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Adolescents in Care Are Also Interested in Science: Impact of Extending Learning Time Through STEM Actions

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Abstract There is a large body of scientific literature documenting educational inequality affecting children in care and unequal access to supportive environments and role models linked to science, technology, engineering, or mathematics (STEM). However, fewer social impact studies have been conducted to show how to overcome this barrier. This research introduces an extended learning time intervention based on dialogic scientific gatherings (DSG) around different STEM topics followed by training sessions with scientists on human evolution, palaeo-ecology, physics, and chemistry. The study was carried out in a residential care environment involving adolescents ($N=9$) aged 17–19 years old and social workers ($N=5$), and it is framed within communicative methodology (CM) through communicative semi-structured interviews conducted with all participants involved in the project ($N=14$). From the

In Memoriam: We dedicate this article to Miquel Guardiola-Fígols, who was deceased at the end of this work and was implicated in the whole process, deeply impacting the lives of the adolescents involved in this research to whom he managed to transmit his passion for science and the desire to follow in his footsteps.

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participants' voices and their social workers' perceptions, the results allow us to assert that adolescents in care are also interested in science when successful evidence-based actions are implemented. This research describes specific actions that can contribute to overcoming educational inequality by opening up possibilities for access to STEM careers for adolescents in care.

Résumé Il existe une abondante documentation scientifique portant sur les inégalités en matière d'éducation qui touchent les enfants confiés au système de soins en résidence et sur l'accès inégal aux milieux techniques liés aux sciences, à la technologie, à l'ingénierie ou aux mathématiques (STIM). Cependant, rares sont les évaluations des répercussions sociales qui montrent comment surmonter cet obstacle. Dans cette recherche, nous présentons une intervention fondée sur le prolongement du temps d'apprentissage qui s'appuie sur des « Dialogic Scientific Gatherings (DSG) [en français, des événements scientifiques axés sur le dialogue]» portant sur différents sujets liés aux STIM, suivies de séances de formation avec des scientifiques sur l'évolution humaine, la paléoécologie, la physique et la chimie. On a mené l'étude dans un environnement de soins résidentiels impliquant des adolescent(e)s (N = 9) âgé(e)s de 17 à 19 ans et des professionnel(le)s du travail social (N = 5). L'étude s'inscrit dans le cadre de la méthodologie communicative (MC) et s'appuie sur des entrevues semi-structurées communicatives menées auprès de tous les participant(e)s impliqué(e)s dans le projet (N = 14). À partir des témoignages et des perceptions de toutes ces personnes, les résultats nous permettent d'affirmer que les adolescent(e)s placé(e)s en soins en résidence s'intéressent également aux sciences lorsque des actions fondées sur des données probantes sont mises en œuvre avec succès. Dans cette recherche, nous décrivons certaines actions spécifiques qui peuvent contribuer à remédier aux inégalités en matière d'éducation en ouvrant des possibilités d'accès aux carrières dans les STIM pour les adolescent(e)s bénéficiant de soins en résidence.

Keywords Residential care · Successful educational actions · Extended learning time · Dialogic scientific gatherings · STEM · Science literacy

Introduction

Children and adolescents in care settings face increased vulnerability to mental health issues and developmental challenges compared to their peers (Lou et al., 2018; Mendelsohn, 2015). Foster care institutions may provide both support and harmful experiences, occupying an ambiguous space in children's lives (Pessoa et al., 2018). Research consistently shows that children and adolescents in out-of-home care face significant educational challenges compared to their peers. Youth in residential care are particularly disadvantaged in terms of academic outcomes and school experiences (Montserrat & Casas, 2018; Benbenishty et al., 2018). One of the greatest challenges for institutional child protection systems across Europe is to favour a broader approach focused on school achievement as a key to breaking with educational inequality, promoting the transition to adult life and contributing to the social inclusion of this population at risk (Salvadó et al., 2021). However, there are few research and interventions aimed at improving the school achievement of young people in care (Tordón et al., 2020). To fill this gap, the scientific literature presents the successful educational actions (SEAs). The SEAs were identified in the European large-scale project 'INCLUD-ED Consortium. Strategies for Inclusion and Social Cohesion in Europe From Education' (European Commission, 2006–2011) through research involving more than 100 researchers from 14 European countries. SEAs are those actions that increase academic success and contribute to generate social cohesion in any context where they are implemented.

