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The effects of children's participation and co-creation in science

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The scientific literature shows that children's participation in video games is increasingly common. However, there is no analysis of the involvement of children in the development of video games promoting social science learning. The framework of the EU H2020 funded project "ALLINTERACT. Widening and diversifying citizen engagement in science" contributes to filling this gap by analysing the co-creation process between children, families, teachers, and researchers of a video game for children to distinguish between hoaxes and evidence to overcoming bullying. To this end, a 24-h Science Game Jam was recorded, which took place in a virtual space for group meetings in which five children, five family members, four teachers and four researchers participated in the co-creation of the video game and a collaborative document in the cloud including the guidelines of the video game, with their proposals for the development. Finally, they participated as well as in the co-creation of the video game itself. The key finding is that co-creation through an egalitarian dialogue, solidarity, and focus on scientific knowledge allowed these children to play a leading role in developing a video game where children of all educational stages learn to distinguish hoaxes and evidence in overcoming bullying. The involvement in science and the co-creation of science-based products benefited these children; as they were protagonists in science, they could express their concerns and the real problems they faced in their schools, which increased their scientific knowledge and strengthened their critical capacity about bullying. Furthermore, the adult participants also benefited from the knowledge provided by the children, especially in the development and creation of the video game.

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Introduction

The current social, sustainability, political, health and economic challenges that society is facing nowadays can be solved by science, technology and innovation (Owen et al., 2012; Parkinson et al., 2022) as science enables social progress, so a scientifically literate society promotes longer and happier lives for more people (UNESCO, 2023). Based on this fact, this research has involved children, families, and teachers in developing a video game based on scientific evidence in the social area.

The science landscape rapidly evolves for self-improvement (Murphy et al., 2020). In this era of transformation, there exists an opportunity to redefine scientific culture in a manner that caters to, emanates from, and serves the interests of society, thereby fostering greater inclusivity and openness in the scientific domain (Bedessem et al., 2021; O'Grady and Mangina, 2022). Consequently, there is a growing call for increased citizen engagement in knowledge production and research expertise (Strasser et al., 2018). Hence, in the execution of this research, both citizens and researchers have actively participated in knowledge production through collaborative efforts in creating a video game. This kind of participation in science empowers citizens, increases their learning, and develops new governance tools. However, science is acquired through the interrelationships people establish with others motivated by science or cultural elements promoting scientific knowledge (Jirout, 2020; Luce and Callanan, 2020).

Children's social interaction in science learning. The relationship between children's and scientific learning has been extensively studied recently. These researches have generally focused on children's acquisition of science (Cobanoglu and Yurttas-Kumlu, 2020; Howitt and Rennie, 2021), motivation for science (Li et al., 2020), the effect of science learning on their academic performance (Jones et al., 2022) and children's scientific vocations (Howitt and Rennie, 2021).

Most research indicates the significance of scientific literacy during the early stages of life, particularly in the period spanning from birth to 6 years. O'Connor et al. (2021) underscore the critical role of science experiences in the initial year of life in shaping children's understanding of science, acquisition of scientific knowledge, and development of enquiry skills. This underscores the importance of early engagement in science education, as Pereira et al. (2020) highlighted, demonstrating that active science teaching in early childhood facilitates learning and establishes a foundation for subsequent science education.

Despite these benefits of making children literate at an early age, there is a global trend towards low interest in science in young people (Kennedy and Odell, 2014; Thomson et al., 2016). Therefore, programmes and schemes have been introduced over the last three decades to encourage young people to take up science (Museus et al., 2011; European Commission, 2022). Most of these interventions focus on the concept of understanding science through reading, argumentation and rebuttals (Cervantes-Barraza and Cabañas Sánchez, 2022; Kim et al., 2021), collective behaviour change (Spitzer and Fraser, 2020), skill acquisition (Isik Uslu et al., 2022), and encouraging exploration (Nayfeld et al., 2011). Gelir (2022) observed the significant influence of teachers engaged in educational programmes, emphasising their pivotal role in advancing science learning. Notably, Gelir highlighted increased learning effectiveness when teachers actively participated in these programmes. Alongside these initiatives, there is a rising trend in the prevalence of science festivals, drawing the participation of both children and families (Jensen and Buckley, 2014). Examining the enduring effects of these festivals on children and their families, Idema and Patrick (2019)

demonstrated that, over time, children developed a perception of themselves as active participants.

