ZDM – Mathematics Education
https://doi.org/10.1007/s11858-024-01558-y

ORIGINAL PAPER

Common spaces matter: curricular experiences through mathematics with young prisoners and prospective teachers

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Accepted: 9 February 2024

Abstract
Mathematics teaching usually occurs in a "public space"—e.g., a classroom is a public space with rules defining student and teacher roles that cultivate hierarchic relationships. Working in prison with young inmates (18–23 years old) from marginalized populations, we promoted alternative "common spaces" (physical and symbolic) challenging established hierarchies through equal contribution. Such mathematics curriculum employs an antideficit model (Louie et al., 2021) as prisoners co-research their lives with mathematics. Common spaces empower through recognition while enabling identity transformation. Qualitative data from the CoSpIRom [Common Spaces for Integration of Roma Project (http://cospirom.sed.uth.gr).] project explores: (a) whether common spaces, recognition and equal participation can support mathematics literacy while empowering and emancipating young prisoners; and (b) if and how this framework might prepare prospective teachers within contemporary diversity. Bringing together young prisoners and prospective teachers affects both populations. Mathematics curriculum developed through collaboration meets a consistent request from prisoners that educational programs bridge with the outside world as re-entry preparation. Contrasting life stories from prospective teachers operate as alternative models motivating prisoners to rethink their own life stories and self-concepts. Prospective teachers demonstrated significant intercultural communication skill development, empathy and solidarity for marginalized people, reporting important professional identity growth.

Keywords Prison education · Mathematics education · Teacher education · Common spaces · Prospective teachers · Young inmates

1 Introduction

I understand access and participation as Social Justice — D'Ambrosio (2012)[1]

Although a fundamental academic subject in prison schools as in the "outside" community, mathematics in prison is a special case of addressing cultural differences and social barriers (Frezzotti et al., 2000). Recent scholarship suggests a focus on "useful mathematical literacy" both during and after release (Farley & Pike, 2016). New proposals explore "social" and "cultural" orientations to mathematics (Warr, 2016), for understanding the complexity of mathematics teaching and learning in correctional facilities, for modifying the typical prison framework (Jęczeń, 2017; Warr, 2016), and for stressing intercultural and adult education (Petsas, 2017). Most prison students' backgrounds in poverty, as refuges or migrants (In our Greek context Roma or other marginalized communities) accompany negative school experiences and low self-esteem tied to school refusal, low achievement, and early school dropout (Mallett, 2014). Literacy skills are significantly weaker than those of public school agemates (Pytash & Li, 2014). Many have not attended school for years, making school expectations for sitting and abstract thinking for extended periods challenging.

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[1] Ubiratan D' Ambrosio illustrates the implicit influence of critical ethnomathematics on our work. He explains: *"Our most urgent concern is to teach Mathematics for access and participation, understood in the broad sense of helping humans to attain well-being, which comprise the basic components of a good life, freedom and choice, health and bodily well-being, good social relations, security, peace of mind, and spiritual experience"* (2012, p.8).

Published online: 26 March 2024

Loss of interest in intellectual activities, disconnection from external reality, and depression are widespread among inmates (Frezzotti et al., 2000), suggesting mathematical interaction (Jablonka, 2003) with teachers from the outside could facilitate mental and psychological well-being. Ideally, mathematical literacy would be a positive contrast with prior negative experiences, whereas practices mirroring typical school mathematics are likely to trigger disruptive negative associations. Using mathematics skills and concepts as tools for positive emotions and to engage in a communal space is a promising vision. We paraphrase Vygotsky (1994) for the prison context: *"not only does the student* [*inmate*] *change, because the relationship* [with] *their environment changes, but the environment itself begins to have a different influence on them"* (p. 346).

Byrne and Carr (2015) highlight the special circumstances of teaching inside a prison: *"A teacher in prison has to expect the unexpected… Remembering the successes helps; the times when a student gets it, when he turns and teaches another, when he can talk about what he has learnt and how he learnt it."* (p. 34). They encourage teachers to emphasizing pedagogical relations with their students (prisoners), employing an empowerment orientation. Recent studies promote democratic practices as both supporting mathematics learning objectives (Ferrarello & Mammana, 2022) and for achieving democratic practices through mathematics (Aguilar & Zavaleta, 2012; Jablonka, 2003). Ferrarello and Mammana (2022) argue that mathematics for democracy is especially important for the social skill and ethics development of prison students.

Alongside the complexity of mathematics education in prisons, future teachers must develop intercultural competencies and the awareness of social justice issues related to mathematics education (Bryan, 2017). A common experience promised benefits to both groups, close in age. Exploring theoretical background for such a project, we realized that a traditional approach to mathematics teaching and learning seeks a classroom characterized by what some call a "public space", similar perhaps to the public spaces that led to incarceration for the young prisoners. Might the contrasting notion of a "common space" be more appropriate? Recognizing the marginal cultural backgrounds of the prisoners, and the asymmetrical power relations with the future teachers (Pratt, 2012), we sought to avoid treating members of either group as objects of our study, that is, to avoid research as a "dirty word" (Tuck & Yang, 2014a).[2] We grounded our work in Critical Communicative Methodology (CCM) informed by Habermas' Communicative Action Theory (CAT) (Gómez et al., 2011). Beyond equal participation socially marginalized members of our research project co-designed the collaboration. Advice and contributions of the prisoners guided activity. We explored "common space" as a response to the incompatibility of the existing mathematics curriculum with the learners' interests and needs and found this approach empowering. Theory differentiates "common space" from "public space" defined by regulation of rules and expectations. While school mathematics typically generates a public space, we pursued mathematics education as emerging in a common space; mathematics functioned as a facilitator of collective action.

[2] The lived reality of research involving marginalized communities often positions members of the community as objects of study rather than as co-creators of knowledge and initiators of research questions or goals (Tuck & Yung, 2014a).

