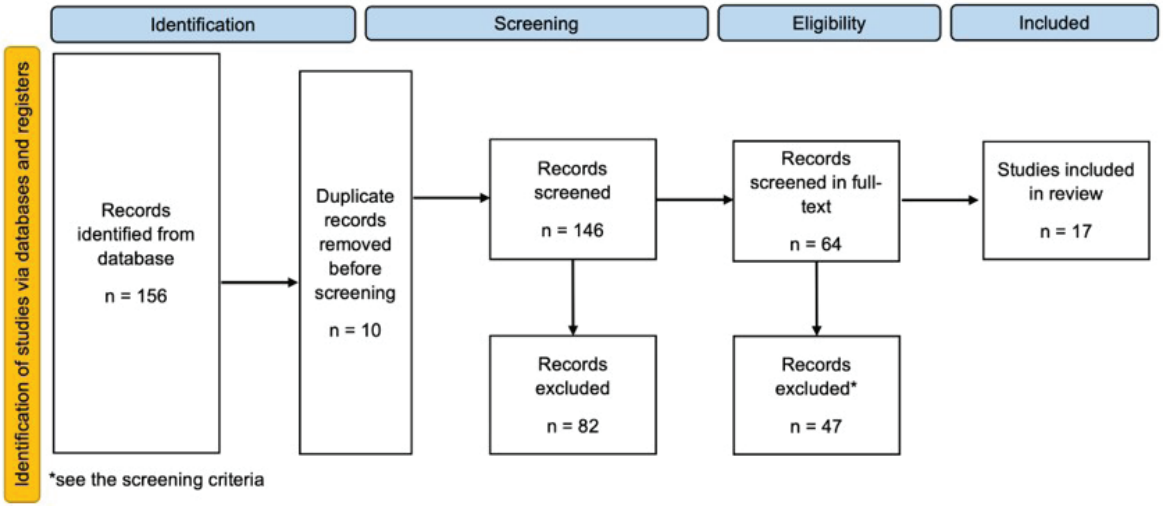
1) In the body of research on mathematics education in prison, what implications for mathematics teaching and learning can we draw in relation to the theoretical framework (including the vision of mathematics and its role) in which the research was conducted? How theories in mathematics educa tion – with their system of principles, research questions and methodologies – allow us to interpret teaching and learning of mathematics specific to the prison context?

2) How do selected studies explore students' perception of mathematics in relation to beliefs and emotional responses within the three-dimensional model of Di Martino & Zan (2011)?

3) Do the studies analysed take into account the accessibility/inclusiveness of teaching plans and pos sible customisation (tools, instruments, methodologies)?

Figure 1

Flow chart adaption of Moher et al. (2009, p. 267).



Considering the research questions, we singled out the following inclusion and exclusion criteria: articles in EBSCO host database, peer-reviewed articles, and full-text articles (including); studies that contained only statistics on the prison population and studies that referred to juvenile settings such as correctional schools (excluding). A time constraint was not placed because we were interested in mathematics education in the socio-cultural prison context as a general research issue. Moreover, specific geographic and linguistic constraints were not considered, in order to take into account the variety of prison systems around the world.

The research team composed by researchers in Pedagogical Sciences and Mathematics Education screened the 64 possible eligible papers in order to qualitatively identify the nuances of the three dimensions in focus (i.e., cognition, emotions and inclusiveness related to mathematical teaching and learning). The interdisciplinary nature of the LeMP research team allowed us to look at the papers through multifaceted lenses, thereby mitigating the risk of biased judgment. The final selection of papers was determined through iterative rounds of analysis and triangulated discussion among team members; disputed cases were discussed until a consensus was reached among the research team.

At the end of the selection process (Figure 1), 17 articles were found to be eligible.

Results

The studies included in this review originate from a diverse range of geographical contexts (see Table 1), primarily across Europe and the Americas. A visual summary of the locations is presented in Figure 2.