This approach is having a collected educational and social impact on the academic improvement and socio-emotional well-being of children and young people in care (Gairal-Casadó et al., (2022). There is already strong evidence that implementing SEAs with institutionalized children and adolescents has

a positive impact on their academic and professional perspectives by extending learning time through these high-quality practices (Gairal-Casadó et al., 2019, 2022). One of the most researched actions is to extend learning time through dialogic reading, which is contributing to reversing the adverse impacts of institutionalized placement, increasing academic achievement, and raising the academic expectations (Natividad-Sancho et al., 2024) also taking into account the impact of the expectations of the professionals (Rainey et al., 2019). Another action for improving the scientific identity, scientific capital, and educational aspirations of this population are science workshops (Salvadó et al., 2021). This action, which includes dialogic reading, gives children a realistic view of science and helps them to achieve high expectations and to perceive a career in science as more accessible. In turn, these interactive learning environments have been researched in a variety of contexts to overcome inequalities with positive results as promoters of violence prevention, improving socio-emotional well-being and mental health, or building positive interpersonal relationships (Elboj-Saso et al., 2021; Fernández-Villardón et al., 2022; Morlà-Folch et al., 2022). Finally, focusing on scientific literacy through SEAs, this is promoting social inclusion and decreasing the vulnerability of at-risk populations throughout the employment of scientific knowledge in their daily lives (Díez-Palomar et al., 2022).

This article explores the SEA called extended learning time, an inclusive action that provides extra learning opportunities and support sessions beyond standard school hours (Gairal-Casadó et al., 2019). The way in which the extended learning time is developed in this intervention is through dialogic scientific gatherings (DSG) and scientific workshops with the aim of increasing the interest in science, technology, engineering, or mathematics (STEM) fields.

Extending Learning Time Through STEM Actions

Extended learning time implies the provision of additional learning activities and academic support outside school hours. It aims to provide more opportunities to make progress and to encourage academic development (Natividad-Sancho et al., 2024). This action has a profound impact on the learning and socio-emotional well-being of children in care (Gairal-Casadó et al., 2019, 2022; Gómez-García, 2022; Salvadó et al., 2021). Along these lines, previous studies on the relationship between learning time and academic achievement have shown a positive and statistically significant correlation between the number of minutes of instruction students receive each academic year and their scores on standardized tests in school (Jez and Wassmer, 2015), so this is an effective measure as a complementary support to promote academic success (Smith et al., 2005). Moreover, recent research highlights how university-based STEM outreach initiatives aim to engage underrepresented and underserved youth populations in extended learning contexts, reinforcing the value of structured out-of-school learning opportunities as a way to enhance educational equity and long-term interest in science (Compeau, 2023).

In order to reinforce learning to ensure that no child is left behind, research has showed that there are numerous ways of extending learning time through inclusive practices outside the classroom: review classes, consultation hours, or extended-day groups (Gairal-Casadó et al., 2019). In this study, it has been carried out through two main science actions: DSGs and, subsequently, by holding scientific workshops facilitated by research volunteers from different scientific disciplines. In the DSG, participants read and share scientific articles published in journals indexed in the main international databases. This practice involves not only reading and understanding the text, but also training oral argumentation skills for science learning through egalitarian dialogues that increase participants' scientific understanding, vocabulary, and critical thinking (Díez-Palomar et al., 2022). In the case of DSGs, opening up additional spaces to participate in workshops with real scientists has a positive impact on academic and professional perspectives (Gairal-Casadó et al., 2019). In both cases, not many extra resources are needed. The DSGs

involve the participation of educators and social workers who work in the group homes and are in charge of moderating the DSGs, i.e., ensuring equal speaking turns and equal participation of adolescents and young people. In the scientific workshops, the involvement of the researchers who are members of the project team was also the resource that facilitated their implementation.

Methodology

This work is framed within the communicative methodology (CM) that stresses the egalitarian dialogues between the scientific community and the participants in the research (Gómez-González et al., 2010, 2019), enhancing social impact and aligning research objectives with agreed goals for the advancement of humankind like the Sustainable Development Goals (SDG) (Gutiérrez-Fernández et al., 2024). This intervention especially impacts on SDG4 'Quality Education' and SDG10 'Reduced inequalities' by implementing actions that have already demonstrated an impact on the production of relevant and effective learning outcomes that support the academic trajectory of participants (Díez-Palomar et al., 2022; Guardiola-Fígols et al., 2024; Natividad-Sancho et al., 2024).

This methodology has been effectively implemented across various projects associated with the European Commission Framework Program, which acknowledged it as one of the best approaches for analysing the circumstances of the most disadvantaged social groups (Gómez-González et al., 2010, 2019), including the adolescents and young people who live in group homes who have participated in the current study.

The qualitative study is part of a broader research project called 'Extended Learning Time IV: Contributing to the generation of scientific vocations in residential care' (2021–2022), funded by the Spanish Foundation for Science and Technology of the Spanish government. Previous research has already identified that SEAs are contributing to increasing interest in STEM areas and educational improvement (García-Yeste et al, 2017); however, in this study, we deepen the analysis of the educational interventions of the DGS linked to science workshops in bringing science closer to the young people in care, focusing on the impact it has had on their motivation for STEM, improving and increasing their educational learning and increasing future expectations to develop a profession linked to science.

Through these interventions, we respond to some of the main competencies of a professional in this field, such as intervening with vulnerable groups and contributing to their social integration and welfare, thus providing new knowledge applicable in the field of social work. More details on this connection will be provided in the 'Discussion and Conclusions' section.