2 The idea of a common space

Education is commonly taken as good. Indeed, education is assumed to be rather straightforward, bringing a teacher and students together. However, this commonsense notion of school carries cultural, political and other social hierarchies. Contemporary mathematics education employs principles of a classroom formed around discourse fostering shared conceptual understanding. This shares values and goals of a public gathering. The philosopher Jürgen Habermas (1989) employed the concept of a public space to describe a place created through critical discussion, open to all. As a response to demands within post-war Western democracies for better institutional support of non-normative voices, Habermas imagined a collectivity whose "public discourse" acts as a control on central power. Even this dream of an ideal public space has been criticized as failing to accommodate everyone on the margins–the forgotten, the silent and the undesirable (Kurniawati, 2012), because participation tends to demand conforming to mainstream expectations for appropriate participation, silencing marginal voices (Appelbaum & Enomoto, 1995). Habermas tempered this by assigning responsibility to members of the dominant society for educating themselves about sharing, and techniques for respecting the rights of others.

The concept of public space has been transferred by some scholars to an ideal classroom realizable through instructional best practices. For example, Weiss (1989) urges apprenticeship for democratic participation: *"… the public space is one in which freedom of expression is maintained. Again, the classroom has as much chance to be such an arena as any in society"* (p. 7). Weiss and others in the late 20th Century inspired by such rhetoric were not (yet) attuned to issues of equal access or the erasure of forms of knowledge incompatible with a discourse-centric space. They focused on the educational potential of a plurality fostering the exchange of ideas–ideas conceived without the wisdom of post-colonial studies and more contemporary

awareness of indigenous ways of learning and knowing. However, even in the early days of celebrating an imagined classroom as a public space there were parallel critics. One prominent example is Gordon (1989), who questioned the feasibility of constructing a classroom as a genuine public space. Rather than striving to generate an ideal exchange of ideas in an abstract conception of thinking, Gordon emphasized the responsibility of all members of a social group to be active thinkers: *"The educator for democracy cannot create a public space in the classroom, but he or she can encourage pupils to think"* (p. 55). He noted a key problem of authority: "*students haven't responsibility for the principles governing their life in the classroom, since the teacher and the administration assume that responsibility"* (p. 56). Contemporary concerns about classrooms as public spaces realize that access is associated with power and culture, and that institutional power can amplify inequality. Brown and Kelly (2001) demonstrate the demands that public spaces make on those who would hope to be included: *"Students in the classroom are entrusted with the responsibility of assimilating/internalizing specific knowledge regimes. This process can generate tensions in students who view themselves as different from and other than the "citizen" advocated within a curricular context"* (p. 516). Like Gordon, they suggest transforming classrooms through inclusive dialogical practices appropriate for democratic citizenship. Here they echo John Dewey (2015), whose conception of a mutually constructive experience of education and participative democracy necessitated that freedom of expression be associated with the requirement that expressions be "heard" and used by others.

Slowly but surely educational hopes for a classroom as a public space have chipped away Habermas' dream. Mary Pratt (2012) wonders about each participant's experience of the space. Presumably, "*all are engaged in the same game", a game that* is supposedly addressed to all. Yet, Pratt notes, *"this hardly can apply when speakers are from different classes or cultures, or one party is exercising authority and another is submitting to it"* (p. 176). She writes of "highly asymmetrical relations of power" unrelated to some sort of "common sense of reality" because of participants' different backgrounds. More accurate is her term, "contact zone", where *"cultures meet, clash, and grapple with each other, often in contexts of highly asymmetrical relations of power"* (p. 172). A classroom is such a place. Pratt argues for empowerment of students who have no power in their society. Their voices are weak and likely ignored. Because their classrooms are conceptualized as public spaces, the asymmetries of this contact zone must be challenged if they are to be seen and heard.

Axel Honneth (2015) proposes the seemingly less confrontational concept of mutual intersubjective "recognition" as a tactic for empowering people/students to challenge asymmetric relations of "contact zones". He characterizes schools as cooperative communities with mutual recognition, essential for self-respect and self-esteem, self-realization, and thus autonomy and participation (Honneth, 2015). In a recent interview (Stojanov, 2020), Honneth clarified that recognition is the process necessary to reach the pedagogical goal of "emancipation": *"By emphasizing the reliance on recognition I'm again stressing the communicative or cooperative structure of all processes of "Bildung" or education"* (p. 103).

Through both experience and theory (e.g., Solorzano & Yosso, 2001) we believe negative categorizations of culturally diverse groups can be weakened within systematically organized cultural contacts. However, the disadvantages of public spaces persist even through efforts to avoid them. As Cianciotto (2020) notes, public spaces have implicit rules for participation, and even for simple presence. Using as an example a public park and mentioning the restrictions regarding access, he notices there are many cultural assumptions about appropriate use in any park anywhere in the world. Classrooms as public spaces are analogously policed, so that those who challenge normative expectations must be removed for others to enjoy their freedom of participation. In our work with young prisoners, they have bumped up against such policing of the public space. They are keenly aware of the results as they daily live punishment for nonconformance. Work with young prisoners should avoid hazards of a public space, and also repair the associations that have crushed their participation in society.

"Common Space" is an alternative conception valuing recognition, empowerment and emancipation. It emerges through the ways that people act and interact (Cianciotto, 2020). *"Where public space is putatively open to all … so long as one abides by predetermined rules, common space's openness and accessibility is locally constructed and context specific"* (p. 677). Common spaces are always becoming, evolving through social practices of "commoners" known as "commoning" (Harvey, 2013; Stavrides, 2016).

We strived for common spaces collectively constituted by the young prisoners, the researchers and prospective teachers as the local "commoners. We hoped to facilitate increased cultural awareness for the future teachers and to challenge the erasure of prisoners' cultural perspectives. We centered prisoners' input into the mathematics curriculum as a direct application of Santos (2007), who described their life experiences as always existing on the "other side" of an abyssal line. Participatory approaches promised opportunities for the less vocal and less powerful to find more choices in the common space (Santos, 2007), as well as the potential for reaching wider questions of citizenship, rights and governance (Gaventa, 2002).