Figure 2

The geographical distribution of the selected papers

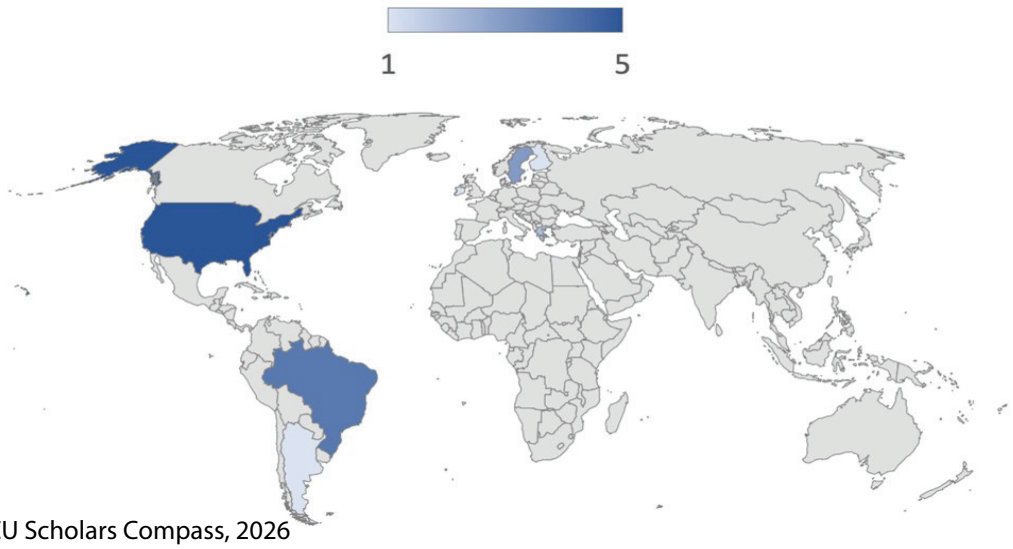


Table 1
List of the papers included

Paper	Country	Continent
Hassi et al., 2010	Finland	Europe
Byrne & Carr, 2015	Ireland	
Ahl & Helenius, 2021	Sweden	
Ahl at al., 2017		
Ahl, 2019		
Chrysikou et al., 2023	Greece	
Stathopoulou et al., 2024		
Brown, & Rios, 2014	Florida	North America
Reder, 2020	United States	
Stergios & Poynton, 1974	Michigan	
Kilgore, 2011	California	
Stahl, 2011	New England	
Gomes & Caldeia, 2014	Brasil	South America
Meira & Fantinato, 2015		
Braga & da Rosa, 2022		
Barros et al., 2024		
Pérez, 2021	Argentina	

An overarching approach to the issue of education in prison is provided by Miles et al. (2013). The authors of the RAND corporation conducted a systematic review of correctional education programs for incarcerated adults and juveniles in the US. This included a meta-analysis on correctional education's effects on recidivism and postrelease employment outcomes for incarcerated adults, as well as a synthesis of evidence on programs for juveniles. The study also included a nationwide survey of state correctional education directors to understand how correctional education is provided today and the recession's impact. The authors also compared the direct costs of correctional education with those of reincarceration to put the recidivism findings into a broader context.

The systematic review highlights that the different socio-cultural contexts affect the approach to prison education. With regard to mathematics, we have seen that North America studies are based on quantitative methodologies that look at the relationship between mathematics teaching, curriculum and assessment, and the recidivism and postrelease employment outcomes for incarcerated adults. On the other hand, South America studies, influenced by Critical Thinking and Ethnomathematics, are focussed on qualitative research methods based on socio-cultural theoretical stances in mathematics education. Europe is positioned in between the above contexts ranging from attention to higher education and rehabilitation of imprisoned students, students' attitude towards mathematics, constructivist approaches to learning to sociocultural frameworks.

1. Insights into the teaching and learning mathematics in prison

To organize the description of the results provided by the PRISMA methodology we have outlined three emergent categories regarding the teaching-learning of mathematics in prison: the vision of mathematics and its role in education; the presence of a mathematics education theoretical framework that consistently drives to teaching-learning principles; the focus on the sociocultural context and the individual's biography.

Regarding the first category, our analysis was driven by Skemp's (2006) distinction between an instrumental and relational understanding of mathematics. Instrumental understanding is described as "rules without reasons" (Skemp, 2006, p. 9) which reflects the idea of mathematics as made of procedures and algorithms to be uncritically performed where the product has a central role; relational understanding is more focused on the processes that characterize mathematical thinking and the connection between the mathematical ideas and relations. The educational interventions which promote a relational vision of mathematics foster a more positive attitude in mathematics related to emotions and perceived competence (Di Martino & Zan, 2011) also in the prison context (Ahl et al., 2017). A group of articles follow what Skemp (2006) calls *relational understanding* of mathematics. Meira and Fantinato (2015), Gomes and Caldeira (2014), and Stathopoulou et al. (2024) adopt an ethnomathematical approach. Braga and da Rosa's (2022) study continues a similar line of thought with a stronger nuance on activity theory and Vygotsky's ascent from the abstract to the concrete. Ahl (2019) conceives of relational mathematical thinking and learning within Vergnaud's (2009) conceptual fields, the study refers to the conceptual field of proportional reasoning.

Learning mathematics in prison is also seen as *instrumental*, in a broader sense compared with Skemp (2006). Mathematics is perceived as an *instrument* – a *tool* or a *means* – for other personal achievements, both for the students and for the educators. We highlight Byrne and Carr's (2015) experience in Ireland where mathematics is preparatory or mandatory for higher professional development; Hassi et al. (2010) show how in Finland learning mathematics is perceived as useful to pursue studies at an advanced level. A specific focus on curriculum for the impact of mathematics in inmates' project of life and empowerment is described by Byrne and Carr (2015), Gomes and Caldeira (2014), Chrysikou et al. (2023) and Stathopoulou et al. (2024). Byrne and Carr (2015) and Hassi et al. (2010) call for appropriate teachers' professional development programs, while Chrysikou et al. (2023), Stathopoulou et al. (2024) and Barros et al. (2024) propose a first attempt in the direction of providing prospective teachers with a meaningful experience in prison education.

As for the second category, Meira and Fantinato (2015), Gomes and Caldeira (2014), Stathopoulou et al. (2024), Braga and da Rosa's (2022) present coherence between strong theoretical frameworks and their ensuing teaching learning practices. Such theoretical approaches are based on sociocultural stances in mathematics education that drive teaching-learning practices stemming from the interplay between the individual's positioning in the prison sociocultural context and joint activity mediated by signs and artefacts.

Akin to the above papers, Ahl and colleagues (2017) stems from a solid theoretical framework based on Di Martino and Zan (2011) tripartite model of *attitude towards mathematics* looks at the interrelations between a person's own *perceived competence* (can do/cannot do), the person's *vision of mathematics* (relational/instrumental), and the person's *emotional disposition* towards mathematics (like/dislike). The article shows how distance learning involving an inmate student changes the relationship between such elements and the ensuing outcome of his attitude towards mathematics with respect to culturally significant and challenging mathematics activities.