Research on social interactions and science literacy indicates that children increase their knowledge and motivation when establishing pro-science relationships. Research such as that of Sonnenschein et al. (2022) found that families' motivations and beliefs increase science learning if these educational interventions were reinforced at home through enjoyment. Similarly, Li and colleagues (Li et al., 2020), who observed positive peer relationships, claim that these relationships lead to higher motivation associated with higher scientific literacy. Therefore, environments where children enjoy and discuss science can encourage them to increase their science knowledge.

Research on scientific literacy generally focuses on acquiring content to be learned by the child (Datu and Yang, 2021; Guler and Unal, 2021). Ma (2022) points out that attitudinal factors such as interest in science, scientific self-efficacy, and instrumental motivation to learn science are significant mediators of enquiry-based learning. Moreover, Jacques-Avino et al. (2020), who investigated types of citizen participation, found the existence of five types of participation in science: (1) contributory, where people participate in the observation of a phenomenon by collecting information; (2) collaborative, where people contribute with data and also contribute to the design, interpretation and dissemination of results; (3) co-created, where the research team and citizens participate mutually from the beginning of the scientific project; (4) contractual, where people demand that research teams carry out a particular study and make their results known; (5) independent, where activist movements or non-professional citizens promote research projects. In contrast to these typologies, Aiello, and colleagues (2021) point out that co-creative participation between researchers and citizens makes it possible to promote the social impact of research.

Children's participation in inclusive science communication. Science communication entails distributing scientific information and knowledge to the public, yet its accessibility remains uneven. Addressing this issue, Dawson (2022) advocates for an emphasis on inclusivity in science communication. The author defines inclusive science communication as a transformative approach that challenges structural patterns and acknowledges forms of knowledge, practices, and communities often overlooked in research (Dawson, 2022). Consequently, this form of science communication delves deeply into understanding the socio-political and cultural histories that underlie inequalities while simultaneously recognising individuals as active and empowered agents. This communication model prioritises inclusion, equality, and social justice (Dawson et al., 2022).

This new approach to science and communication is a significant step forward as it democratises scientific knowledge to citizens; it includes a diversity of audiences from design to governance and implementation; it identifies social changes and includes science communication strategies; and it impacts society intending to transform it (Massarani and Merzagora, 2014).

Co-creative participation between researchers and citizens is important in promoting science learning, particularly among children, and improving science in this era of rapid transformation. So, this type of science is currently being carried out by different social collectives and in different spaces. Thus we can see youth groups participating in scientific topics to understand the importance of scientific methodology (King-Kostelac et al., 2022), as well as people from ethnic minorities participating in research being conducted in their community (Aiello et al., 2022), young people participating in STEM activities (Godec et al., 2022) or

women participating in the co-creation of safe spaces to eradicate violence (Gómez-González et al., 2022).

However, children are one of the least actively involved targets in research, which may be because they are a particularly vulnerable group and because the involvement of children in research is considered a sensitive issue (Powell and Smith, 2009). Nevertheless, research carried out by King-Kostelac and colleagues (2022) indicates that the non-participation of children in science decreases the opportunities to learn and practice science communication. Against this background, authors such as Powell and Smith (2009) argue that children should be treated as social actors and stress the importance of having a central role in making decisions about their participation in research.

