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Impacting life expectancies of incarcerated people through dialogic scientific gatherings and dialogic scientific workshops in prisons

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The scientific literature has presented evidence that participants in dialogic scientific gatherings (DSGs) transform their scientific interest in science. DSGs are based on a dialogical perspective, where egalitarian dialogue and the co-creation of knowledge are the two corner pieces that allow the development of new meanings for participants, improving their scientific literacy. There is a clear gap in scientific studies regarding DSGs in prison. This is the first research to address the impact of DSG and dialogic scientific workshops in prisons. The study presents the positive impact of the DSGs and scientific activities in promoting scientific interest in incarcerated people. A communicative case study was conducted in a Catalanian (Spain) prison between February and April 2022. Nineteen males who were incarcerated aged between 29 and 44 participated in twenty-one DSGs and twelve scientific workshops following a communicative approach. Data were collected through fifteen communicative observations during the application of the DSG and eight interviews with incarcerated people and two interviews with prison workers involved in implementing the DSG. The activities conducted and analysed in this study demonstrate that bringing science closer to all people, including the traditionally excluded population, is possible. The results show that the persons who experience incarceration's motivation to participate in these scientific activities, which fostered their awareness of and interest in science, gave meaning to their learning and transformed their interactions in and out of prison.

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Introduction

The sustainable development goals (SDGs) aim to achieve a better and more sustainable future for all people by 2030 (United Nations, 2023). Specifically, SDG4 (quality education) refers to achieving inclusive and effective learning environments for all. In general terms, the scientific literature shows that situations of economic inequality disfavour academic results (Cross et al., 2018; Williams et al., 2017; Gustafsson et al., 2018). Despite the long tradition in research of highlighting the consequences of educational inequalities, less research has focused on showing actions to overcome the exclusion of the most vulnerable groups. In this regard, one of the most crucial tasks of the social sciences is to study the different degrees and types of inequality, but especially to define strategies that reduce them (Soler-Gallart, 2017).

There may be more than 11.5 million people in jail worldwide; in Spain, the total of this population is 55097 (7.1% are women) (World Prison Brief, 2021). The education gap between the incarcerated and general populations is vast. For example, studies in the United States showed that the incarcerated population had lower average literacy and numeracy scores than the overall, and less than 5% had a college degree (PIAAC, 2014). However, Emma Hughes' (2016) study exposes people who experience incarceration's desire to undertake a fundamental transformation and their interest in solving their problems, and that an educational commitment from prison policies can be assumed to motivate lifelong learning. The person who is incarcerated participates in education programmes because they see clear opportunities to improve their employability after being released. Clark (1991) generated data that answered the question of whether completing a college degree during prison incarceration reduced participants' likelihood of returning to prison. This study showed that the participants who earned a diploma returned to prison at a significantly lower rate (26.4%) than people who did not get a degree (44.6%). Similarly, Duwe and Clark (2014) demonstrated that a post-secondary degree in prison is associated with a more significant number of hours worked, higher overall wages, and less recidivism.

Successful Educational Actions (SEAs), identified as effective and transferable evidence-based actions, are the optimal ground for developing educational theory, actual practice, and policy-making (Flecha, 2015). SEAs have demonstrated their ability to achieve excellent results concerning academic success and increased social cohesion in different contexts, for example, in schools (Morlà-Folch et al., 2022), residential care institutions (Gairal et al., 2019; Gairal-Casadó et al., 2021) or prisons (Alvarez et al., 2016). The INCLUD-ED project identified dialogic gatherings as a SEA based on the dialogic reading. Dialogical reading depends substantially on interactions; discussions with other people allow different interpretations of the text to be shared, which promotes critical reflection and learning (Flecha, Garcia and Gomez, 2013; Soler, 2015). In this way, dialogic reading addresses the "Matthew effect" in reading, meaning that the more you have, the easier it is to have more (Stanovich, 1986). This "Matthew effect" is also present in the case of access to science. The literature shows the gap in their access to science for the most vulnerable students (Arnold and Doctoroff, 2003). Young people who feel attracted to and are better at performing scientific activities are precisely those who have participated in scientific activities outside scheduled classes (Thiry et al., 2011; VanMeter-Adams et al., 2014), which occurs less often for vulnerable students.