Participants

The group home engaged in this study is an out-of-home care resource for adolescents and young people between 15 and 21 years old, in a situation of lack of protection or at risk of social exclusion, without serious psychological pathologies and without family burdens, who cannot remain in the family or foster care environment. The study also involves an educational team of four social workers, two educational assistants, and the resource manager. This resource is located in an urban area of a city in northern Spain and has ten places divided into two connected flats within the same building, where the adolescents and young people are placed according to their educational level. Admission to the resource is structured in four phases: (1) When the children join the project, they are introduced to the space, the educational staff, and the other companions, as well as the rules and timetables of the group home. (2) The young person and her reference educator jointly set work objectives through an individual interview. (3) Socio-educational intervention and short- and medium-term objectives are defined in programmes according

to the needs detected. (4) The last phase is autonomy, when the objectives have been met and enough tools have been acquired to start the exit.

The study involved all the people implicated in the project, nine adolescents and young people, eight girls and one transgender boy aged between 17 and 19 years old, all of whom entered the girls-only centre between 2018 and 2022. Five of the participants are currently involved in vocational training, one is in the first year of Bachillerato (upper secondary education), another is in the first year of university, one is in the last year of secondary education, and finally the last one is involved in a course for unemployed people (Table 1). In addition, five members of the educational team also participated in the study. Three of them are social educators, one is the coordinator, and the last one works as an assistant technician (Table 2).

Intervention

The intervention was carried out in four phases (Fig. 1). Firstly, the research team held a meeting with the social workers. In this session, the project team, the participating centres, and the scientists were introduced, and the impact of the extending learning time, the development of the intervention, and all phases of the research were explained. Secondly, the intervention was initiated through DSGs in which the participants read and discussed a scientific text. This phase was intertwined with a third phase in which training was planned by the research team and the scientists involved in the project. These sessions followed each DSG intervention so that the participants had already read and discussed the topic and had more tools for understanding and more opportunities to generate discussion and questions for the scientists. In the fourth phase, all fieldwork was carried out by collecting information through communicative-oriented interviews.

Table 3 below provides all the information on phase 2 of the intervention. First, the group read and discussed a scientific article in one session and, in the same month, another session was scheduled in which a meeting with a scientist was held with whom they had the opportunity to dialogue, ask questions, and generate connections between scientific knowledge and different aspects of daily life.

Data Collection Techniques

Semi-structured interviews were conducted to gather data at the end of the project (June, 2022). Two instruments, both semi-structured interviews, were created to explore the perspectives of the social workers and the adolescents and young people involved in the project. The interview for social workers covered topics such as introductory questions, residential environment, expectations for adolescents and young people, the project's impact, and concluding questions. Additionally, a second instrument was developed to interview the adolescents and young people, focusing on areas like introductory questions, perceptions of science, fostering scientific careers, the impact of SEAs, science and diversity, residential environment, and concluding questions. Both instruments were designed to capture participants' perceptions and the project's impact.

The interviews were conducted in a room in the centre, ensuring that the interviewees felt comfortable at all times. The interviews were audio-recorded with a voice recorder, and all interviews were transcribed verbatim by the project research team.

Data Analysis

It was employed to identify the barriers and obstacles (exclusionary dimension), as experienced by the participants, as well as the strategies they utilized to overcome these challenges (transformative dimension) (Gairal-Casadó et al., 2019).

Table 1 Socio-demographic profile of adolescent and young people participants

Code	Age	Gender	Occupation	Educational process	Starting in the centre from
P_TCD2	17	Female	Vocational training (care for people in situations of dependency)	3	2021
P_TCD1	17	Male	1st Baccalaureate	3	2021
P_TCDS2	17	Female	1st university (labour relations)	1	2022
P_TCD3	17	Female	Vocational training (care for people in situations of dependency)	3	2022
P_TCD00	17	Female	Vocational training (business activities)	3	2022
P_TCD007	18	Female	4th secondary school	3	2019
P_TCD01	18	Female	Vocational training (hairdressing and aesthetics)	3	2021
P_TCDT21	19	Female	Carpentry course for unemployed people	4	2019
P_TCDP75	19	Female	Vocational training (pharmacy and parapharmacy)	4	2018

Table 2 Socio-demographic profile of social workers involved in the study

Code	Age	Gender	Current occupation	Seniority in the centre
ET_1	47	Female	Social worker (coordinator)	2002
ET_2	40	Female	Social worker	2007
ET_3	44	Female	Social worker	2004
ET_4	32	Female	Social worker (assistant technician)	2010
ET_5	39	Female	Social worker	2008

The collected data was analysed to identify both barriers and opportunities that could either limit or promote access to scientific knowledge. A coding scheme was developed based on previous studies and the communicative discussions among researchers regarding the data transcripts (Table 4). This coding scheme was applied by researchers to review and discuss the data, following an egalitarian dialogue in line with the communicative methodological approach. The category called *Scientific literacy attitudes* contains three subcategories according to the OECD Report (2013) for Programme for International Student Assessment (PISA) 2015. Here, we have included the data collected from the interviews that show two of them, the *interest in science and technology*, that which is not only enjoying learning, but also appreciating the personal value of science, showing motivation for science-related activities or even considering a career in STEM areas in the future. *Appreciating scientific approaches to research* involves identifying, supporting, and valuing the research procedures that participants have read and discussed (OECD, 2007). Next, the category *Academic improvement, motivation, and expectations* includes elements that can contribute to improve young people's and adolescents' formal learning, such as enhanced competences in the use of language and academic vocabulary, increased motivation towards learning science, and increased academic expectations.