3 Toward common spaces for mathematics education

Policy documents and prison education practices place high expectations on the formal school within the prison for "rehabilitation"[3] and successful reentry following incarceration. Mathematics is attributed special purposes due to its assumed associations with career opportunities However, differences between prison schools and those outside prison are typically overlooked. Mathematics learning in typical school classrooms usually adheres to features of "public spaces" by appealing to universal rules, policies, and procedures; school programs embedded in prisons naturally extend these features. Public spaces construct marginal groups as "counter-publics" that threaten the public accessibility or livability of the so-called public spaces, in turn, ironically, making the public spaces open only to particular people, not everyone. Public spaces thus serve a social function of clarifying membership in "the public" through marginalization of "others". The usual mathematics curriculum in the prison of our project is consistent with this role of school as a public space, literally transferring practices directly from the public school to the prison school, using the same curriculum and textbooks. As a public space, school mathematics expects learners to practice procedural tasks far removed from prisoners' lived realities and neglects their age and life histories. Also, the wide range of past schooling as well as the broader social context of the school experience are ignored, e.g. children return to a nurturing family on a daily basis, while the prisoners in contrast experience the brief school hours as an escape from their more restricted prison life (schools outside are often lived as "prisons", while prison school is a space for some freedom). Research demonstrates that prisoners, as adult learners, often demand more than students in public schools (Fovos, 2023).

Contemporary critique worries about the kind of education that would support better reintegration following detention. Prisoners are frequently attributed deficits, and rehabilitation in this sense "normalizes" them by striving to correct deficiencies (Warr, 2016). Prison school is reduced to an intervention for correcting deviant behavior rather than providing knowledge and skills aimed at personal uplift, future development, or successful reentry. This shapes prison education as a restoration process, an intervention rather than a long-term strategy. Prison school restricts the prisoner to self-perception as an offender needing short-term skill training (Warr, 2016).

Teacher education ordinarily prepares for the public space of classrooms with normative values and expectations for school, knowledge, the discipline of mathematics, and the assumption that mathematics is primarily learned in school. Mathematics becomes defined and illustrated by school. This contrasts with the enormous variety of informal mathematics and conceptual understanding that young prisoners bring as funds of identity (FoI)[4] (Hogg & Volman, 2020). Indeed, characteristics of a typical school outside of prison are mostly inappropriate for this population. Working with prisoners in a common space also challenges future teachers' perceptions of teaching as filling knowledge gaps, by confronting the inappropriate deficit framework.

Our work in the prison and with teacher preparation shifts practice and teacher training away from public spaces toward "common spaces" produced by shared activity and use, in sites of collective knowledge and communal norms. We explored both groups' needs and hopes (Tuck & Yang, 2014a). The experiences analyzed in this article took place within the CoSpIRom Project, which promoted "common spaces" as a tool for empowerment.

We are not making a simplistic argument for common spaces always replacing public spaces. Work with prisoners and pre-service teachers would ideally combine public and common spaces to achieve an understanding of how such spaces occur in their life worlds. Mathematical literacy activities would benefit prisoners by facilitating their ability to differentiate these two kinds of communal space. Understanding the expectations that each holds for successful navigation and reappropriation of its resources supports a happy and meaningful life. Entering a public space demands awareness of its policing, and thus choices about conformance or confrontation. Co-created "common spaces" also bring demands, including sharing of oneself and one's life experience in an ongoing co-production of activity. Similarly, prospective teachers exposed to mathematics literacy instruction and assessment in public and common spaces would understand the strengths and weaknesses of facilitating classroom learning in each framework.

[3] This term is problematic as it connotes a perception of the prisoner as a damaged person, with the identity of a criminal, whom the citizenship identity, with rights and needs, being challenged (Crewe, 2011), while at the same time covering social responsibility for marginalization.

[4] FoI: *"aims to break down deficit thinking and to enhance the inclusivity and equity of education by acknowledging and building on knowledge and skills that students acquire out of school and define as important aspects of their identity"* (Hogg & Volman, 2020, p. 863).

4 The study

4.1 Methodology

Methodology combines theoretical commitments with ways of working (Leavy, 2017). We are committed to reducing subjectification of research subjects, empowering marginalized members of our community, and developing meaningful mathematics education for all learners. We combine these with a community participation approach using Critical Communicative Methodology, which promised direct attention to inequality and exclusion (Caterino, 2013).

4.1.1 Research questions

Our main research questions were: Can common spaces, recognition and equal participation support mathematics literacy while empowering and emancipating young prisoners? Might this framework prepare prospective teachers within contemporary diversity?

4.1.2 Research setting

The young prisoners of this rural Greek facility walk to a separate school building under guarded supervision. Usual space arrangement demands typical school practices: Students sit in rows facing a teacher. Our first intervention changed the arrangement to facilitate a common space: chairs in a circle or standing together as a group. Data collection over two years included transcripts and notes from meetings and year-end theater performances developed by 25 participating inmates and 20 prospective teachers (in rotation) (Table 1). Court orders, trial preparation and frequent changes in incarceration meant inconsistent participation or anxious distraction for some.

4.1.3 Procedure: steps and tools for (Pragmatological) data selection

Our sequence of intervention and data collection was as follows:

a. Prisoner Preparation: orientation and prisoners' needs analysis
b. Future Teacher Preparation: Orientation to prisoner inputs and 8 workshop needs analysis
c. Common Space Through Mathematics Literacy

Table 1 Participants

Participants	Age	Origin	Previous experience
P1	20	Pakistan	Primary School (PS)
P2	22	Greek Roma (GRo)	PS
P3	21	Pakistan	–
P4	20	Egypt	Secondary School (SS)
P5	19	Pakistan	–
P6	23	GRo	PS
P7	20	GRo	PS
P8	23	GRo	PS
P9	22	Syria	PS
P10	21	Syria	PS
P11	22	Syria	University 2nd year
P12	20	GRo	PS
P13	19	Syria	–
P14	22	GRo	SS
P15	22	Afghanistan	SS
P16	22	Algeria	SS
P17	20	GRo	SS
P18	23	Iraq	SS
P19	22	Pakistan	PS
P20	20	Afghanistan	–
P21	21	Syria	SS
P22	20	GRo	SS
P23	21	GRo	–
P24	21	GRo	PS
P25	23	GRo	PS
20 prospective teachers in rotation			

d. Thematic Analysis of Data[5] (Braun & Clarke, 2006).