Even though scientific literacy is essential for individuals to participate fully in democratic societies, inequalities in accessing scientific knowledge still exist worldwide (Díez-Palomar et al., 2022; OECD, 2013). Despite the growing interest in the

democratisation of science, there are still groups on which little research has been done yet to involve them in scientific advances. A particular case is the prison context, where more research needs to be done concerning successful actions to foster awareness of and interest in science.

The fieldwork conducted by the Extended Learning Time IV: Contributing to generate scientific vocations project (Dirección General de la Fundación Española para la Ciencia y la Tecnología, FCT-20-15780), the main objective was to promote scientific vocations among children, adolescents, and adults in highly vulnerable situations through the implementation of dialogic scientific gatherings (DSG) and researchers are carrying out scientific workshops about the texts of the DSG. Specifically, this paper focuses on the results obtained with the adults in a penitentiary centre. It is a case study in Catalonia (Spain), and the action was carried out in the men's module between February and April 2022. During these three months, the DSGs were carried out, which consisted of reading scientific articles proposed by the researchers and sharing their interpretations and reflections with the group. Training sessions complemented the readings in a workshop format conducted by expert researchers on each topic.

Theoretical framework

Research has widely demonstrated that the educational level attained is essential in determining social outcomes. People whose highest level of education is primary education are almost three times more likely to live in poverty or social exclusion than those with tertiary education (European Commission, 2017). In 2019, the rate of Early leavers from education and training stood at 10.2% in the EU-27, down from 14.0% in 2009 and very close to the 2020 target (Early leavers from education and training, ELET rate should be lower than 10% by 2020). However, Spain has the highest rate in Europe: 17.3% (European Commission, 2019). Also, in Europe, for the general population aged 15 to 64, the unemployment rate is much higher for those with only primary education (16.6%) than for those with tertiary education (5.1%). Therefore, focusing on lifelong learning is crucial to overcoming inequalities (European Commission, 2017).

The vast majority of people in prison have a basic level of education. Considering the importance of lifelong learning and that education is a fundamental human right (UNESCO, 2021), education in science becomes a critical factor in the personal development of persons who experience incarceration. At the same time, there is evidence that learning science can facilitate prisoner rehabilitation, prosocial behaviour, and alleviating correctional staff fatigue (LeRoy et al., 2012; Nalini et al., 2013; Vaccarino and Comrie, 2010). Traniello (2015) states, "we can all agree on the importance of bringing STEM to marginalised populations". However, at the same time, it is essential to overcome the social stigma that incarcerated people face because tremendous obstacles persist in this group. The scientific literature has presented evidence that through dialogue, people exchange ideas, learn together, and co-create knowledge, finding and developing new meanings that transform life expectations (Flecha, 2000, 1997; Evans et al., 2017). This evidence is presented below. On the one hand, we present the impact of science and high expectations for all. On the other hand, we offer the approach of bringing scientific activities for all through the Dialogical Scientific Gatherings (DSG) and scientific workshops.

Science and high expectations for all. Access to science education is disparate across regions, cultures, socioeconomic backgrounds, and gender. Access is neither widespread nor uniform across society. Specifically, the social groups identified as isolated

from scientific interests are mainly determined by three factors: (1) gender (UNESCO, 2015), (2) socioeconomic status (Lee, 2016), and (3) ethnicity (Lee and Luykx, 2006). Science, technology, engineering, and mathematics (STEM) are cornerstones of economic and social development. In this regard, promoting science careers contributes to a skilled STEM workforce. Additionally, the importance of facilitating the participation of the general public in STEM activities has been highlighted (Moote et al., 2020; Millar and Osborne, 1998; Archer et al., 2022). Based on the relevance of STEM in current society, studies have mainly focused on interventions conducted in secondary schools. However, it is important to study other educational environments where interest in science, STEM skills, perceptions, and proofs of the utility value of participating in STEM courses are fostered (Salvadó et al., 2021).

Previous studies show the relevance of egalitarian dialogue and co-creation for creating knowledge in our dialogic society (Flecha, 2000). As Ramon Flecha explained in the book *Sharing Words* (2000), it is essential to create spaces of egalitarian dialogue where participants can speak without fear of criticism or being prematurely confronted with authoritative explanations with the pressures of power (Freire, 1970; Hynd et al., 1994; Ruiz-Eugenio et al., 2023). In that sense, Habermas (1981) emphasised the role of validity claims (verbal and non-verbal language). Communicative action ideally leads to a consensus that is not based on coercion or manipulation but on the rational assessment of the validity of claims. Rational argumentation conforms to universal norms of validity, not to the relative power status of the interlocutors. Validity claims are a key concept in his theory, particularly in communicative action; individuals can collectively assess the validity of truth claims, rightness claims, and truthfulness. That is the framework to create environments where people have ample opportunities to formulate their ideas about scientific concepts, infer relationships between concepts, and combine them into an increasingly complex web of theoretical propositions (Rivard, 2004).