Ethical Considerations

The project was approved by the Ethics Committee of the Community of Researchers on Excellence for All (CREA) (reference 20231112).

All the participants in the research were informed of the purposes of the research and personally signed an informed consent form, including the possibility to revoke it at any stage of the study. Also, it was ensured that the data treatment would guarantee participants' anonymity using codes. It is important to stress the importance of anonymizing all information that could identify the participants. Apart from that, consent was also obtained from the Institute of Social Services of the government of the region.

Results

The results obtained are organized in three sections below. The first describes the *exclusionary dimensions* that reflect the barriers that make achieving the aspects of scientific literacy attitudes difficult. Barriers allow us to know in depth those elements that impede access to science for adolescents and young people. After that, the transformative categories that contribute to overcoming these barriers are presented. The first one refers to the transformative dimension aimed at identifying improvements in the participants' *scientific literacy attitudes*, in terms of both increased knowledge and improved attitudes towards science, as well as increased interest and motivation for science. *Academic improvement* is

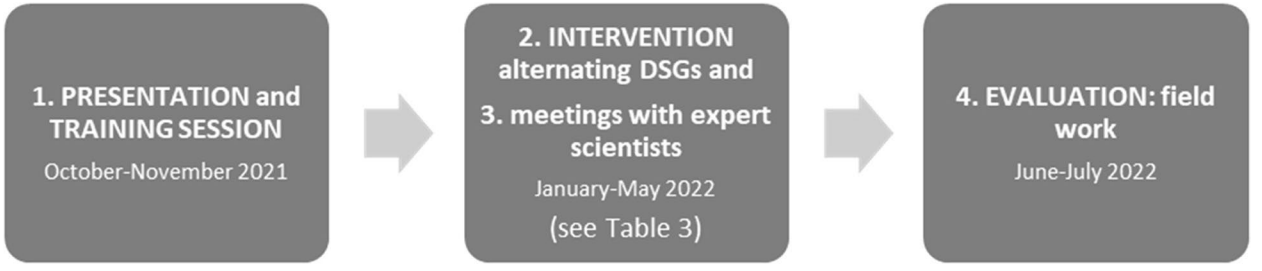


Fig. 1 Intervention phases from the beginning of the research to fieldwork

Table 3 Topics covered in each session: DSGs and meetings with scientists

Date 2022	Article	Core concept
January	**DSG1** - Kashuba et al. (2019). Ancient DNA from mastics solidifies connection between material culture and genetics of mesolithic hunter–gatherers in Scandinavia. *Communications Biology, 2*(185). https://doi.org/10.1038/s42003-019-0399-1 **Meeting with scientist 1**, head of the Catalan Institute of Human Paleoecology and Social Evolution (IPHES)	Human evolution, palaeo-ecology, archaeology
February	**DSG2** - Kim, L. J. & Jeong, J. (2021). Bats, blood, and the biology of iron: it is all about balance. *Frontiers for Young Minds, 9*(575121). https://doi.org/10.3389/frym.2021.575121 **Meeting with scientist 2**, member of the Catalan Institute of Chemical Research	Human health
March	**DSG3** - Vera, L. A. & Wooding, S. P. (2017). Taste: links in the chain from tongue to brain. *Frontiers for Young Minds, 5*(33).https://doi.org/10.3389/frym.2017.00033 **Meeting with scientist 3**, member of the Department of Chemical Engineering at Rovira I Virgili University	Neuroscience and psychology
April	**DSG4 -** Aguilar, C. (2019). Evolution in a bottle. *Frontiers for Young Minds, 7*(75).https://doi.org/10.3389/frym.2019.00075 Additional material consulted: Durland, J. & Ahmadian-Moghadam, H. (2022). Genetics, Mutagenesis. In: *StatPearls* [Internet]. StatPearls Publishing. PMID: 32809354 **Meeting with scientist 4**, Professor of Didactics of Specific Sciences at the University of Zaragoza	Biodiversity
May	**DSG5 -** Knipper, C., Mittnik, A., Massy, K., Kociumaka, C., Kucukkalipci, I., Wittenborn, F., Metz, S. E., Staskiewicz, A., & Stockhammer, P. W. (2017). Female exogamy and gene pool diversification at the transition from the Final Neolithic to the Early Bronze Age in central Europe. *PNAS, 114*(38). https://doi.org/10.1073/pnas.1706355114 Additional material consulted: Introduction to the topic developed by an IPHES Socialization Technician and adaptation of the article reviewed by a specialist in Human Evolution **Meeting with scientist 1**, head of the Catalan Institute of Human Paleoecology and Social Evolution (IPHES)	Human evolution, anthropology