Ahl and Helenius (2021) is a borderline article in that it does not present a mathematics education framework for the learning of mathematics in prison, but it provides a rationale (sociological or instrumental) to outline the students attitude and motivation towards mathematics. Kilgore (2011) shows the perils and pluses of bringing critical pedagogy in prison to change the power relationship between teacher and student identifying effective educational principles in this regard.

The remaining articles touch upon issues such as the curriculum, educational materials, students' previous knowledge, collaboration, and the role of real tasks related to their future jobs. Nevertheless, they do not present structured frameworks as the ones of the studies mentioned above.

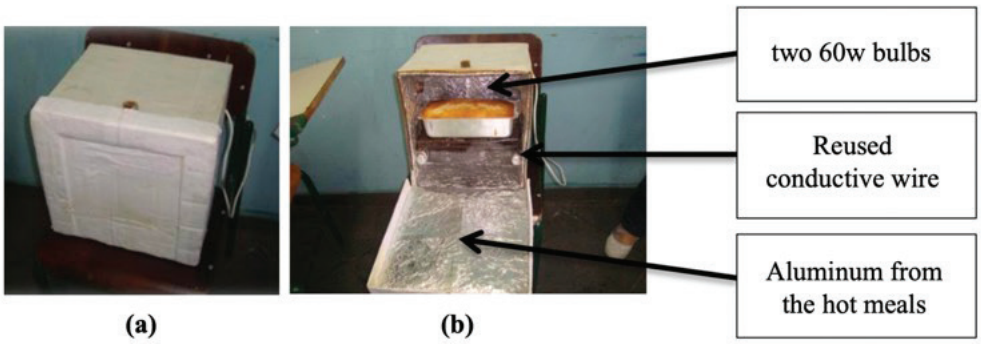
In reference to the third category, all papers deem important the role of sociocultural elements and the student's personal biography. Braga and da Rosa (2022), Gomes and Caldeira (2014) and Meira and Fantinato (2015) are embedded in sociocultural perspectives, being either Ethnomathematics (D'Ambrosio, 2001) or Activity Theory (Leont'ev, 1978). In this group of articles, the sociocultural environment is the fabric of the teaching and learning of mathematics in prison. Although with a political nuance, the sociocultural environment still plays a prominent role in Kilgore's (2011) contribution. Within the framework of critical pedagogy (Freire, 1970), the restructuring of the social context in terms of power relations and students' personal experience is prioritized to overcome the disempowering prison rules and social relations. In other papers the sociocultural elements play an instrumental role as a background that informs teaching-learning processes: Ahl and Helenius's (2021) look at the school context and Ahl's and colleagues (2017) at prisons embedded in the Swedish sociopolitical background. The remaining papers bring evidence of the relationship between mathematics learning in prison and the individual biography, looking at how it affects assessment and the use of artefacts, and how to help inmates manifest their past experiences via narrative approaches.

We discuss six articles that provide insights according to the three categories mentioned above.

Meira and Fantinato (2015), against the backdrop of ethnomathematics, consider math a cultural strategy that humans have developed to explain and manage their natural and historical context. We briefly describe an activity carried out, within a *community of practice* (Wenger, 1998), in a Brazilian prison based on this approach. The inmates built an oven with leftover materials facing constraints of the prison environment such as finding money to buy the light bulbs or hiding the oven in the jail cell. The construction of the oven was discussed during the math lesson based on their previous knowledge. One of the students said: "Teacher, I learnt how to make the oven here and I teach it to my mates. Each one perfects it." This artifact is currently forbidden inside the prison, but some inmates worked out appropriate measures to hide it and dismantle it quickly. Using the oven to cook a cake (Figure 3), a student explained how he cut out 6 squares of cardboard, five squares measuring one and a half meters, to ensure that the baking tray would fit inside the oven. The sixth square is a little bigger, as it will be the oven door and needs to be a little larger. He leaves some leftovers on the sides of the 6 squares, about the width of 1 finger, so that he can glue them together. As this one will have two light bulbs, he drills two holes in the side where two nozzles will go in to install the bulbs. He did not use a ruler because it is not admitted in prison, so he prefers measuring with his hands.

Figure 3

The oven (a) and the cake cooked during the lesson (b)



Besides the students' social and cultural engagements, the activity has an interdisciplinary approach involving mathematics, physics, technology, and language.

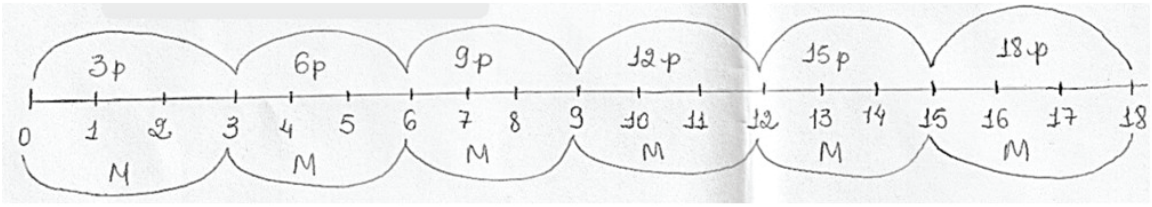
Within an ethnomathematics framework, Gomes and Caldeira (2014) stress the importance of students' own experiences, internalized through their actions, through mathematics learned outside of school and in an experimental way. It facilitates their interaction in the socio-cultural environment through a life cycle where reality informs the individual who carries out actions that modify the reality which in turn informs the individual, so on and so forth.The authors thus propose a learning experience in a Brazilian prison based on