Similarly, high expectations and challenges are crucial even for people in highly vulnerable contexts. Specifically, a recent study in Australia shows that students who experience high expectations have better learning outcomes and are also more likely to have (1) greater interest and motivation in classes, (2) higher attendance, (3) more positive school behaviours, and (4) greater likelihood of completing school (Centre for Education Statistics and Evaluation, 2020). High expectations promote students' academic performance and well-being (Clifford, 1990). Research also shows that the expectations of teachers, parents, and peers affect students' self-esteem, feelings of self-efficacy, and academic motivation. In prison, many people have low self-esteem and personal barriers to reintegration. However, it has been shown that educational programmes, such as higher education, impact overcoming the stigmatisation of released people living in detention because they see themselves positively, which can improve their reintegration and life trajectory (Evans et al., 2017; Mittal et al., 2012). In short, previous literature presents that high expectations are linked to motivation and better results in different educational contexts.

Dialogic scientific gatherings, bringing science activities to all.

Intending to bring science activities for all, dialogic scientific gatherings (DSG) is an evidence-based action created to promote scientific literacy (Díez-Palomar et al., 2022; Buslón et al., 2020). The INCLUD-ED project, *Strategies for Inclusion and Social Cohesion in Europe From Education* (European Commission, FP6), identified dialogic gatherings as a Successful Educational Action based on dialogic reading that improves the communicative

abilities and reading levels of all participants (Flecha, 2015). Dialogic reading encourages discussions about what they have read, what they understood, and what they did not, and different interpretations of the text are shared, promoting critical reflection (Alvarez et al., 2016). As a dialogic reading activity, DSG is a space where people sit in a circle and share the reading. The gathering is facilitated by the teacher or a volunteer, whose role is not to teach or guide a correct interpretation of the text but to facilitate sharing ideas and joint reflection, assigning turns, and ensuring egalitarian dialogue. Beforehand, the participants read the text or the selected pages of the book.

While participants read the text to prepare for the gathering, each participant highlights a paragraph and writes down the reason for his/her choice. Then, during the DSG, the participants read the paragraph or paragraphs they want to share with the rest of the group. Firstly, s/he says on which page of the text the paragraph is so that the rest of the participants in the DSG can follow the reading. Secondly, s/he reads aloud his/her paragraph. Thirdly, s/he explains the reason for his/her choice, opening the floor for other participants to ask questions or adding more reflections about that paragraph and always prioritising the persons who participate less often.

Previous research has highlighted how experiential education fosters scientific literacy by relating science to participants' life experiences, encouraging their active participation in scientific enquiry by learning science by doing science (Aikenhead, 2006; Waldrop, 2015). Scientific literacy involves teaching science to all, without exclusion, so that citizens can construct their own opinions based on objective facts and participate responsibly in decision-making processes on issues that affect their lives. In this regard, the study conducted with adolescents by Salvado et al. (2021) showed that interventions based on science workshops had a positive impact on participants by increasing their knowledge about the existence of scientific disciplines that they were previously unaware of and improving their view of science, making them see science in a more realistic, functional, complex and interconnected way. In the same vein, previous research shows the relevance of egalitarian dialogue to building trusting relationships, minimising social disadvantages, and contributing to reversing inequalities (Oliver et al., 2011). Following this evidence, the participation of scientists in science workshops is relevant, as it contributes to the premise of making science with and for society (Soler and Gómez, 2020).

Methodology

The main objective of this study is to analyse the impact that scientific literacy activities (DSG and scientific workshops) in prison had on the participants. The present study follows the Communicative Methodology (CM), which is based on promoting egalitarian dialogue between the different social actors involved in the research (Gómez et al., 2011) oriented to overcoming inequalities. Researchers contribute by providing available and updated scientific knowledge, while those being researched contribute with their experience related to the situations or issues being analysed to build collective knowledge (Gómez, 2019). Intersubjective dialogue between the various actors throughout the project lifespan is one of the most effective strategies to promote the social impact of the research (Aiello et al., 2021). Specifically, based on CM, the social impact of Successful Educational Actions in different vulnerable educational environments has been extensively analysed (Gómez, 2019; Roca et al., 2022; Vieites Casado et al., 2021; Álvarez-Guerrero et al., 2021), also in the context of prisons (Alvarez et al., 2016).