Table 4 Analysis and categories and subcategories for data collection

	Scientific literacy attitudes		Academic improvement, motivation, and expectations		
	Interest in STEM areas	Appreciation for scientific research	Transfer to the classroom	Motivation	Academic expectations
Transformative dimension	1	3	5	7	9
Exclusionary dimension	2	4	6	8	10

the last aspect approached, which includes academic vocabulary acquisition and other knowledge, an increase in motivation, and an increase of academic expectations.

Barriers to Scientific Literacy Attitudes for Adolescents and Young People in Care

One of the main barriers identified in line with the scientific literature review refers to the inequalities affecting children and adolescents in residential care systems, their previous background, and the consequences on cognitive, emotional, social, and language development (Juffer et al., 2011; Lum et al., 2018; Nelson, 2011; Tottenham et al., 2012):

> Yes, because the population we work with has many deficiencies (…). When they arrive with us, are around 15 and 16 years old and many of them arrive with school failure which, well, we don't really like to call it that, but that's how they come, that's how they come, failures with the... ok? They are people who don't care. Moreover, because of their age, they can't go back to the fourth year of ESO and they get left behind. So, we make a lot of use of Basic Vocational Training to get them back into the system. So, of course, these are people who are very discouraged about their studies, about everything, because apart from the fact that they don't see themselves as capable, they don't see themselves as having the time, right, they are very close to the age of majority, so the experiences they have had in relation to schools have not been very positive. Then we have to take into account that our population are very damaged people. Very, very damaged. We could practically put the word trauma next to the photo of each and every one of them. And, of course, learning also falls apart, it is more difficult for them to assert themselves (ET_1).

It also shows that the transition to independent living is often forced and accelerated for young people in residential care. They receive the message that education is important, while on the one hand, they are advised to enter the labour market as soon as possible, which leads to dropping out of school. In this regard, the educational team states how most of the participants have to work while studying and, although they try to continue their studies for as long as possible, sometimes the situation makes it difficult, especially when it comes to thinking about demanding scientific careers and long-term studies:

> She is very clear; she wants to get out of the group home and earn a living. So, studying science for her is a long way off at the moment. She knows, she knows that she is good at it, but no... it is not among her priorities (…). Then, many times they are the ones who bring us down to reality: "I don't have time, we have to get out quickly, how am I going to survive outside like this? I'm in the first year of my degree, how do I pay for it?". So, since they do not have that type of extra support that could be scholarship policies for this group, not general scholarships! but specific scholarships so that young people in residential care can study (ET_2).

Another institutional barrier refers to the difficulty of transferring these SEAs to other resources, which impedes a greater number of children in care from benefiting from them. One of the educators interviewed expressed this lack of involvement of the public administration to promote such a transfer:

> The thing is that since we started implementing SEAs here, we have always had in mind that other young people from other centers would do it, that it would be offered by the administration for other centers because we see the results! And, furthermore, to... I don't know if it is to remove the stigma that these young people have, but to give them as an orientation, a strength towards higher education (ET_2).

Scientific Literacy Attitudes

Findings demonstrate that the intervention has promoted scientific literacy knowledge by providing participants access to direct contact with science. Firstly, by giving them the opportunity to read and discuss scientific papers and, secondly, by opening spaces for dialogue and debate with scientists. The intervention has helped them to know or understand better the scientific knowledge worked on in the sessions, to become interested in, and appreciate the value of science.

One of the participants' interventions refers to how this scientific knowledge is absent in school curricula and how incorporating it would help them to better understand content related to science. In this case, reference is made to the first DSG on DNA found in a small mass of birch resin that turned out to be a chewed gum thrown by a girl 6000 years ago (Kashuba et al., 2019); and in the DSG2 about the biology of iron (Kim & Jeong, 2021):

> It has helped us to understand many things that we didn't even know could happen, because these things, for example, many of the things we have talked about in the papers, at school they don't talk about these things (...) they don't explain to us what happened with the girl with the chewing gum. Or, for example, about bats, which, in biology classes, they have not explained any of this to us, that is, not even comparable! (...) with bats talking about iron, about the lack of iron or the excess, and that they can die from excess or lack (P_TCD007).

In this way, dialogues emerge that recognize the relevance of epistemic knowledge, its applicability to everyday life, and appreciating the personal value of science. All this in a learning environment in which they also enjoy themselves and where a key element has been the solidarity meeting with real scientists who explain the work they do.

> You learn in the end and you do have a good time because you understand what they are telling you and what you are reading, because reading it without understanding it frustrates me. But when they explain it to you and you read it, you say "it makes sense". Then at the end we go in headfirst, you want to know what, what's next, what else it says (P_TCDS2).