mathematics modelling in the field of construction. The activity starts with a questionnaire containing questions about inmates' lives outside prison. The students and the teacher then analyse the laws governing zoning in the municipality and the rules on building houses up to 70m². During this process, they realized that institutional mathematics was included in various aspects of the regulations, especially the geometry content, which seemed familiar to them because of the comments they made about how they used to work in their former environments. Asking them to feel free to exchange ideas with their classmates the researchers distributed the following material to each of them: sulphite paper, black and coloured pencils, an eraser and a ruler and proposed the following mathematical activity: *design a single-family home of up to 70m² in accordance with the laws studied, which we called 'building the models'.* In the modelling process, students consider several instruments that root their mathematical activity in and out of school everyday activity. The design of the home involved several mathematical domains: geometry, rational numbers, proportions and algebra. The dimension of teaching and learning mathematics through mathematical modelling used in this research proved appropriate for understanding the mathematics used in construction and served as support for other areas of knowledge.

Braga and da Rosa (2022) present a teaching-learning experiment in a Brazilian prison during the COVID-19 pandemic based on the ascent from the abstract to the concrete. The tasks were based on the following problem regarding the duration of their sentence: *if every three days of classes equals one day less of a sentence, how many days less of a sentence will we have if we attend all the classes?*

Figure 4

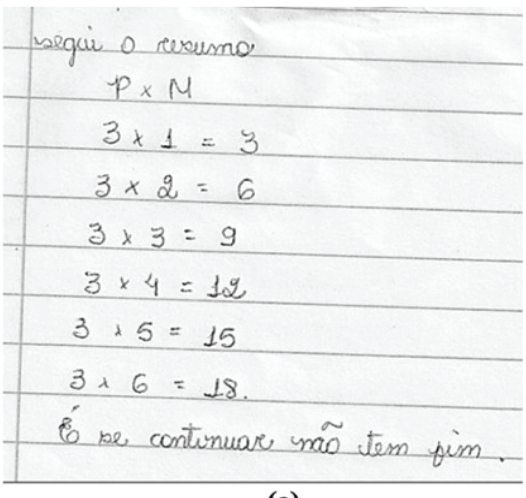
Sensuous graphical solution that grasps the generality of the relation between the days of school and the days less of the sentence



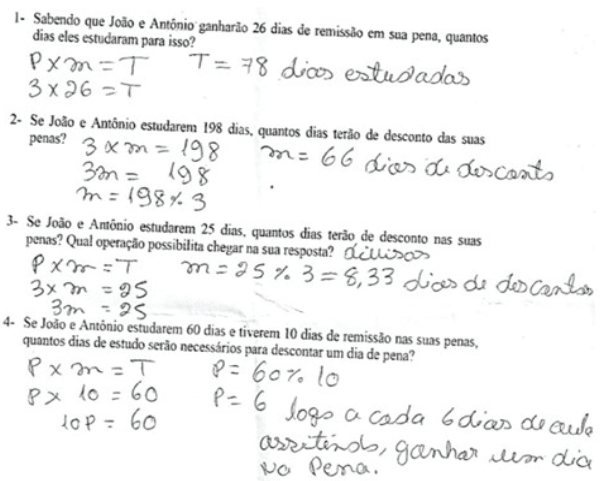
The protocols presented in Figure 4 show the turning points in the solution of the problem based on the dialectics between the abstract and the concrete. Figure 5 shows how the students arrived at a symbolic algebraic solution.

Figure 5

(a) The ascent from the abstract relation grasped in Figure 4 to the concrete specific number cases. (b) The algebraic solution developed in the abstract/concrete dialectics



(a)



(b)

Categ

In their project ACTinPRISON and CoSpIRom, Chrysikou et al. (2023) and Stathopoulou et al. (2024) work in the Critical Communicative Methodology, informed by Habermas (1989), for developing mathematics and language literacy that extends previous action creating *common spaces* (Cianciotto, 2020) with young prisoners and prospective teachers that act as co-researchers of their experiences. Considering the special situations of prison education in Greece (e.g. lack of appropriate curricula and specific teachers' professional development), the research rests on two pillars: (1) An alternative conception about curriculum grounded in dynamic processes across local and cultural borders; challenging knowledge as a skill set and replacing standardized tests with reflection about the inmates personal biographies; (2) A methodological approach, creating an environment of mitigating disciplinary practices within a collaborative community. These studies take careful account of the professional development of teachers and show how prisoners and teachers can construct meaningful knowledge together, moving beyond a colonial approach to learning.

These studies address the complexity of mathematics education in prisons, where future teachers must develop intercultural competencies and the awareness of social justice issues related to mathematics education. In this respect, the authors propose a shift from the classroom environment envisaged as a *public space* (Habermas, 1989) – in which students have to assimilate and internalize specific knowledge regimes – to a *common space* (Cianciotto, 2020). It is an alternative conception of the teaching environment that values recognition, empowerment, and emancipation. It emerges through the ways that people act and interact. Where public space is open to all as long as one complies with predetermined rules, common space's openness, inclusion and accessibility is locally constructed and context specific. Common spaces are always evolving through social practices of their actors (i.e., prospective teachers and inmates), where everyone can suggest mathematics content for jointly developing mathematics curriculum. The common space thus challenges future teachers' perceptions and beliefs of teaching as filling knowledge gaps and an intervention for correcting deviant behaviour rather than providing knowledge and skills aimed at personal empowerment, future development, and successful reentry. Mathematics was a resource for the characterization of the common space as much as the common space led to mathematics learning objectives. This approach produces a novel mathematics curriculum that meets the learner's interests, needs and socio-cultural identity.