The CM proved to be the most suitable for the development of this study for two fundamental reasons: its orientation towards

social transformation and the joint interpretation of reality achieved when it is applied. Social transformation becomes possible when research is carried out with and for the participants, making them participants through an egalitarian and intersubjective dialogue in the different research phases. The application of CM helps in transformative processes because it fosters processes of co-creation of knowledge among all participants (Ruiz-Eugenio et al., 2021). Therefore, CM is the best option to work with people deprived of their freedom and who have been habitually excluded from society since otherwise it would be tough to achieve personal transformation processes among them.

Study context and participants. The study was conducted in a prison for men in Catalonia (Spain). Within the prison is an adult school, which is the context in which the workshops and dialogic scientific gatherings (DSG) take place. The scientific literacy activities analysed in this article occurred between February and April 2022. The participants were all people living in prison and participating in adult school. Concretely, the sample was 19 men, from 29 to 44 years old. The teachers from the adult school in prison were previously contacted to be informed about all planned activities and the project, and they received two training sessions. In these sessions, members of the research team explained the principles and the scientific basis of dialogic learning and DSG, as well as the relevant methodological aspects for its implementation. All activities were carried out in parallel in two groups of school participants. The sessions were organised in four thematic blocks, each containing between one and three DSGs and one or two workshops conducted by a researcher expert. The same researcher who conducted the workshop was the one who proposed the scientific articles that were previously discussed in the DSG about the workshop s/he would be leading. Teachers and students in prison specified the number of texts to be read before the workshop. Most of the articles in English were translated by the project's research team. Then, the researchers in charge of each workshop validated the translation to guarantee the use of proper domain-specific terminology. Participants read the articles in their cells and prepared the DSG; individually, they marked excerpts they wanted to share with their companions in the discussion. This was followed by the DSGs, where the participants shared and discussed their ideas. A total of 21 DSGs were carried out between the two groups of people living in prison (Group 1: 10 DSGs and Group 2: 11 DSGs). After the discussion, workshops related to the texts were held to investigate the subject. A total of 12 workshops were held, six in each group. In this line, the researchers also provided complementary resources such as links to conferences, videos, or articles to complement their learning. Table 1 details the organisation of each thematic topic.

Data collection and data analysis. The data reported in this article include two different instruments: in-depth interviews and observations. Firstly, researchers collected data using 15 observation tables of the DSG. All information included in these tables was interpreted by researchers, giving powerful information regarding the development of the DSG. The observations were carried out using a semi-structured table. Qualitative and quantitative information was collected from a series of items to assess and evaluate how the DSG had developed. At the end of the table, there was a free space to add any information considered necessary by the observer. In some cases, the debate on the same article lasted more than one day, and the same observation table was used. For this reason, the number of observation tables is lower than the number of sessions, but all sessions were observed. Secondly, ten semi-structured interviews were carried out, eight

with participants (see profiles in Table 2) and two interviews with the teachers of the penitentiary centre.

Of the 19 people in prison participating in the DSGs and workshops, with the only condition of participating in the activities, eight freely decided to join the interviews. The participants provided their consent. The interviews explored the students' and teachers' opinions and experiences regarding implementing these scientific literacy activities in prison. The entire project development has ensured compliance with ethical requirements, such as obtaining informed consent from all participants. It should be noted that the anonymity of the participants was guaranteed in all phases of research, and pseudonyms have been used to ensure privacy (more information in the Ethical Statements section).

All interviews have been transcribed for their analysis. A system of categories was created deductively following the topics identified in the scientific literature, which guided the project's development. Four categories were created to identify the potential impacts of the scientific literacy activities on the participants. Following the principles of the communicative methodology (Gómez et al., 2011, 2019), these categories were divided into exclusionary and transformative dimensions. In this case, the exclusionary elements are those barriers that people living in jail face related to learning. At the same time, the transformative dimension includes those elements that help to overcome these barriers (see Table 3).