These discussions also led the group to show an appreciation for scientific approaches to research, surprised to see how it managed to extract from such ancient material a DNA sequence that allowed them to learn a lot of information. In this context, participants thought deeply about how much DNA they were leaving in the world and what information would be extracted from them thousands of years from now. Talking about the importance of the body's iron balance in the blood, scientific vocabulary was incorporated into the conversations with words such as 'hepcid' (P_TCD1), the importance of a healthy diet for human life, about conditions such as anaemia (P_TCDT21), or about how certain plants also need iron to survive (P_TCD1).

In addition, there is a perceived increased motivation for science or even considering a scientific career in the future. The educational team also detects an appreciation for scientific approaches to

research even in themselves and an added value of the intervention in relation to the opening up of possibilities for scientific knowledge:

> They have been meeting people who dedicate their whole lives to research (...). Of course, if you don't see it, you don't know it exists and you can never want it. And so, this brings them a little bit closer to this world (…). On the other hand, if you know it, you can think "well, I want to do that too". Then, there it is... you awaken the desire, and the motivation follows (ET_1).

Besides the DSG, an important part of each session, which the participants appreciated, was that the scientists explained to them what they did, what their day-to-day work was like, what kind of research they carried out, and what the aim of their research was (P_TCD3):

> Many of them do not have any scientific reference or do not know any scientist outside of what they study at school, which are usually men, women do not usually know, and seeing close scientific professionals and also learning about their careers... has helped them to approach science as something that can be, and they wanted to visit their laboratories (ET_2).

Academic Improvement, Motivation, and Expectations Through DSGs

DSGs and scientific workshops have proven to be effective in stimulating scientific vocations in an attractive way and raising academic expectations. Results have shown that participants have been able to transfer this knowledge to school, increase their academic vocabulary, their motivation, and their expectations for future studies. So, the intervention has had an impact on the academic development of the participants, who stated that the knowledge gained in each of the sessions was subsequently applied at school:

> What I noticed is that in the DSGs they were more advanced subjects than those at school. So that has helped me, for example, to answer some science questions that were asked in class and no one knew how to answer them (P_TCD2).
> I liked having more information, because then I came to class and the subject came up, so I talked more about it because I had gathered information from the DSGs. So, it has helped me a lot and, above all, I still had an exam, and I got a lot out of the DSG (P_TCDP75).

The educational team even commented that they noticed an improvement in school grades (ET_2). This may be because another essential component in the SEAs is the perceived improvement in argumentation skills, oral expression, active listening, or the acquisition of academic vocabulary. Along the same lines, participants have valued acquiring valid knowledge that allows them not only to participate more actively in school at an academic level, but also in day-to-day life, in conversations with friends, helping them personally, academically, and socially:

> When it comes to speaking, it's not the same as how I expressed myself before the DSGs as it is now. Because there I am, I have noticed it, for example, when I have had oral presentations in class and I had to present a paper, I have also noticed it, not soon after, but now in the last sessions. In the last articles that we were discussing I have noticed, because I gave presentations recently and I have noticed that my way of expressing myself changed and that I felt less nervous when speaking in public, and when speaking to people (P_TCD007).

Other interventions clearly show the motivation that DSGs provoked and how this helped them to become more interested in academic content in their studies or to broaden their knowledge:

> The truth is that it has opened doors for me... yes. Maybe there was a subject about atoms and so on, and I teach these things in class, in the lab, but there were things that didn't. So, I was more interested in them and then, when I went to the lab, I looked for formulas and so on. So, I was more interested and then, when I went to the lab, I looked for formulas and that. I liked the subject of chemistry, laboratory... and this was chemistry and laboratory, but it also awoke my interest in that thing that they look for in the earth, I can't remember what it's called... archaeology! (P_TCDP75).

It also increases self-esteem, as they perceive themselves capable not only of reading a scientific article, but also of discussing it in a group and having conversations on complex topics with real scientists:

> The DSGs always taught you something new, something you didn't know, and in the end, they are a way of learning and I liked it. Partly because of that, because I learned new things and at that moment, I felt very intelligent (P_TCDS2).
>
> Let's see, it encourages concentration, being, thinking, giving opinions… The key is self-esteem and self-confidence. If they see that they are capable of reading it and sharing their knowledge with a person who is an expert and on top of that the expert asks them questions and they also respond with very good judgment and very well, then their confidence increases, their self-esteem increases and that benefits them and helps them when doing anything else (ET_3).

Motivation also increases when supportive relationships are generated that allow a participant with reading difficulties to reach the goal and to participate equally in the DSG:

> Let's see, they [the educational team] helped me... I just... I don't read very well because I'm dyslexic. So, the day I had to read that... it was a show, but I read the whole thing! And as they are long texts, as I don't do it very much... yes, that helps me (P_TCD3).