Research such as that conducted by Doná (2006) found that children acting as advisors in research contributed to overcoming essentialist conceptualisations of children. Mayne et al. (2018) consider that children’s active participation in research will enable a better experience of children’s participation and stresses the importance of valuing them as meaningful citizens with rights.

Conversely, numerous studies highlight the educational potential of video games as cultural tools, especially given their increasing consumption by children (Barko and Sadler, 2013; Morozova, 2019; Amedu and Hollebrands, 2022). Morris and colleagues (2013) emphasize that these digital products can contribute to the development of scientific literacy. However, a critical examination is needed concerning children’s involvement in the creation of video games aimed at promoting scientific literacy. One collaborative practice in video game development is the Game Jam, where participants collaborate to create video games within a brief timeframe, typically no <24 h challenging their creativity and skills to achieve rapid results. Matthews and Thomas (2022) demonstrate that such events effectively enhance the collaborative capabilities of multidisciplinary teams in designing, developing, and implementing games. Research on these events indicates that they facilitate multidisciplinary team collaboration, promote learning among participants (Matthews and Thomas, 2022; Meriläinen, 2019; Arya et al., 2013), motivate participants (Aurava and Meriläinen, 2022), and contribute to the advancement of game development practices (Gaudl et al., 2018). This research analyses the co-creation participation process between children, families, teachers, and researchers of a video game for other children’s players to distinguish between hoaxes and scientific evidence to overcome bullying.

Methods

During the weekend of November 26–27, 2022, a 24-h Science Game Jam was organised and recorded in a virtual space for group meetings in which researchers, teachers, family members and children participated in the co-creation of a videogame. The Science Game Jam was defined as a case study based on citizen co-creation methods.

The 24 h of video game creation (Science Game Jam) were divided into three parts. First, the Science Game Jam began with an initial conference by Professor Emeritus Ramón Flecha, from the University of Barcelona, the principal investigator (PI) of the ALLINTERACT research project. ALLINTERACT is a widening and diversifying citizen engagement in science project funded by the European Commission (Horizon Europe Research Programme). Prof. Flecha explained the project and the main idea of how the Science Game Jam would work. That same afternoon, there was another conference given by Dr. Oriol Ríos, from the Rovira i Virgili University, about bullying and social media. The Science Game Jam event ended with a final conference given by Dr. Cristina Pulido, from the Autonomous University of

Barcelona, on the dialogic creation of video games. The three conferences were held through the Zoom platform. All of them provided the main framework for the Science Game Jam activity, setting up the scope of the work within the ALLINTERACT project. The keynote speakers communicated to the audience the principal contributions made by the scientific community regarding citizen engagement in science. They highlighted the collaborative efforts of citizens, researchers, and other stakeholders in co-creating key features through dialogic interaction grounded in the sharing and utilising contributions validated by scientific evidence.

The Scientific Game Jam was developed using the Wonder platform, where different virtual spaces were created, and participants could join the group of their choice according to their interests. In one of the groups, it was decided to make a Game Jam about school bullying. Owing to the inherent limitations of this article, which does not seek to undertake an exhaustive investigation to contrast and validate a specific hypothesis but rather aims to explore how a diminished cohort of children, families, teachers, and researchers collaboratively generate knowledge during their involvement in a video game Jam aimed at aiding individuals in discerning between fallacious claims and scientifically substantiated evidence about bullying, we have gathered a constrained quantity of empirical data. The virtual workshop had 18 participants, including five children, five parents, four teachers, and four researchers (see Table 1).

Drawing on the communicative methodological approach principles (Gómez, 2017; Gómez et al., 2019), the communication maintained at all times was of equal and respectful dialogue with all participants and no disrespect was allowed at any time. The children took the lead and were the protagonists of this video game creation. All decisions made for elaborating and developing the video game were discussed and agreed upon by all participants. Each time a proposal was made, there was an equal dialogue, and participants made decisions among all of them. Everyone could participate, contributing with their ideas and comments. To foster the participation of all attendees, a norm was set up during the Science Game Jam activity: “People who had spoken the least had priority, as well as children.”