Results

The results obtained are organised into three subsections to show the impact of the DSG and scientific workshops on prison participants. First, we present evidence of how the DSG allowed the people who experience incarceration to participate in high-level scientific activities and how it motivated them. Secondly, we show how participation in these scientific activities awakened their desire to participate and changed their previous perception of science. Moreover, finally, we analyse the opportunities for personal and social transformation generated due to the dialogue between the agents, including other colleagues in prison, teachers, or family members.

Engaging people living in prisons in scientific activities. Only one of the prisoners interviewed in this study had undertaken studies beyond the compulsory level. However, Xavier, when asked if he would like to continue studying, said, "I think I still have time." In Manuel's case, he said that he was planning to study law. Not all the interviewees show interest in continuing their studies, inside or outside prison, but they all see the correlation between the degree of academic studies and the social stability they desire. For example, Lilian points out: 'Given the events related to the pandemic and the 2007 financial crisis, my life would have been more stable had I pursued a career as a civil servant or a teacher.' They highlight education as a critical element to escape poverty and secure a more hopeful future. When asked about their situation and whether they had considered pursuing academic studies linked to scientific careers, they answered that they had never considered it. Along these lines, José points out that the most important thing for him when he gets out of prison will be looking for a stable job and having something to get by. However, when analysing the exclusionary dimension, we observe that negative stereotypes associated with their prisoner status and low levels of previous studies persist, limiting their possible dreams about pursuing scientific careers.

The prisoners interviewed have in common that they had not previously shown interest in scientific activities, for example, in the words of Xavier: "I had never considered participating in

Table 1 Structure and schedule of the activity.

TOPIC 1. Palaeolithic: human evolution, cultural and biological milestones.

Research group	IPHES—Catalan Institute of Human Palaeoecology and Social Evolution	
Scientific workshop	Two workshops in each group	
Selected articles		Dates group 1: 28/2/22; 07/3/22
Haber M, Mezzavilla M, Xue Y, et al. (2016) Ancient DNA and the rewriting of human history: be sparing with Occam’s razor. <i>Genome Biology</i> 17(1):1–8 https://doi.org/10.1186/s13059-015-0866-z .		Dates group 2: 31/1/22; 4/2/22; 7/2/22; 18/2/22; 21/2/22; 11/3/22
Jensen TZ, Niemann J, Iversen, KH et al. (2019) A 5700-year-old human genome and the oral microbiome from chewed birch pitch. <i>Nature Communications</i> 10(1):1–10 https://doi.org/10.1038/s41467-019-13549-9		

TOPIC 2. The evolution of living organisms

Research group	Group of Didactics of Experimental Sciences and Researcher of the Department of Specific Didactics (Universidad de Zaragoza)	
Scientific workshop	Two workshops in each group	
Selected article		Dates group 1. 21/3/22; 23/3/22; 28/3/22
Aguilar C (2019) Evolution in a bottle. <i>Front Young Minds</i> 7(75). https://doi.org/10.3389/frym.2019.00075		Dates group 2. 18/3/22; 21/3/22

TOPIC 3. Climate change

Research group	Researcher of the Dept. of Physical and Inorganic Chemistry (Universitat Rovira I Virgili)	
Scientific workshop	One workshop in each group	
Selected articles		Dates group 1. 19/2/22; 24/2/22; 26/02/22
Kim L, Jeong J (2021) Bats, blood, and the biology of iron: it is all about balance. <i>Front Young Minds</i> 9(575121). https://doi.org/10.3389/frym.2021.575121		Dates group 2. 1/4/22
Talley L (2021) Global ocean climate change: observing from ships. <i>Front Young Minds</i> 9(495240). https://doi.org/10.3389/frym.2021.495240		
Trascasa-Castro P, Smith C (2021) What can we do to address climate change? <i>9(672854)</i> . https://doi.org/10.3389/frym.2021.672854		

TOPIC 4. Surrounded by science, technology, engineering, and mathematics

Research group	Researcher at the Department of Chemical Engineering (Universitat Rovira I Virgili)	
Scientific workshop	One workshop in each group	
Selected articles		Dates group 1. 25/4/22; 27/4/22
Vera L, Wooding S (2017) Taste: Links in the Chain from Tongue to Brain. <i>Front. Young Minds</i> . 5(33). https://doi.org/10.3389/frym.2017.00033		Dates group 2. 22/4/22

Table 2 Profiles of person who is incarcerated’ interviewees.