5 Thematic analysis with sample vignettes[6]

5.1 Preparing young prisoners for common spaces

Introductory meetings with the young prisoners included project aims for improving the mathematics curriculum with their input. We described the idea of a common space (equal participation, shared decisions and responsibilities). The prison office provided basic educational profiles. More informative were individual and focus group interviews about cultural and previous school backgrounds, desires and

[5] This approach includes the steps: Become familiar with the data, Generate initial codes, Search for themes, Review themes, Define themes. Data are interpreted and discussed data in respect to literature review and to research questions.

[6] Due to the nature of qualitative research, we interweave data collection with emerging thematic categories. The findings of need analysis informed our next step.

Table 2 Thematic categories

TC1	Previous school experience	TSC1.1 Duration of schooling TSC1.2 Imprint of schooling
TC2	Funds of identity	
TC3	Expectations and desires	

expectations, and attitudes toward school and mathematics, generating thematic categories (Table 2).[7]

5.1.1 TC1 previous school experience

Most inmates were out of school for years and found it challenging to sit and think abstractly about hypothetical ideas. A minority Pomakian complained of lost dreams: *"I haven't attended school at all. My dream was to go to school. I worked in tobacco…but I wanted to go to school. I went to school here in prison for the first time."* An Afghani reported no school: *"there was no school where I lived"*. Such stories are consistent with the lack of opportunities available to marginalized populations existing from early years on the invisible side of the abyssal line (Santos, 2015). Histories shared inadequate literacy experiences consistent with the low self-esteem tied to school refusal, low achievement, early school dropout and failure in the literature (Mallett, 2014). Further stories confirmed previous research on marginalizing school practices (Bacher-Hicks et al., 2021), such as encouraging students with preexisting knowledge gaps to leave school, understood as "protecting" more advantaged students. Memories explained inadequate school mathematics backgrounds: *"…there was no time for the teacher to explain (mathematics) because there were a lot of students"*. Asked to suggest mathematics content for jointly developing curriculum, they seemed embarrassed and surprised: *"In our country, we were not asked what we wanted to do. Whatever the teacher told us, we had to learn it."*. They seemed lacking in autonomy, having fully accepted teacher authority, unable to conceive of themselves as decision-makers: *"we can't decide, whatever you bring to us we will do"*. More difficult experiences were reported: "*In my country, we were beaten at school"*. Preparation for the common space required empowerment through recognition (Honneth, 2015): They had been consistently weakened by challenging lives, further exacerbated by the dehumanization of prison (Vasiljevic & Viki, 2013). We pursued trust and recognition by asking about interests, treating them as co-planners, clarifying that we needed guidance in preparing workshops for the university students and consistently explaining that they were to be participating as human beings (Tuck & Yang, 2014a) in this special space away from the more carefully guarded areas of the prison. Our post-visit reflections and planning for subsequent visits aimed to avoid asymmetric relations characteristic of Pratt's (2012) "contact zone".

5.1.2 TC2 funds of identity

Our antideficit approach to creating a common space and establishing recognition required gathering the prisoners' FoI (Hogg & Volman, 2020). Some described mathematics learning within family or work experiences, the majority from an early age: *"I learned math at work from my boss"*, *"I only know plus and minus because when I was a teenager I worked as a bus collector next to my father"*. One family farm story emphasized usefulness for family income: *"I learnt* [mathematics] *on the farm, because we didn't have calculators"* and of mathematics usefulness *"…for income-expenses"*.

Young prisoners come to prison class as adults with *"potential educational resources, mediational devices or 'acts of thought' which can provide the 'conceptual fabric' for the development of school aims"* (Esteban & Moll, 2014, p. 71). They normally follow a curriculum and textbooks incompatible with their age (Petsas, 2017) that ignores their FoI and emphasizes their distance from everyday life outside of prison. Consequences include disruption of self-realization and autonomy (Anna, 2018) and denial of their full humanity (Biesta, 2006). In contrast, our efforts to learn about their previous experience and wealth of mathematics skills, toward recognition within the common space, was a first step in bridging curriculum with the outside world (a demand of adult education, Petsas, 2017). Data in this theme overlapped extensively with the third, expectations and desires, discussed next.

5.1.3 TC3 expectations and desires

Imagining possibilities as deciders, at least in the context of school, was new to the prisoners. Insisting that prisoner-learners guide curriculum went beyond recognition toward "rehumanizing" counter-narratives against dehumanizing research methods (Tuck & Yang, 2014b), empowering prisoners from the other side of the abyssal line. This was also a refusal to situate future teachers within *"a matrix of commitments, histories, allegiances, and resonances that inform what can be known within settler colonial research frames, and what must be kept out of reach"* (Tuck & Yang, 2014b, p. 811).

Most prisoners wished for problems, not simple exercises: *"I prefer to solve problems instead of exercises. Through problems you can learn more things…"*, *"I would like to learn geometry; in our country we aren't taught geometry"*.

[7] Space limitations necessitate some details for TC1 only.

Others focused on application: *"I would like to do problems with money dealings, to know how to spend my money"*, *"…mathematics helps you in a way that you can think more cleverly"*, *"it's necessary in calculations, in commerce: it helps you not to be robbed in stores"*.

5.2 Preparing prospective teachers for common spaces[8]

Like the initial interaction with the prisoners about becoming co-researchers, the future teachers contributed to 8 workshops eliciting both ideas for joining the prisoners in constructing a common space and also data on their understanding of the imminent intercultural experience. Enthusiastic about exploring mathematics without a need to be experts "in charge" of what to learn, they were excited to take the prisoners' expectations as their own, at least in terms of how they understood them. The workshops followed a university syllabus structure:

1. Ethnomathematics for Teaching Mathematics
2. The Prison World
3. Hetero- and Self-Identification
4. Language Issues
5. Creativity, Linguistics and Identity
6. Developing Curricular Experiences
7. Narrative Storytelling
8. Drama in Education

5.3 The common spaces of young prisoners and prospective teachers

Pragmatological material from two phases of the project illustrates different school years with different prisoner groups and pandemic conditions. A "lived curriculum" perspective (Pinar, 2012) guided each year, alerting us to any moment of everyday life as a rich curricular opportunity.