The video game was created through the Scratch platform. Two participants, a primary school teacher and a child, oversaw sharing the screen through Wonder, where the rest of the participants could listen, see, and contribute to the creations, adding

Table 1 Profiles of the participants.

No.	Participants	Age	Profile	Gender
1	Javier	12	Child	Male
2	Manuel	14	Child	Male
3	Marc	12	Child	Male
4	Albert	10	Child	Male
5	Carlos	10	Child	Male
6	Sophie	47	Family	Female
7	Carlota	49	Family	Female
8	Sonia	49	Family	Female
9	Jesús	70	Family	Male
10	Tamara	48	Family	Female
11	Maria	23	Teacher	Female
12	José	45	Teacher	Male
13	Alfonso	40	Teacher	Male
14	Lucas	22	Teacher	Male
15	Marta	28	Researcher	Female
16	Marcos	46	Researcher	Male
17	Laura	31	Researcher	Female
18	Nuria	42	Researcher	Female

the modifications they considered for the creation of the video game.

The children contributed many ideas about how the video game should be; they mentioned different conflict situations that usually abound in school playgrounds and the possible responses a child could give in such cases. The researchers helped and contributed to identifying options based on scientific evidence that contribute to resolving conflicts at school. Parents also contributed from their perspective. In addition, the children explained technical and programming issues to the adults.

The moments where there was more participation were at the beginning of the Science Game Jam, during the morning and in the afternoon. The Science Game Jam was paralysed at night, and the participants were back online the next morning.

Video and audio recordings were used to collect the data from the digital platforms (Zoom and Wonder) (Archibald et al., 2019). Qualitative methods (Denzin and Lincoln, 2011) were used to analyse the data collected, drawing on the communicative methodological approach. According to this methodological perspective, social phenomena are socially communicatively constructed by human beings through the interaction among individuals. Knowledge creation is the result of dialogue among participants in interactional episodes. In this sense, the methodology to approach knowledge must be open to examining communicative processes, using dialogue (including speech acts and other communicative signs, such as icons, gestures, etc.) as a “unit of data” to reach (and understand the meanings of) this knowledge. All participants in the social phenomena examined are part of and participate in the social construction of the object of study. Hence, because knowledge is socially constructed, the communicative methodology draws on co-creation methods (based on analysing the interactions in which individuals participate) to collect and analyse the data.

In this sense, co-creation indicators were used to describe participants’ engagements within the game creation process (including definition of the game scope, design, technical development, features, etc.), as shown in Table 2.

The communicative methodology always distinguishes between exclusionary and transformative dimensions of the social phenomena being analysed (Gómez et al., 2006). Three components were considered to discuss how some minors created a video game so that people of their age could distinguish between hoaxes and evidence of bullying: dialogues, actions and sources (from both dimensions).

Exclusionary dialogues refer to types of dialogue (non-egalitarian) that do not facilitate participation but rather prevent situations from being created in which all the participating people can share, exchange and contrast their respective knowledge, experiences, etc., about the phenomenon studied (the understanding of bullying and how to design and create a video game to help other children to identify bullying situations that can be found in their everyday life). Conversely, transformative dialogues refer to that type of dialogue (egalitarian) that encourages the participation of all people so that they can share their experiences and their previous knowledge about the object of study and can be contrasted in a debate based on claims of

veracity (that is, in contrasted evidence, based on arguments that have been validated by previous scientific research).

Exclusionary actions (individual) refer to those that prevent or make it difficult for people (in this case, children) to identify the hoaxes about bullying and confuse them with scientific evidence on the subject. Instead, transformative actions (shared) refer to those actions that contribute to making it easier for children to identify the hoaxes about bullying and distinguish them from what is scientific evidence.