The systematic review brought us a fragmented landscape of research in mathematics education in prison. We rarely find clear theoretical frameworks more often linked to quantitative research that does not provide examples of good practices and teaching-learning principles in the context of prison. Moreover, studies often follow an instrumental and utilitarian approach to mathematics that seemingly fosters a negative attitude (Di Martino & Zan, 2011) both in the individual's emotional disposition towards the discipline and in aiming at a meaningful learning. Indeed, the usual mathematics curriculum in prison often "expects learners to practice procedural tasks far removed from prisoners' lived realities and neglects their age and life histories" (Stathopoulou et al., 2024, p. 350).

Nevertheless, it comes out that a sociocultural theoretical perspective is fruitful when we have to work out educational strategies. Meira and Fantinato (2015), Gomes and Caldeira (2014) and Stathopoulou et al. (2024) draw on Ethnomathematics perspectives bestowing the sociocultural environment of the inmates a prominent role in the learning of mathematics. The access to artifactual resources is crucial in establishing via mathematics a dialogue between their personal biography and the sociocultural dimension. On the same page, Braga and da Rosa (2022) follow the activity theory approach that triggers the dialectics between the abstract and the concrete. Chrysikou's et al. (2023) and Stathopoulou's et al. (2024) perspective stresses the importance of language and communication in the learning of mathematics. Moreover, the shift of the classroom from a public space to a common space, where prospective teachers and students carry out a socio-cultural joint activity, accomplishes a twofold objective. On the one hand teachers and inmates devise a context-based curriculum rooted in the personal biographies and cultural identities of the imprisoned. The learning activities expose them to a significant and relational approach to mathematics that empowers and emancipates them by feeding their interests, needs and socio-cultural identity. On the other hand, teachers are exposed to training activities that go beyond the mere assimilation of mathematics and pedagogic content knowledge. The transformation of the mathematics classroom into a common space is in line with Kilgore's (2011) Freiran approach that offers a challenging proposal to pursue inmates' empowerment.

2. Perception and affect in students' relationship with mathematics

The analytical framework employed to address the second research question draws on the model developed by Di Martino and Zan (2010; 2011), which reconceptualizes attitude toward mathematics as a complex and situated construct comprising three interconnected dimensions: emotional disposition, perceived competence, and vision of mathematics. The literature consistently highlights how mathematics education in prison is shaped by a dynamic interplay of negative emotional dispositions, low perceived competence, and instrumental visions of what mathematics is and can be. In the analyzed articles, students are shown to enter the prison classroom burdened by deeply rooted affective responses to the subject, most commonly anxiety, fear, and frustration (Ahl & Helenius, 2021; Chrysikou et al., 2023; Hassi et al., 2010; Kilgore, 2011; Stathopoulou et al., 2024). They recall past formative experiences of trauma or repeated failure in school settings, where mathematics became associated with humiliation and powerlessness. Kilgore (2011) describes a student whose decision to leave school stemmed from a single math problem that left him feeling inadequate. Similarly, in their study on alternative curricula in prison, Chrysikou et al. (2023) and Stathopoulou et al. (2024) report that students entered the learning environments with resistance to formal instruction, associating mathematics with boredom, frustration, and an enduring sense of personal inadequacy. Community is the solution most frequently proposed to generate a change in the emotional experience of students entering the mathematics classroom in prison. Peer validation, in particular, reinforces these changes: multiple studies document that incarcerated learners trust peer reinforcement more than institutional validation, finding comfort and confidence in learning from (fellow) prisoners. Actually, students reported learning more effectively through horizontal collaboration in a non-judgmental space, where their contributions were acknowledged and their reasoning socially affirmed (Byrne & Carr, 2015; Meira & Fantinato, 2015). Byrne and Carr (2015) observed that students in an Irish prison math class relied more heavily on peer feedback than on teacher assessment to validate their learning, suggesting that people in prison often trust social interactions within prison more than institutional authorities. In Braga and da Rosa's study (2022), learners progressed from hesitant responses to conceptually grounded explanations through collective reflection and dialogue. Despite limitations imposed by the COVID-19 pandemic and reduced teacher interaction, students compensated by developing shared strategies, relying on visual representations to construct abstract concepts. By the end of the program, they had moved beyond empty procedures to deeper conceptual understanding, emphasising the centrality of dialogic learning environments.