The educational team values the transformative potential of the intervention, which opens up a horizon of academic possibilities and high expectations that the participants were unaware of and therefore could never have wished for. For example, when it is said that this intervention has managed to awaken hidden interests and to think about what they want to study in the future (ET_1). This is something that all the participants have also stated even as a turning point that could change their lives:

> It's like you don't know anything until you take part in the discussions, you've informed yourself and suddenly you discover that you like it and suddenly you discover that you can study it. That's it, it changes your life (P_TCDP75).

Lastly, social workers also refer to the lack of academic expectations suffered by children and adolescents under guardianship and how this type of intervention helps to recover this crucial dimension:

> If we didn't have these kinds of activities (...), you forget [the academic dimension], because what they want is something else, they don't want to study or want anything at first... so this is like keeping them hooked on academic life (ET_3).
>
> Doing this type of SEAs based on evidence helps us a lot in subsequent work. We understand them better. I really like, above all, to say that it changes our way of looking at them. There are times that no matter how much intervention you make or how much report you read, suddenly, in a DSG, the way you look at that person changes because of something they have said, because of something you have read, because of something... or because of how he said it, because of how he read it (ET_2).

Discussion and Conclusions

One of the biggest challenges for institutional child protection systems across Europe is to encourage a broader focus on educational achievement as a key to breaking educational inequality, favouring the transition to adulthood and contributing to the social inclusion of this population at risk. Despite these barriers, previous studies have shown that extended learning time through STEM actions has a positive impact on the academic and professional perspectives of the population under alternative care (Gairal-Casadó et al., 2019; Guardiola-Fígols et al., 2024; Salvadó et al., 2021). This work is aligned with these previous researches, contributing to promote the interest in STEM areas among groups usually excluded from this field through SEAs responding to the SDGs: 4, 'Quality education'; and 10, 'Reduced inequalities'. This paper provides specific tools to increase the interest in science of young people in care, which has an impact on enhancing motivation, learning, and academic expectations.

We highlight that to achieve the desired impact in this study, it has been key to conduct it through high-quality actions such as the SEAs that are developed in interactive environments based on dialogic learning (Molina et al., 2021). The results suggest that DSGs and scientific workshops can be effective measures that manage to broaden learning spaces, increase academic expectations, encourage the diversification of quality educational interactions, promote scientific vocations, and contribute to the academic progress of young people in care, reducing the educational inequalities that affect them.

Firstly, concerning scientific literacy attitudes, showing an interest in STEM areas and appreciation of scientific approaches to research. All participants state that this has been the only opportunity for them to get close to direct scientific knowledge through reading and meeting real scientists. In addition, the dialogic gatherings have allowed them to enjoy a shared space for dialogue that was previously absent from their daily routine. This has been especially important for getting to know each other better, sharing concerns and worries, and improving coexistence and social cohesion (García-Yeste et al., 2017). Thus, all participants declare that they have gained a better understanding of scientific knowledge and its value and application to everyday life and to the betterment of humanity in multiple fields, and this can help them to make better decisions in the face of the challenges of today's society (Buslón et al., 2020). The intervention has led to the discovery of a clear scientific vocation in one of the participants, a greater motivation for STEM knowledge in the whole group, and, in some cases, a broadening of dreams of future studies in this direction (Guardiola-Fígols et al., 2024). This has been possible thanks to the transformative potential of the interactive spaces for dialogue, the high expectations projected on the group, the highly complex readings provided, and the solidarity meetings with scientists who managed to dialogue with the group from an equal perspective. This shows that working with real scientists can have a positive impact on the academic and professional prospects of the participants, enabling them to aspire to go much further than before they participated in these scientific workshops (Gairal-Casadó et al., 2019).

Secondly, the results highlight other dimensions linked to academic improvement. In several cases, participants have stated that they have been able to transfer the learning acquired in the intervention to the school context. Not only certain knowledge of greater complexity, but also in terms of active participation in classes, improved oral expression and argumentation, or greater self-confidence to intervene in the classroom (Gairal-Casadó et al., 2022). These results are in agreement with previous research showing that DSGs improve scientific literacy in the concrete dimensions of instrumental learning, analytical and critical thinking, and social skills (Díez-Palomar et al., 2022); and with studies that demonstrate the potential of interactions in dialogic gatherings to improve and accelerate reading skills (Valls et al., 2008). On the other hand, the intervention has increased the motivation for STEM areas in the participants and their self-esteem by seeing themselves capable of directly

accessing the most complex scientific knowledge and understanding it with the help of the group and equal dialogue with real scientists.

Finally, academic expectations have also increased. This is a point highly valued by the educational team and self-perceived by the participants, who recognize the potential that the intervention can have to change their lives. These findings are in line with previous works demonstrating the impact of extending learning time on improving academic performance and developing socio-emotional skills that reduce vulnerability risk factors in adolescence (Natividad-Sancho et al., 2024). It has also shown how intervention can contribute to overcoming some barriers like the age of the participants because of their long history of inequalities and the systemic hurdles that make it difficult for adolescents and young people in care to continue studying. Positive results have been achieved both in attitudes towards science and in the academic skills, which can act as a protective factor in the future.