5.3.1 Year 1

Drama in Education techniques (DET) for team building shifted the problem of creating a common space to the *possibility* of a common space (Block, 2008). This facilitated communication among all—also among the prisoners themselves since they ignored others' names and spoke different languages. We exploited all communication options, including gestures. Discussion clarified research project goals and roles, criteria of equal participation and

Fig. 1 Young prisoners calculate area and perimeter

shared/common responsibility, and strategies for living a culture of recognition (Boyadjieva & Ilieva-Trichkova, 2021). While brainstorming about potential curricular activities, a prisoner shared a Roma fairytale, "The Lucky Shoemaker".[9] The group quickly identified this story as something they could explore together. We collaborated with DET to make sense of the story and remodel it with mathematics and language development. Each member's unique background contributed to a synergistic common space as we became a team developing the story into a performance. Team members divided into subgroups—mixed—to help "The Poor Shoemaker" get money from "The Clever Shoemaker". These puzzles first required playful experiments with basic arithmetic and increased in complexity. Some prisoners readily responded to the tasks, helping others. Groups presented solutions within a lively whole team discussion focused on thinking processes and method comparisons. Participants shared related life stories in a pleasant atmosphere, mutually encouraging and celebrating unique mathematical ideas and strategies. Future teachers frequently praised and honored prisoners' persistence and perspectives: *"Come on, I believe in you"*.

We needed a physical model of the Shoemaker's shop, introducing geometry to the common space. Small group presentations and whole team processing focused on perimeter, area and measuring techniques. Prisoners demonstrated comprehension of area and unit measure as they considered story details for the "store".[10]

[8] Space limit doesn't let us to share the need analysis contacted for exploring prospective teachers needs for participate in this common space with young prisoners.

[9] *Shoemaker* story, coincidently included in a recently published book in the local Roma community. Young Roma were proud of it.

[10] Adult Education is facilitated by real-world modeling and applications. And the combination of skill acquisition with recognition as a social justice and self-esteem strategy transforms the existential meaning of education for the adult learner (Boyadjieva & Ilieva-Trichkova, 2021).

Fig. 2 The researcher and the young prisoner work on measuring units

In Fig. 1 two prisoners calculate perimeter and area, first with arbitrary units, then with conventional units suggested by a research team member. In a moment illustrating the collaborative nature of the work, a prisoner expressed confusion. A future teacher in his group stood in the space to help him understand in a real-life context, introducing meters and centimeters; a researcher seized the opportunity for further elaboration of relationships (Fig. 2). The prisoner declared: *"I can do everything now!"* This vignette depicts first that prisoners were involved and enjoying the collaboration because they were interested in the story. They were also contributing their own resources, validating FoI while centering contributions to emerging mathematical literacy.

5.3.2 Year 2

Life circumstances introduced changes in the second year of the study. Pandemic restrictions limited entry permissions for prospective teachers. Institutional operations led to prison student changes. The pandemic also introduced issues forming our lived curriculum. Reiterating the first-year approach, we began with the prisoners' guidance, discussing life experiences in and out of school. Bringing clearer expectations from the previous year, and now looking forward to increased input on the emerging curriculum, they enthusiastically offered suggestions.[11] Anxiety about COVID-19 led to our activity. The staff asked if they wanted to be vaccinated. They had heard of side effects on television.

(All of) YP[12]: *They* [prison staff] *asked us if we want to get the vaccine* [brand name] *and we don't know what to do? What do you say…?*
PT[13]**1**: *I wasn't sure to do it or not, but if I don't, I should present my rapid test results twice per week, something that costs, so I'm vaccinated.*
R[14]**1**: *We cannot and should not tell you* [what to do], *but if you would like to take into consideration what scientists say… I mean to get the science help… what is the crucial question you think will help you decide?*
YP1: *Normally, we should ask a doctor.*
R1: *What will the doctor need to know to be able to answer you?*
YP1: *If this vaccine is good.*
R2: *And what is a good vaccine?*
YP2: *I think the one that helps people not to die, or at least not get seriously ill.*
R2: *How do you think the doctor could know this?*
…
PT2: *Would you like us to search for this on internet and then share the information?*
(All of) YP: *Yes! Are you going to do this for us? Thank you so much!*
PT2: *Please, let us know. How should we search on the internet? What should be the question-the key words?*
YP2: *How many died and how many got sick?*
R2: *Wait a second to find the numbers on the internet and we will provide the information to you, then you will find the answer for yourself…*[15]

When asked what mathematics might help, they had no ideas.

R2: *Well, guys,* these numbers *show who were vaccinated… and died and who became seriously ill.*
YP3: *Oh! Such big numbers! How could we understand?*
R1: *Right. How could we write these numbers to make them easier to understand?*

[11] They expressed interest in calculations and estimates related to daily life and health, estimating work costs, cooking and nutrition, drugs and addiction, and in learning about interesting mathematical patterns and data. They also proposed direct study of the prison building and environment, the politics of punishment, temperature and climate change, and prison design in general, proposing specific activities involving situated mathematics knowledge.

[12] YP: Young Prisoner.

[13] PT: Prospective Teacher.

[14] R: Researcher.

[15] The prison forbids internet in the classroom. A research team member went to the school office, to obtain the prisoners' requested information.