Turning to the second dimension identified by Zan and Di Martino, numerous studies highlight a widespread belief among incarcerated learners that they are inherently incapable of learning mathematics – a perception often reinforced by disrupted educational paths, cognitive gaps, and prolonged disengagement from schooling. Ahl (2019) demonstrates how students entering prison education frequently misapply additive reasoning to proportional problems, a sign of both conceptual misunderstanding and deep-seated self-doubt. The article includes the experience of Andreas, a man with impulse control disorder, whose emotional volatility initially prevented him from receiving face-to-face feedback. His perception of mathematics as a threatening obligation led to impulsive reactions – slamming doors, exiting the classroom – that inhibited learning. However, once transitioned into a distance learning format where feedback was delayed and asynchronous, Andreas exhibited greater patience, deeper reflection, and increased persistence in problem-solving tasks. Over time, his motivational stance evolved from extrinsic to intrinsic, culminating in his voluntary engagement with advanced mathematical content. This trajectory exemplifies how targeted pedagogical interventions can reshape both perceived competence and emotional stance toward mathematics. Instructional design also plays a crucial role in mediating these perceptions: Stergios and Poynton (1974) observed that student self-confidence improved within a mastery-based system that permitted exam retakes and gradual progress. The article by Stathopoulou et al. (2024) expands this perspective by conceptualizing mathematics education as a relational process within "common spaces," where mutual recognition and co-construction foster both emotional safety and epistemic agency. The study documents how young prisoners shift from passive recipients to active contributors, expressing growing confidence ("I can do anything now") and reimagining mathematics as a tool for life, rather than a site of failure. Even in technology-mediated contexts, emotional and epistemic engagement is mediated by learners' confidence and prior exposure. Stahl (2011) reports that many students avoided using calculators during GED practice tests, either because of a lack of familiarity or a mistrust of technology-generated results. The role of affective and epistemological transformation in prison mathematics education is

further explored in Pérez (2021), whose study offers valuable insights into students' shifting emotional and cognitive relationships with learning. Initially, many participants perceived education, and mathematics education, as a bureaucratic strategy to reduce sentences rather than a meaningful activity. Over time, however, the classroom became a site of self-definition and collective agency. One student, reflecting on his transformation, stated: "At first, I thought I wouldn't be able to do it, that school wasn't for people like me, but here, I feel like I can finally learn something useful" (Pérez, 2011, p. 15). This reconfiguration of self was often enabled by teacher and peer validation. Education, in this view, became not only a means of acquiring knowledge but a form of resistance to dehumanizing structures, a practice of freedom even within confinement (Pérez, 2011).

Concerning the third dimension of Zan and Di Martino's analysis, literature confirms that many incarcerated students conceive of mathematics as abstract, arbitrary, and disconnected from their lived realities – a vision that reinforces feelings of alienation and irrelevance (Gomes & Caldeira, 2014; Meira & Fantinato, 2015; Stathopoulou et al., 2024). However, when mathematical activities are grounded in students' experiences – such as construction work, Drama in Education Techniques (Stathopoulou et al., 2024) or everyday decision-making – this vision begins to shift. In their study of prison-based modeling tasks, Gomes and Caldeira (2014) found that contextualised problem-solving enhanced both engagement and perceived utility of mathematics. Similarly, Meira and Fantinato (2015) document an instance where students rejected traditional methods of calculating parole eligibility in favor of an intuitive, self-developed approach used by an illiterate inmate, demonstrating that prisoners often rely on practical mathematical reasoning rather than abstract, school-taught algorithms. These findings point to the transformative potential of reframing mathematics as a meaningful and flexible tool, rather than as a fixed school subject. The participatory studies by Chrysikou et al. (2023) and Stathopoulou et al. (2024) reinforce this point: by positioning students as co-researchers, and inviting them to engage with real-world problems through collaborative methods, the program enabled learners to rediscover latent mathematical competencies and redefine the discipline as accessible and relevant.

In sum, when mathematics education in prison attends to learners' emotional histories, reconstructs their sense of competence, and redefines the meaning of mathematics itself, it becomes a powerful site for personal transformation, resilience, and social inclusion (Chrysikou et al., 2023; Hassi et al., 2010; Kilgore, 2011). Nevertheless, persistent structural barriers—such as rigid curricula, inadequate access to technology, and deficit-oriented pedagogies—continue to limit these possibilities (Stahl, 2011). These findings underscore the need for prison education programs to move beyond rote instruction, ensuring that mathematics is not merely taught but experienced as a means of self-efficacy, identity reconstruction, and preparation for life beyond incarceration (Pérez, 2021).

3. Inclusion in prison

In order to address the third research question, it is necessary to identify reference frameworks that make prison education inclusive. From the literature analysed, it is very difficult to understand how the world of disability is managed within prison facilities around the world, also due to the different legal systems that include certain types of disability (clearly minor) in prison and other states where there are still psychiatric facilities where sentences are served.

Furthermore, there is a lack of uniformity in the diagnostic criteria for disabilities or learning difficulties, diagnoses that are not completed or never handed over to prison educational/scholastic structures and therefore difficulties in creating learning/teaching situations that are truly calibrated to the specific difficulties of the students.

The reference model for universal school design that takes into account as much as possible the difficulties and diversity of students' learning styles is the *Universal Design for Learning* (UDL) framework (CAST, 2024). The UDL framework was chosen to observe the inclusiveness and accessibility of teaching proposals because it offers a perspective of openness and attention to the different learning modes of people, beyond diagnostic labels, given that in the world prison context these are particularly diversified or absent.

UDL is based on three principles:

1) Providing multiple means of representation
2) Providing multiple means of action and expression
3) Providing multiple forms of engagement

Within this methodological framework, the focus is on teaching/learning methods that take into account the specific needs of each student already at the design stage.

In order to trace teaching/learning experiences based on personalisation/individualisation in the literature, tools used for this purpose, methodological and strategic practices were sought from the accounts of teachers or researchers.

Although no specific explicit references were found to UDL or the accessibility of the materials and contents presented in the various articles analysed, the elements of attention of the teachers/researchers involved in the literature selected for this research are briefly presented here.

In almost all studies, a focus on identifying students' starting levels to generate personalized pathways is evident, but then the rapidly changing prison context and the limited number of teaching resources do not allow for real personalisation of pathways.