Concluding, through DSGs and scientific workshops, the direct approach of the participants to the field of science is encouraged, regardless of age, gender, culture, or individual background. This is particularly relevant for children and adolescents in care, as the inequalities in the levels of scientific literacy faced increase the barriers to improving their daily lives in essential areas such as education, health, and other fundamental rights (Díez-Palomar et al., 2022). Research also corroborates that access to science and communication between the scientific community and all citizens increases their democratic participation (Spanish Foundation for Science and Technology, 2022). Although the scientific literature had already highlighted the importance of DSGs and science workshops in fostering interest in STEM areas and motivation for education in foster children (Buslón et al., 2020; Gairal-Casadó et al., 2019), the following study goes a step further and focuses on the role that this action is having in young people in care who are living in group homes. It also delves into the effect that these actions are having on scientific literacy and future expectations of being able to develop a work in this field. Furthermore, from the perspective of social work practice, this research demonstrates that socio-educational intervention with young people in care, especially forged in scientific evidence of social impact, can achieve improvements in reducing educational and social inequalities. The transfer of this approach to social policies, including social care policies, is one of the aspects that some governments are already promoting (Munté et al., 2011). In fact, the successful action approach has demonstrated that it can be transferred to diverse contexts, such as school education and health, and countries, achieving excellent results (Elboj et al., 2021; Padrós et al., 2024). The empirical demonstration of the impact of this successful action approach has mostly been evaluated through the communicative methodology (Gairal-Casadó et al., 2019), as in the case of the research presented in this article. Based on the indicators established by the SGD, the progress has been verified in the lives of the participants themselves through qualitative data collection techniques.

Strengths, Limitations, and Future Lines of Research

The strengths of the study whose results have been presented in this article focus above all on the visible social impact on the lives of the research participants. Moreover, the abovementioned transferability of the successful action approach is another element that is in line with the main objectives of the discipline of social work as well as the SDGs. Nevertheless, the study has several limitations. First, the small sample may be a limitation when generalizing the findings obtained. In any case, the size of the sample was a methodological decision directly related to the intentionality of the case study that it was decided to carry out by the research team engaged in the FECYT project. Secondly, an inductive design of the research will help us in the future to better consider other dimensions of scientific literacy that do not appear in this work: a *perception and awareness of environmental issues* as an important dimension in

scientific literacy attitudes as a global concern with enormous relevance to all aspects of human life and its future; and the three subcategories of *scientific literacy knowledge* according to the OECD Report (2013) for PISA 2015: an understanding of concepts and theories about the scientific knowledge worked on in the sessions (*content knowledge*), about how this scientific knowledge is generated (*procedural knowledge*), and the arguments in which the participants specifically recognize its applicability to their daily lives (*epistemic knowledge*). We started from a deductive approach because we already had previous knowledge that allowed us to establish specific analytical hypotheses, and we decided not to change this decision because the results provided new knowledge that previous research had not provided.

The positioning of the authors throughout the research, especially in the interpretation of the data, has been shaped by the principles of communicative methodology centred on the rupture of the hierarchy of interpretation, in which the groups and persons researched, through an egalitarian dialogue, also reflect on the interpretation of the results (Gairal-Casadó et al., 2019). The creation of advisory councils with members of these groups allows for this joint interpretation, where researchers contribute their scientific knowledge and those being researched contribute their knowledge of the world of life. Finally, this intervention focused exclusively on STEAM topics. Therefore, the results cannot be generalized to other areas not specified in the methodology. Future research could explore whether similar motivational effects appear when young people interact with professionals from different fields.

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Data Availability The authors will make available, without undue reservation, the raw data supporting the conclusions of this work.

Declarations

Ethical Approval The research fully complied with all applicable ethical regulations. The study was part of a project funded by the Spanish Foundation for Science and Technology (FECYT). At the time the project was carried out and the impact data were collected, ethical approval by the university's ethics committee was not a mandatory requirement at the Universitat Rovira i Virgili (URV), the institution to which the project's principal investigator and most of the research team belong.

Informed Consent All participants were informed of the research objectives and personally signed an informed consent form, which included the option to withdraw at any stage of the study. In the case of minors, informed consent was obtained from their legal guardians following prior notification to the Child and Adolescent Care Team of the Government of Catalonia. Data processing ensured the anonymity of participants through the use of codes and pseudonyms in both the manuscript and the tables, and all information that could lead to their identification was strictly anonymised. Confidentiality, data protection and the well-being of all participants were guaranteed at all times. Furthermore, the study did not interfere with the usual educational activities of the participating institutions. This ethical framework ensured respect for the dignity, rights and autonomy of all participants, particularly in contexts of high social vulnerability.

Competing interests The authors declare no competing interests.

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