Finally, exclusionary sources (single) refer to those sources, references, or examples based on one’s own experience that have not been confronted with other people, nor, above all, with what the scientific evidence says about bullying. On the contrary, transformative sources (checked against) refer to sources, examples, etc., that have been shared and contrasted through an egalitarian dialogue using scientific evidence as a source of argumentation.

Before the creation of the Science Game Jam and the recording, participants were informed of the purpose of the study, that participation was anonymous and voluntary, and that the data would be treated confidentially and used only for research purposes. All participants agreed to provide the researchers with information relevant to the purpose of the study and signed an informed consent form. Family members of the children also signed the informed consent to allow data collection regarding their children’s participation in the Science Game Jam. Ethical requirements were addressed following the Ethical Review Procedure established by the European Commission (2013) for EU research, the Data Protection Directive 95/46/EC, and the Charter of Fundamental Rights of the European Union (2000/C 364/01). All data have been anonymized and fulfilled the Regulation (EU) 2016/6791 and the EU General Data Protection Regulation (GDPR).

Results

Engaging in collaboratively creating a science-oriented video game has yielded beneficial outcomes for participants, particularly children who have articulated their concerns, acquired scientific knowledge, applied it, expanded their understanding, and cultivated critical skills related to bullying. This positive influence stems from the equitable dialogue fostered among all participants during the Science Game Jam, the prevailing sense of solidarity among participants in knowledge-sharing, and the participants’ proficiency in researching and learning from scientific sources. The results obtained through the dialogues between children, families, teachers, and scientists during the Science Game Jam are classified into two main blocks: the effects produced by the active participation of children in science and those obtained by the co-creation of the video game.

In the first block concerning the impacts of children’s active involvement in the scientific research project, the findings underscore children’s pivotal role as central figures in the research. This participation has enabled them to articulate their concerns and authentic challenges encountered within their school environments. In response to these concerns, a unanimous decision emerged among the participants to focus the video game narrative on school bullying. Illustrating this perspective, Marc, a 12-year-old participant, communicated the prevalence of bullying as a pressing issue within schools, stating, “One idea is to make it about bullying because it constantly happens in my school, and the school does things, but they don’t get results” (Marc, 12 years old).

After deciding on the theme, the children contributed to the script by depicting scenes based on real situations they experienced in their schools. Children participating in the

Table 2 Co-creation indicators based on the communicative approach.

	Dialogues	Actions	Sources
Exclusionary	Non-egalitarian	Individual	Single
Transformative	Egalitarian	Shared	Checked against

Video Game Jam declared that the main places for bullying are usually the playground, the changing room, the lunchroom, the stairs, the street, and (at home) through social media (cyber-bullying). They decided to include those spaces within the video game. Thus, participants in the video game will find themselves in situations in which they will have to make decisions to overcome a situation of bullying. Children pointed out the importance of having scenes in which teachers acted based on occurrences, such as “It’s kids’ stuff”, scenes of violence generated by groups of peers, or characters who follow the group. The scripts for these scenes were constructed by the children with phrases they had heard during their bullying experiences. Carlos, 10, and José, 45, a teacher, constructing some sentences from the script:

José (45 years old, teacher): How would you say a phrase in English from “tonta”?

Carlos (10 years old): You are a loser. You are nothing.

José (45 years old, teacher): And to say “empollona”

Carlos (10 years old): Nerd. It could be something like, “You are a loser and nerd”.

On the other hand, the children participating in the event increased their knowledge of the scientific evidence on gender and education. They became aware of the educational and socialising potential of the video game. Thus, after listening to scientific conferences, children and adults began to devise the video game in which an egalitarian dialogue was established, and scientific sources were shared to elaborate the script and the narrative of the audio-visual product. Thus, we observe, for example, that in the elaboration of the video game, evidence was sought in two scientific platforms where scientific hoaxes and evidence on gender and education are differentiated, such as Adhayaya and Sappho. The following dialogue, carried out by two teachers and a child, shows different participants’ search for scientific evidence.