Pseudonym	Age	The highest level of education achieved in the Spanish system
Philip	25-29	Compulsory Secondary Education (he entered prison with the third year of compulsory secondary education (14 years) and finished compulsory education in prison).
Diego	25-29	Compulsory Secondary Education (16 years)
Xavier	35-39	Compulsory Secondary Education (16 years)
Manuel	35-39	Post-Compulsory Secondary Education (18 years)
Lilian	35-39	Primary education (12 years)
Marcos	40-44	Primary education (12 years)
Juan	40-44	Compulsory Secondary Education (16 years)
José	40-44	Compulsory Secondary Education (16 years)

scientific activities before.” However, once the scientific activities started, the motivation to participate was one of the shared topics raised by the participants and highlighted by the two teachers interviewed. One of the teachers interviewed notes: “My students

are not always punctual; I call them at 9:15 am, and they arrive at 9:30 am. However, on the days when I was preparing for the dialogic gatherings, they were waiting for me in front of the door” (Marta). Furthermore, she adds that in some cases, new students were waiting for her at the door to sign up and, surprised, asked her: “Are you the teacher? They told me you do something related to science that’s never been done here” (Marta). Similarly, José explains: “I told him (the teacher) that I wanted to try the talks (DSG and workshops) to see if I liked it or not. And then I went one day to try it out, and I was one of those who have never missed it”. Xavier is also among the participants who expressed high motivation for the scientific literacy activities: “Last Monday, I recommended to a colleague that he should attend the classes.”

New members were always accepted to broaden ‘prisoners’ participation and respond to their manifested interest, although the workshops had already started. The only requirement was that they committed themselves to regular attendance. Unlike other activities organised in the penitentiary centre, the workshops and the DLG had the particularity that, in the end, they were not given a diploma or a specific certificate as in other cases. However, this was not a handicap as many students showed

Table 3 Table of analysis of the results.

	Academic expectations	Science learning	Communicating science in highly vulnerable environments	Motivation for learning
Transformative dimension	1	3	5	7
Exclusionary dimension	2	4	6	8

interest and regularly participated in scientific activities; they wanted to join because of their interest in learning. In Magda's (teacher) words:

But more people who had not previously participated have signed up, and they know that no degree or diploma will be awarded. They joined "only" because of their interest, which has been very interesting, not to have this pressure that sometimes they must take the subjects from here. It was very different for them, especially because they were motivated. Some of them were participants from other courses.

Bringing science closer to all. The project aimed to promote a more inclusive scientific identity among vulnerable populations. In this regard, the project also aimed to build the scientific capital of vulnerable people through scientific literacy activities, focusing on expectations towards science and changes in the perception of science. The different quotes from the interviewees show how the prisoners have improved their learning due to the scientific topics addressed in the sessions. Teacher Marta noted, "Students had improved their oral expression a lot; previously, it was much more challenging for them to express themselves." As well as improving their oral expression through presenting their ideas and debate, they have also improved their scientific knowledge. A specific example is when the IPHES researcher, Miquel Guardiola, spoke to them about the species that preceded *Homo Sapiens* in understanding human evolution. Along these lines, Professor Magda comments:

This topic [human evolution] prompted them to consider certain things they had not considered before, and they discussed it extensively. Even the history teacher approached me and asked: What kind of classes are you teaching them? Because they are telling me things that not even, I know as a history teacher, they have come to say that they are no longer called hominids but hominins. Moreover, I have noticed that they remember and discuss these topics in class.

The interviewees emphasise that individually or on their initiative, they would not have read the articles or been interested in participating in the workshops a priori. Along these lines, Juan points out: "I would not have read it outside; it does not make me laugh. But I did read it, and I found it fascinating". At first, the teachers played a crucial role in encouraging the participants, talking to them, and explaining the relevance of this activity with quality educational actions. However, as shown in the previous point, the participants showed interest once it started. From the discussions held in the sessions, both in the DSG and the workshops and from the interviews, it can be seen that they had a biased view of science. First of all, in many cases, they associated science with very complicated subjects that were difficult to understand. However, we can see how this perception is overcome after the DSG and the workshops. For example, José says: "Well, I have found it a bit easier than in school." This statement can be related to the dialogic dynamics implemented, as the content was not more superficial than in primary and secondary school. Secondly, their view of the work of scientists has been transformed into a more realistic and interconnected

view of their reality. He stated that they are now more aware of the value of science for society. In this vein, Juan explains that he had a perverse perception of science, arguing that many scientific advances could be used to harm citizens themselves. Now, once they know what science means, he says, "I see that there are people who use science for the greater good. I have seen people who do things for science, but for the worse, and I was not convinced, so I did not read about them".