YP1: [Pakistani with mathematical confidence] *Let's use percent?*
R2: *What do you say? Do you agree with YP1?*
(All of) YP: *Yes!*
PT2: *Guys, do you know what "percent" is?*
(All of) YP: *Yes!*
R1: *How did you come up with this, YP1?*
YP1: I have seen such things on TV, they speak about percent.
R1: This [written on board] *in Greek is called percentage—but why will this help?*
YP1: We understand better when it is percent.
R2: *That is, what do you understand?*
YP1: *Here. If it is 5 percent, it shows us that if there are a hundred people, 5 are sick.*
R2: *Do you agree, YP1?*
(All of) YP: *Yes!*
R2: *So, what do we need to find?*
YP2: *How many percent died or are sick.*
R2: *And then?*
YP2: *The smaller the number, the better.*
PT3: When you went to school, did you learn how to use percent?
YP1: *We did, but I don't remember how.*
YP3: *We… I remember… we found "percent" of a number, not the other way round.*
PT4: Do you remember what those numbers were?
YP4: *Yes, usually for money.*
R2: *Great. How can we find it?*
YP3: *That, we said, we don't know. You must tell us.*[16]
R2: *Great. Write first, the numbers on the board. So, can you tell us how many got this vaccine?* [Numbers on the board: vaccinated-dead-sick. Most had forgotten or never knew the Greek word million and used the English word "million". We reminded them of the Greek usage.]
R1: *What do we want to find?*
YP3: *What percentage died and what got sick.*
R1: I want you to tell me under which of the 3 numbers on the board you think we should write 100.
YP1: *Under the…* [number of vaccinated]
R1: *Very nice. So, we want to find how many died,* ["X?" was written under the number of dead] *and how many got sick* ["Y?", under the number of sick]. *It reminds you of something… the way I wrote the numbers and letters…*
YP1: *Yes, it tells me something, but I don't remember how we did it at school…*
YP1: *The numbers are large and the operations difficult. How to do them?*
R2: *We will use the laptop calculator. Who wants to do it?*
[Only two seemed familiar with percent on a calculator. Others avoided participation, waiting for the results, seemingly embarrassed about not knowing how to use it.]
YP1: *Me, I can do them.*
[He calculated; we found both percentages. The future teachers organized small teams and helped prisoners understand percentage concepts.]

Table 3 Thematic categories

TC4	Common Spaces Bridge Worlds through Mathematical Literacy
TC5	Common Spaces Facilitate Self-Transformation through Mathematics
TC6	Theory and Praxis in/and Common Spaces
TC7	Mathematics Curriculum as Mutual Exchange

The common space established a bottom-up experience addressing learner interest, facilitating a crucial life decision. Marginalization because of both incarceration and low levels of mathematical literacy had prevented access to important information. The experience highlighted for researchers and prospective teachers how a marginalized population is easily manipulated and disempowered through denial of information essential for basic life choices. Common spaces are one path toward identifying and responding to such access gaps, demonstrating the social justice role of mathematics education.

6 Interpretation and discussion of data

This section interprets the initially generated themes[17] in terms of our research questions and the (sparse) literature on prison mathematics education (Table 3).

[16] Realizing most had forgotten or had never learned about ratio, proportion and percent, and supporting conceptual understanding through analogical reasoning, we introduced simple examples (based on reduction to the unit) before direct instruction on standard algorithms.

[17] Space limits require skipping the intermediate thematic analysis process.

6.1 TC4 Common spaces bridge worlds through mathematical literacy

Dialogues within small groups demonstrate emerging relationships within the evolving common space. Not explicitly mathematical yet nevertheless critical to understanding the context for mathematics, they promoted reexamination of life roles and social perspectives beyond lived realities. A brief exchange in the first-year data demonstrates the trust and emotional connections developed in the common space processes:

> **YP1**: *I'm thinking, how is the world outside right now?*
> **PT1**: *Strange.*
> **YP1**: *Yes, but also beautiful. You can do whatever you want.*

Future teachers found dialogues between mathematical activities important: *"The best parts of participating in CoSpIRom were definitely the Smalltalk during and in-between the activities."*. These "small talks" can be understood as "commoning" (Harvey, 2013), and demonstrate how mathematics teaching is not only about mathematics. In the university workshops, they worried about contributing to a successful common space, only a fleeting feeling: *"How quickly we became a team all together was something I didn't expect. I felt like we already knew each other, there were no awkward moments among us, just pure interest, and laughter. We coexisted with authenticity."*.

Both groups experienced challenges to symbolic boundaries:

> *We teared down the wall between us and them.* (PT)
> *We have a beautiful bond and cooperation. We are all one team!* (YP)

Baker (2022) highlights, *"through the processes of transgressing and transcending boundaries, those very boundaries themselves are transformed, potentially opening up new social spaces and identities."* (p. 288). Commoning marked the transformation from public to common.

Recognition and equal contributions dictated by the nature of a common space rather than a prevailing authority (Stavrides, 2016) empowered prisoners, powerless in the society (Pratt, 2012), to lead in crossing the abyssal line by appropriation of mathematical literacy (Santos, 2015). One prisoner demonstrated the sense belonging established in the common space. Fearing he would miss out due to a prison transfer, he declared: *"Don't tell me about transferring, I'm not going anywhere"*.

We believe such relationships create a pedagogic space for mathematical literacy development. Emphasis on relationships may be the key for mathematics teaching, rather than content (especially content not directly relevant to the students' lives, and moreover for the prisoners), or even the common space approach (Appelbaum, 2008; Biesta, 2006).

6.2 TC5 common spaces facilitate self-transformation through mathematics

Challenging symbolic boundaries as discussed in 6.1 was a first step for renegotiation of both groups' identities. Replacing stereotypes with personal relationships was critical. Mostly concerned with marginalized populations, stereotypes are socially constructed through a discourse of coloniality (Kidd, 2008) often amplified in the media, dangerous because of their association with power. Particularly relevant to prison education is that *"stereotypes are reinforced by the justice system and in society"* (Gomez, 2022, p. 5). While the future teacher workshops were a start, the group interaction and sharing positive feelings for the collaboration were more effective (Govaris & Manousou, 2015). Some typical comments expressing change:

> *I think everyone has been in some conversation about Roma people, but it's only after you have an encounter with them…that you can truly understand how different and yet how similar our two cultures are.* (PT)
> *I have plenty of common ground with these young prisoners who have experienced different things in their life, as result it not right to judge them.* (PT)
> *They have dreams they want to fulfill, and despite the difficulties that they have experienced in life they hope for a beautiful future.* (PT)