A focus on personalisation is shown in the work of Byrne and Carr (2015): the authors state that they used different strategies to encourage students to reflect and share their experiences, although the authors do not specify which ones. Students were also motivated to self-assess themselves, thus reflecting on their own learning journey from a metacognitive perspective.

The study by Chrysikou et al. (2023) also refers to the importance of personalising mathematics learning in prison, in which case the creation of small groups or small classes is suggested. The small number allows the teacher to pay more attention to the individual needs of the subjects.

In Kilgore's article (2011), reference is made to students with ADHD (Attention Deficit Hyperactivity Disorder) or bipolar disorder and students with a very labile memory due to substance abuse; for these students, the author says that he repeated the contents of his lessons several times and on different days to enable better understanding and memorisation. Furthermore, the author emphasises the importance of negotiating content and objectives with his students, calibrating them to their previous experiences, emphasising involvement through practical activities in small groups and linking subjects with everyday issues. By agreeing on learning stages with the student and establishing rules of mutual collaboration, the teacher has noticed greater student involvement and a more open atmosphere. Dividing the class into small groups allowed the teacher to follow the various levels of student learning, encouraging peer collaboration (*peer tutoring*) and individual help. Reference is also made to different ways of actively involving students, creating a positive and collaborative working environment.

The research by Ahl et al. (2017) deals with the study of an individual detained student with a behavioural disorder and related difficulty in controlling his relationship with the teacher and with the sense of frustration resulting from difficulties in learning mathematics. For this student, distance learning during the COVID period made it possible to relate to the teacher in a virtual manner, through the exchange of an exercise book, and improvements in the management of negative feedback and frustration were noted, avoiding direct contact with the teacher. This strategy, although related to an emergency period, can be supportive with students who cannot follow the lessons in the classroom or who show particular difficulty in managing their own behaviour, keeping possible a 'thread' linking the student to the teacher, by exchanging activities and exercises through a personal notebook.

Ahl's (2019) study reflects on the creation of a test to identify students' starting levels in order to create individualised instructional pathways, but the article does not provide any further suggestions on the actual personalisation of activities and pathways.

In the study by Stathopoulou et al (2024) there is an explicit focus on inclusion through a reference to Caterino's (2013) "Critical communicative methodology" model that emphasizes the importance of focusing on equity to avoid exclusion. Common Spaces become places where equal participation, shared decisions and responsibilities are to be ensured, encouraging active participation and involvement of all students, moving away from a deficit-based model. The article also stresses the need to train future teachers so that they know how to disengage from stereotypes and their own biases, adopting an anti-deficit perspective.

From what emerges from the literature it is therefore not possible to draw much evidence of a focus on the accessibility and inclusiveness of teaching proposals in prison contexts, attention to different ways to access information and the identification of the strengths of the detained student could also make the learning process more functional and meaningful.

Discussion

In light of the LeMP project, the systematic review we carried out provides theoretical tenets that drive research regarding mathematics education in prison. We have pinpointed three pillars that sustain mathematics education in such a context: a strong mathematics education framework, students' perception of mathematics in terms of beliefs and emotional responses, accessibility to mathematical learning and inclusiveness. The outcome of the systematic review provides a holistic view of teaching-learning processes in prison that encompass the three pillars mentioned above. Robust theoretical frameworks, which comply with a relational view of mathematics, based on socio-cultural approaches foster inmates' mathematical learning. Research findings (Radford, 2021; Roth & Radford, 2008) show also that the accomplishment of meaningful mathematical learning, in the ascent from the abstract to the concrete, requires suitable artefacts which mediate mathematical activity. The articles selected in the systematic review show that best teaching-learning practices in prison require the design of learning environments, where prisoners can carry out activities mediated by suitable cultural artefacts that allow them the encounter with a relational approach to mathematics. Moreover, the design of mathematical activities consistent with the distinguishing features of prison environments can enhance inmates' empowerment in an environment, which usually disempowers, and acknowledge their personal biography - in line with the principles of critical pedagogy. In this respect, suitable teacher training and insightful curriculum design play a prominent role. The development of common spaces that intertwine prospective teachers' and prisoners' mathematical activity is a promising answer towards the quest for professional training and curriculum that allow detained students to overcome the lack of empowerment, recognition and emancipation. Teaching-learning environments that foster a relational view of mathematics in meaningful shared activities can enhance inmates' empowerment and self-efficacy. In fact, such teaching-learning environments allow inmates to develop a positive interplay between the vision of mathematics, perceived competence and emotional disposition (Di Martino & Zan, 2011) and accomplish, despite the harsh prison environment, their project of life.

These findings underscore the need for prison education programs to move beyond rote instruction, ensuring that mathematics is not merely taught but experienced as a tool for self-efficacy, identity reconstruction, and preparation for life beyond incarceration (Pérez, 2021). In this context, communities of practice and research that actively involve learners in the co-construction of knowledge play a crucial role. By creating collaborative, dialogic spaces, these communities make it possible to overcome some of the structural and epistemological constraints that characterise prison environments, allowing for more meaningful, situated, and transformative educational experiences. Nevertheless, while such transformative practices are emerging, the field remains fragmented. Research still tends to prioritise quantifiable outcomes over the affective and representational dimensions of mathematical experience. There is a need for research approaches that foreground learners' voices and lived experiences, capturing the complexity of mathematical learning as a deeply situated and relational process within the carceral context.