From the interviews and observations, the participants in this research acknowledged the importance of the advances in science and the relevance of scientific topics. When the interviewees were asked about the workshops and DSG, they responded that they found them "interesting"; another adjective used to define them was "curious." Along these lines, Marco notes: "I liked them. You discover curious things that you had not previously paid much attention to". Alternatively, as Manuel explains, the scientific workshops provide answers and explanations you did not know. He points out: "Of course, there is an explanation for why and how this fermentation is obtained. It is due to a bacteria...". In short, the results show that through the workshops and the DLGs, there is a change in the perception of science. The participants know its relevance in explaining the facts around us and that they can also participate in this knowledge.

Transforming conversations through science. From the fieldwork, we observed that this scientific activity impacted the incarcerated participants from an instrumental dimension—learning scientific concepts—and from the diversity of their interactions—giving meaning to their participation in this scientific activity. The teachers emphasise the positive interactions established around the readings and the workshops, and Marta specifically pointed out: "I believe it has made them become non-prisoners again." Along the same line, one of the prisoners, Mario, emphasised: "And we are human too, [...] they [researchers] are interested in us, and they make use of this opportunity to learn is a good thing". In the scientific workshops and the DSGs, egalitarian dialogue prevailed based on claims to validity, not power. In this context, the interviewees also emphasised the learning interaction with scientists. José said: "... I did not understand it, but he explained it to me again, and in the end, I understood it".

The prisoners state that most interactions they establish in prison are related to court cases and trials, and participating in these dialogic literacy activities provided new shared spaces and dialogues. For example, one of the prisoners, Juan, commented that sometimes they read the articles with other prisoners participating in the workshops. Along these lines, about the preparation of the dialogic scientific gathering, José noted: "I have nothing else to do, so I had to take it [the text] with me, look at it, and read it to myself. Furthermore, when I was with the maintenance crew, I had comments on it, and sometimes three or four of us would get together and discuss it". This shows that new dialogues were established not only between prisoners but also between prisoners and prison workers. Specifically, the civil servants who transfer the prisoners highlight their interactions on the way to and from the DSG; surprised, they told the teacher, "All the way there, they talk about what they have discussed." We

can see, then, how participation in these activities generates new possibilities for dialogue.

Not all of them have shared it when asked if they have talked about it with their families. Some of them justify that they have a little family environment and would not be interested; others say they have little time to talk about it, but those who have shared it show the impact generated. José said they were surprised when he explained to his sister-in-law and wife that he was participating in science workshops. He also said that he had changed his perspective of himself and has passed this on to his family. Another interviewee, Manuel, highlights the relevance of what he has learned for his children, arguing how he can now help them with homework related to the areas seen in the gatherings and workshops, demonstrating his confidence in certain scientific concepts. Another example is Diego, who, when asked if he explains that he is doing scientific training in prison, points out: “I explain it to my little brother, and I tell him: if you want to study, it is never too late to do so. Moreover, there are plenty of opportunities out there.”

As an exclusionary factor in the study, we have found that the idea persists that science is a discipline that requires much effort and that scientific careers are far from reality and their abilities. Despite this, the people interviewed feel that they, too, can learn from a quality education with high expectations. Specifically, José describes his change of perception about science and says, “I enjoyed learning new things, seeing myself capable. Yes, I see it now, and the truth is I have started to like it.”

Discussion and conclusion

Previous scientific literature has shown that economic inequality can negatively impact academic outcomes (Cross et al., 2018; Williams et al., 2017; Gustafsson et al., 2018). Similarly, socioeconomic status is an influencing factor in participation in scientific activities (Lee, 2016). Additionally, previous research highlights the low educational levels of incarcerated people (PIAAC, 2014). However, despite these barriers, previous research has also demonstrated the existence of transformative actions in all educational contexts, including prison (Evans et al., 2017). The scientific literature has shown that dialogic gatherings, particularly dialogic scientific gatherings (DSG), can be transferable to penitentiary institutions and promote positive personal and social benefits among participants. The study presented here shows that the impacts of dialogic scientific gatherings (DSG) align with previous studies of DLG in prisons (Alvarez et al., 2016). However, the contribution is relevant because of advanced knowledge. This is the first study that captures the impact of DSG and the application of scientific activities in prisons so that this evidence can inspire future research.