Prospective teachers described self-transformations fostered by empathy:

> *Our interaction contributed to empathy enhancement in such a sensitive matter and place.* (PT)
> *Leaving the prison school, the first day; prisoners and us, leaving to different directions but keeping eye contact and wishing to meet again as soon as possible… It was like an ending scene of a film, but in reality, it was only the beginning of a powerful experience.* (PT)

Beyond intercultural competencies, transcultural communication promotes *"active participation, adaptation and interaction"* (Jurkova, 2021, p. 102), facilitating transformation. For example, prospective teachers became alternative life models for prisoners; the prisoners began to rethink identities and the potential for transformation:

> *We see different ways of thinking...* (YP)
> *We haven't done anything like this before. We have realized that we can do many things we didn't know we could.* (YP)

They have a goal in life. They affect us and we also want to do something-to succeed. (YP)

Such young prisoner reflections illustrate the role of recognition in promoting self-realization. *"The ideal ethical society embeds the conditions that enable the full and unrestricted self-realisation and autonomy of all its subjects, which in turn ideally leads to a democratically engaged and critical citizenry"* (Anna, 2018, p. 43).

The common space encouraged active contributions to mathematics literacy. Group participation empowered the prisoners: *"If I did this* [speaking about his successful calculation of length and area] *I can do anything!"* Indeed, prisoners changed their posture to school as well as mathematics after successful experiences: "*School makes you human. It teaches you things you have never seen before."*

6.3 TC6 theory and praxis in/and common spaces

Reflections from the prospective teachers paralleled the changes through the experience articulated by the young prisoners. One future teacher recalled her early skepticism: *Initially I had doubts about the effectiveness of the program for the young prisoners.* (PT).

This future teacher and others confirmed the efficacy of embedded, contextual approaches for pre-service development of intercultural competencies identified in the recent literature (Romijn & Leseman, 2021), a strategy of pre-service training through both theoretical knowledge and practical experience with diverse learners discussed by Allen and Wright (2014). The gap between theory and practice has been met through service-learning projects that enable future teachers to embed curriculum within civic engagement (Appelbaum, 2015; Resch & Schrittesser, 2023), and through experiences with non-formal learning environments (Xenofontos & Alkan, 2022). Prison education establishing a common space was similarly influential as a teacher education program in several ways. Enthusiasm for teaching marginalized populations is indicated by the engagement with authentic communication beyond expectations for facilitating mathematical literacy. The future teachers appreciated the broader value of interaction on a personal level of shared interests and issues: "*My interest in teaching such students was rekindled"*. Indeed, Novek (2019) stresses teacher awareness for prison education: "*Mindful educators can provide occasions and topics for discussion that bring students closer to one another and offer regular opportunities for connection and change."* (p. 64).

Bryan (2017) suggests teacher education coursework should explicitly help preservice teachers *"undo stereotypes and biases"* (p. 341) and to adopt antideficit perspectives. Participants believe this experiential opportunity prepared them for teaching diverse populations far more than any education courses or school fieldwork:

The dual organization of the program, in terms of preparation and experience, it was great. I guess one of the two above alone would not have the same impact personally and collectively. In particular, the practice in real conditions and the ability to interact directly and personally with each member of the newly formed team made me realize more substantial aspects, which only on a theoretical level would not be the same. (PT)
Without the live experience in the prison, the theoretical preparation would have been useless. (PT)
Our enrollment in the CoSpIRom in prison filled out us with a lot of expectation, as it looked like an interesting experience that we had not been involved with before. Our expectation was, both through the training and the common experience with the research team and the young prisoners. We interacted by building our own common ground and reality framed by such characteristics, which had a positive impact on each of us (PT)
This experience was a starting point; and in the long run, it can be a strong inspiration for personal redefinition, maybe for all the participants in the community we cocreated. (PT)

Such quotes are samples of reflections from the future teachers indicating how they were experiencing a moment of profound introspection because of the personal relationships with learners who had taught them as much as they were being taught, discussed further in 6.4 below.

6.4 TC7 common spaces: mathematics curriculum as mutual exchange

The future teachers valued small group mathematics collaborations with the prisoners for helping them appreciate the prisoners' knowledge. The common space mitigated asymmetrical relations (Pratt, 2012). Prisoners encouraged to exploit any recourse were connected to their FoI (Hogg & Volman, 2020) unrestricted by formal school mathematics, in refusal of usual prison school practice (Tuck & Yang, 2014a), and in contrast with short-term skill training typical of prison schools (Warr, 2016).

In this framework learner ideas were often more effective:

He [young prisoner] *had quite a bit of difficulty speaking Greek, however in Mathematics he seemed to be at a satisfactory level. He was very fast. But I realized that he didn't master some rules and helped him with that.* (PT)
A remarkable point was when some learners got up to calculate the floor area and the square meter as a

measuring unit, a prisoner in my group told me that understanding these concepts was difficult for him. To help, I stood in the space to show him how it works, using steps… (PT)
A Bangladeshi didn't seem to use their own number system but Arabic with ease, something that surprised me. (PT)
As he told me, he likes math and it showed in the way he did math tasks… My intervention was non-existent, to such an extent that while he provided the solutions, I was still processing the data…I was impressed by the fact that after solving them and arriving at the result, he would then explain to us the way he thought to solve the puzzle. (PT)
Especially with number facts: he did them in his head very quickly. I was really impressed by the knowledge and kind character of this person and my interest in teaching such students was rekindled. (PT)