This is particularly important when addressing the issue of inclusion and accessibility. Although inclusion in a prison context still has undefined contours, also because of the different meanings that the term 'include' includes, what is considered fundamental, also in the light of the in-depth literature, is to pay attention to the background of prisoners, their previous school experiences and how some learning difficulties, perhaps not detected and not properly supported, may have led to experiences of fragility, abandonment and rejection, especially in mathematics. As the *Universal Design for Learning* tells us, it is not necessary to have 'diagnostic labels' in order to choose to personalise or a learning pathway, and this is the great openness that the framework presents and that we wish to emphasise here: the choice to take into account different learning modes, different times and different modes of expression; if the teaching will be able to maintain a focus on these aspects, inclusion will certainly be strengthened, and the learning experience will become positive and more meaningful.

Conclusions and future research directions

The aim of learning mathematics in prison is to empower, emancipate and recognize the socio-cultural identity of imprisoned students. Mathematics can be a privileged domain of thinking and practice to achieve such goals due to its impact on both inmates' reentry in society following incarceration and the production of new subjectivities.

A major result is that best practices for the prison environment stem from suitable systems of theoretical principles that inform research methodologies and the ensuing classroom activities. A common denominator is the relevance of socio-cultural approaches that cast mathematical thinking and learning in communities of practices conceived as ethnomathematics environments, activity theory and common spaces. The context is not limited to the physical environment; we can consider the context of a mathematical theory, the context of problem solving, the context of school. Each context can be interpreted and experienced in different ways: the mathematics can be more or less instrumental/relational, the school can be conceived as a place to learn or not, as a necessary step toward a good job. According to the *social rationale* (Mellin-Olsen, 1981) students' learning is dependent on the social network they are a part of and they learn because they find the topic important and they make sense to learn it, also because it can help them achieve things that go beyond their exams. This means moving from an *instrumental discourse* to a *relational discourse* (Mellin-Olsen, 1981) that "is based on a willingness to understand why something is the case and is characterized by dialogic processes through which understanding is created and the logic of an explanation is examined critically" (Herheim, 2023, p. 391). This change is possible not only by addressing the ways of being in the classrooms, but also by "investigating the school culture that teachers and students are part of" (Herheim, 2023, p. 392).

Indeed, in a socio-cultural stance, mathematics is related on the one hand to the individual's experience, on the other hand to a cultural-historical unity in *fields of experience* (Boero, 1989) and *conceptual fields* (Vergnaud, 2009), thereby transforming mathematics curriculum into a *lived curriculum* (Chrysikou et al., 2023). A relational view of mathematics is essential in characterizing the joint activity. Intertwined to the socio-cultural stances are the student's attitudes towards mathematics and the differentiation of the learning activities for all students (e.g., Hassi et al., 2010). Research findings underscore the need for prison education programs to move beyond rote instruction, ensuring that mathematics is not merely taught but experienced as a tool for self-efficacy, identity reconstruction, and preparation for life beyond incarceration (Pérez, 2021). In this context, *communities of practice* and research that actively involve learners in the co-construction of knowledge play a crucial role. In such teaching-learning environments inmates develop a positive attitude towards mathematics that is the outcome of the interplay between the vision of mathematics, perceived competence and emotional disposition (Di Martino & Zan, 2011).

A sound prison mathematics education also requires an ethnographic and biographical approach to address the individual's sensibilities, personal biographies and rationales for learning (e.g., Ahl & Helenius, 2021). This is confirmed by Stathopoulou et al. (2024) study that shows the prisoners' wish to engage in meaningful problems, instead of rote exercises, that allow them to express their personal sensibility towards mathematics. The literature review underscores the variety of personal biographies and attitudes toward mathematics present in a prison classroom that require an individualized learning. The access to artifactual resources is crucial in establishing via mathematics a dialogue between inmates' personal experiences and the sociocultural dimension. In fact, the introduction of a rich arsenal of ideal and material artefacts to carry out mathematical shared activities, framed by the *Universal Design for Learning*, can address the inmates' personal needs and potential.

The aforementioned features for an effective mathematics education in prison would not apply to the everyday classroom teaching and learning without competent and committed teachers. The literature review provided only two articles on this topic, but they are insightful for the implementation of effective teacher training programs. In the ACTinPRISON and CoSpIRom projects, Chrysikou et al. (2023) and Stathopoulou et al. (2024) promote a teacher training program based on the creation of *common spaces* where young prisoners and prospective teachers act as co-researchers of their experiences identifying meaningful practices for the prison context and the articulation of the mathematics contents. The outcome is the construction of a context-based mathematical curriculum and the training of mathematics teachers, who go beyond the mere assimilation of mathematics and pedagogic content knowledge, aware that teaching in prison requires a shift from how to teach this content to how to co-create a common space (Stathopoulou et al., 2024).

Although the present literature provides insightful research findings regarding mathematics teaching and learning, we identified a general lack of robust mathematics education theoretical frameworks to address the complexity of the prison context and outline general principles for the implementation of best teaching-learning practices. In line with Stathopoulou et al. (2024), we can claim that the (scarce) body of research on prison mathematics education highlights the need for a curriculum revision directly addressing specific

inmates' needs and conditions. Furthermore, the methodological design is often implicit and unclear. Research usually focuses on only one type of student (special needs, single gender) missing the complexity of a prison class. Finally, there is a lack of interdisciplinary research between mathematics education and pedagogy, which could provide a broader theoretical outlook on the intricacy of the prison socio-cultural environment.

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