Firstly, concerning science-related learning, our study shows how the participants had yet to previously could participate in scientific activities, and the DSGs and workshops were their first contact. Their active participation in the DSGs and workshops made them feel science closer and overcome the belief that it was not for them. In this line, previous research remarks that to participate in fully democratic societies, scientific literacy is critical (Diez-Diez-Palomar et al., 2022). For this, the cornerstone is overcoming the view that science is only for one part of society (Lee, 2016). The activities conducted and analysed in this study demonstrate that bringing science closer to all people, including the traditionally excluded population, is possible. This study highlights the relevance of disseminating science in highly vulnerable environments such as prisons. Through their participation, they overcome their biased view of what science is and highlight its usefulness in understanding the world in which we live.

Secondly, the results highlight the relevance of the dialogic context (Searle and Soler, 2004; Flecha 2000), based on the egalitarian dialogue between participants, with teachers and scientists based on claims of validity promoting that everyone has an active role. Our results highlight the impact of the DSG in creating opportunities for dialogue and communication between the participants based on dialogical interactions. Participants understand science’s relevance by discussing scientific articles and participating in workshops conducted by renowned researchers in their fields based on egalitarian dialogue. Additionally, the dialogue with the researchers and the articles read and discussed in the DSG motivates them to perceive science as a more relatable and valuable topic for understanding the world and engaging in more science activities. In these dialogues, in-depth discussions and debates relating to their knowledge and personal experiences are shared, with a transformative approach that increases their self-confidence to participate in scientific activities. This shows the impact of doing science activities with high expectations, activities that improve the competencies they will need upon release from prison. The activity developed in this article demonstrates how educational interventions can be generated that enhance the sense of agency to transform one’s life trajectory (Alvarez et al., 2016; Evans et al., 2017). These scientific literacy activities provide transformative learning, from which the incarcerated participants feel more like citizens (Vaccarino and Comrie, 2010); in this regard, in the interviews, they emphasise that thanks to the DLGs and the scientific workshops, they feel “humans”.

In sum, the results show that people living in prison were motivated to participate in these scientific literacy activities, which foster their awareness of and interest in science, give meaning to their learning and transform their interactions in and out of prison. However, the long-term effect on their lives and families is unknown and should be explored in future research. Therefore, future research lines could be the continuation of scientific activities in the context of Successful Educational Actions to analyse the impacts of these actions and further research on this long-term effect.

Limitations and potential directions for future research

There may be some limitations of the study. The primary limitations derive from the topic’s novelty and from being a specific case study. Firstly, it should be noted that it was possible to carry out all the planned activities, but in a COVID context, some of the workshops were online, and it would have been more interesting to do it in person. Nevertheless, the DSGs were all carried out face-to-face.

In the short term, the DSG has positively impacted the participants, but we need to explore the impact of DSG in the medium and long-term way. At this point, it would be of great interest to be able to develop longitudinal research with a follow-up over time. The long-term effect of DSG on their lives and families is unknown and should be explored in future research. In that line, a future line of research is to continue collecting data on implementing the DSG and other Successful Educational Actions in prisons to study its transferability and social impact in the short, medium and long-term to counteract social exclusion.

Data availability

The datasets analysed in this paper are not publicly available, as participants in the study have been promised confidentiality, but they are available (in anonymised form) from the corresponding author at reasonable request.

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Author contributions

Conceptualisation and supervision: AGG. Material preparation and data collection: MTNM and LJE. Writing—original draft: TMF. Writing—review and editing: MTNM and LJE. Supervision: SMR. Funding acquisition: AGG. All authors have read and agreed to the published version of the manuscript.

Competing interests

The author declares no competing interests.

Ethical approval

All procedures performed in studies involving human participants followed the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the CREA ethics committee reference number 20230115.

Informed consent

Informed consent was provided in Spanish (their language). Besides, all participants have informed consent with the primary information about the project's results, activities, and expected outcomes and impact. In all cases, research participants had time to read the consent form and ask the researcher questions. Explanations were given by the researcher when necessary, and contact information will be provided to share any query with the researcher time. The information provided in the consent form explained the study's objective, the voluntary nature of participation, the possibility to withdraw from the study at any time, the procedure to collect the data, the materials and measures to be used, and the anonymity and privacy statement. Informed consent was obtained from all participants.

Additional information

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