Participant quotes indicate meaningful transcultural communication. Co-constructing mathematical literacy required both groups to exchange knowledge and experience. Prospective teachers provided school mathematics knowledge. Prisoners contributed mostly streetwise wisdom. Recognition practices helped the prospective teachers to appreciate situated knowledge. Initially motivated by recognition goals in early needs analysis with prisoners who valued mathematical action within specific real-life contexts, we further promoted research of refusal (Tuck & Yang, 2014a), enabling a circling back on what might even be considered mathematical in the first place (Appelbaum & Stathopoulou, 2015). While many skills and concepts, relationships or connections risk being overlooked, dismissed, or ridiculed in pursuit of apprenticeship, training, and other labor-focused mathematics curricula (Boeren & Whittaker, 2018; Gal et al., 2020), rich mathematics was essential for the common space formation. Here the mathematics was the aspirin for the headache of intercultural common spaces (Meyer, 2015), although it might have originally been expressed that common spaces were the aspirin for the headache of inadequate prison mathematics education. This shift in focus used mathematics and common spaces of equal participation in mutual development. We see this mutuality as a response to coloniality, which entangles the material (political–economic, ontological, and existential) with the symbolic (social, cultural, and epistemic) (Fúnez-Flores, 2023). Education scholarship drawing on and contributing to decolonial thought does not always make these connections explicit. A mathematics program might emphasize the mathematics content (the epistemological/cultural) and risk accusations of maintaining the modern/colonial order, or work as a catalyst for collective social action, in which case it might appear as perpetuating the inadequacy of its mathematics curriculum. Entering this atypical environment with the goal of a common space changed the future teachers' relationship with both learners and mathematics just as it changed the young prisoners' relationship with mathematics and school itself.

6.5 Interpretive summary of findings

Research on prison mathematics education stresses curriculum revision directly addressing specific inmate conditions (Farley & Pike, 2016; Liebling, 2011). We explored one approach: using mathematics to co-create common spaces. Rather than a barrier to the required standardization of a public space, the common space benefitted from the heterogeneity of the students – Roma, refugees from Syria, Pakistan and Afghanistan, and others. Variations in prior school experience and mathematics skills contributed to active citizenship instead of marginalization. Of special importance as indicators of a common space were the following:

- Demonstration of empathy. Prospective teachers moved away from symbolic boundaries separating them from inmates, challenging longstanding stereotypes through collaboration. The public space "other" became the common space "member of the same team":
- *Our interaction contributed to empathy enhancement in a such sensitive matter and place.* (PT)
- *I remember a prisoner testifying that our meetings were the occasion to learn terms such as theatre, with which they hadn't come in contact in life outside prison.* (PT)
- Prisoner Self-Concept Development. Young prisoners used mathematics to reconsider themselves, their lives, their expectations and future perspectives:
- *We had a great time. We haven't done anything like this before. We realized we can do many things we didn't know we could.* (YP)
- *They* [prospective teachers] *have a goal in life. They affect us and we also want to do something–to succee*d. (YP)
- Curriculum Resource Development. The common space produced "playbook activities" for simultaneous teacher training with prison mathematical literacy work:

    - Creating a common space through conversation about prior school mathematics sharing and storytelling about everyday life mathematics creates mathematics topics students are motivated to learn.
    - Drama in Education enables accessible and powerful communication while demanding concrete mathematical problem solving.

- Cultural stories and fairytales generate mathematical puzzles to solve as a class tries to understand the stories.

In summary, our data demonstrate that pursuit of a common space with recognition and exploitation of FoI can support mathematics literacy, while mathematics literacy can be a conduit to common space. Participation by future teachers is positive and powerful.

7 Conclusion

Marginalization challenges mathematics educators: Mathematics in standardized form, highly valued within the public space, also excludes those not included in the regulated "public". Mathematics is clearly key to social participation, functioning as gatekeeper to social goods. Yet young prisoners are the excluded casualties of public spaces. "Common" spaces avoid such marginalization while facilitating inclusive participation. They shift from policing differences toward exploiting everyone's cultural capital, from deficit models toward a meeting of interests through mathematics.

We initially planned for common spaces to support mathematical literacy. We later realized this also works in reverse: interaction of prisoners and prospective teachers with mathematics enabled common spaces to evolve. Mathematics was a resource for achieving attributes of common spaces as much as common spaces led to mathematics objectives. Future teachers experienced mathematics excitement and surprises when co-creators engaged in purposeful activity. Working together with learners instead of motivating them within lessons and exercises required negotiation of stereotypes and empathy. Despite contrasting life experiences the prospective teachers acquired skills for working with diverse student populations while the prisoners developed new perspectives on what they could achieve for themselves. Mathematics Literacy made these possible. This is a reproducible approach to prison mathematics education combined with mathematics teacher education, readily explored further. A key element for teacher education is the shift from "how to teach this content" to "how to co-create a common space".

Important questions remain. Might a prison mathematics teacher somehow exploit existing, inappropriate textbooks designed for elementary public schools? We advise asking prisoners themselves for ideas, establishing a common space. Some features of the experienced teacher and the university prospective teachers indicate further research directions: flexibility and willingness to adjust and adapt in the moment; listening skills and the genuine interest in what the students care about; and a disposition to seek curricular experiences promoting exploration of one's life world. Our team members were forthcoming in their commitment to social justice and active citizenship. In this respect, they may have been resourceful and successful even without striving to co-create a common space with prisoners. Either way, they now use the language of public and common spaces to describe how and why they were successful with the prisoners.

We maintain we cannot research or introduce curriculum change in mathematics education without using the mathematics for changing prison education in general. It is impossible to speak only about mathematics or mathematics education when working in a prison. The context demands a more complicated approach encapsulating what imprisonment and prison (mathematics) education means to each of numerous constituencies. While questions might begin with mathematics content, and the prerequisites for teaching mathematics in prisons, other questions about pedagogical relationships supporting mathematics teaching are of equal or greater importance. That is, mathematics education is a site for interrogating prison education in general. But this raises another point: Mathematics education elsewhere, such as so-called ordinary schools, are probably just as much about the context. We sometimes focus on mathematics content, instruction, etc., in general, for all schools, without attention to social context. Spectacularly clear when we move into a space with which we are not so familiar, such as a prison, the context cannot be ignored. Maybe we need a similar orientation to "ordinary" school mathematics: What are the restrictive and challenging features a common space approach would mediate?

Funding Open access funding provided by HEAL-Link Greece. CoSpIRom was funded by the European Union's Rights, Equality and Citizenship Programme (2014–2020) (Grant 809859).

Declarations

Conflict of interest No conflict of interest.

Informed consent Informed consent of involved human participants.

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