Alfonso (40 years old, teacher): You must have as a reference during the video game the scientific evidence or hoax that it supports because it is also the way for people to access the evidence. Suppose it doesn’t seem like we are saying it. We say to put Adhayaya and Sappho on scientific platforms.

María (23 years old, teacher): Getting a lot of points through your avatar explains to you that it is because it is not evidence that you have chosen.

Carlos (10 years old, boy): Sounds very good. One question: Does the text always come out if you make the right choice? Does it say why there is evidence? And if you choose wrong, why did you choose a hoax, and why is it not correct?

Hence, participants need to create a video game incorporating scientific evidence, and their personal experiences with bullying have augmented their scientific understanding. This effect is particularly pronounced among the younger participants, who had not received prior training before engaging in the Science Game Jam. Consequently, the children gained insights into scientific concepts related to being an upstander—taking action when witnessing wrongdoing, understanding the dynamics of desiring language directed towards the aggressor, and recognising the significance of making the aggressor appear unattractive. They also acquired knowledge about the preventive role of friendship in addressing bullying.

Lucas (22 years old, teacher): There is at least one punctuation mark in the document we created. In other words, it is as if the character chooses to insult more. If there is more bullying here, it says minus one. I wonder if it is possible.

Marta (28 years old, researcher): We did this with José (teacher) because we wrote some ideas and possible options. We thought, for example, that if you don’t interfere when you see a case of bullying, that’s minus one. But maybe it can’t be done.

María (23 years old, teacher): Sure, it’s that giving a point for passing by (ironic tone). It’s not right.

Carlos (10 years old, boy): Sure

María (23 years old, teacher): Sure, but bullying is worse than doing nothing.

Carlos (10 years old, boy): So, zero for doing nothing and less one for supporting bullying.

María (23 years old, teacher): That’s right.

While children learn scientific concepts, they become aware and critical of the reality they are living in school. Marc, 12, points out that thanks to his participation in video game creation, he has become even more aware of the malpractices in his school and how they are not based on scientific evidence. “By creating the video game, I have realised that my school is not doing well in preventing bullying” (Marc, 12 years old). Consequently, the children’s active participation has contributed to their critical thinking about bullying, thanks to the scientific training they have done to develop the game.

Consequently, the study underscores the significance of centralising children’s voices in scientific projects and affording them a prominent role in research. This approach is pivotal for comprehending children’s realities, enhancing the quality of research, and concurrently enabling them to augment their scientific knowledge through critical and active involvement during the developmental phase.

The second block links with the first one and refers to the effects obtained by co-creating the video game based on scientific evidence about bullying. The results show how science works between people of different ages and knowledge, but with a common goal: increasing the knowledge about science of all participants: children and adults.

The participants in this Game Jam aimed to create a video game so that other children could learn to differentiate between hoaxes and scientific evidence about bullying when playing the game. Therefore, the participants had two challenges when considering the development: on the one hand, to learn about and apply the scientific evidence as the central object of the video game. On the other hand, to design and create the technical aspects of the video game.

The results analysed show that the children participating in the Science Game Jam had more knowledge about designing and creating video games than adults. In comparison, the adults involved provided more knowledge about hoaxes and scientific evidence concerning bullying. In the case of Marc, a child who knew how to design video games told the adults what procedure they followed when creating a video game. “First, I think of an idea that can take a few days, then I carry out that idea, trying to improve it with each thing I do” (Marc, 12 years old). Throughout the event, the participants observed how the adults asked the children to carry out more technical tasks related to the video game. Thus, it is observed how Jose (teacher) asks Marc (child) to perform technical tasks.

José (45 years old, teacher): We will think further about how to attract and de-attract characters. But we need a score list to be generated. Marc (child), can you generate a list so the user has scores for each answer (concerning the technical part of the video game)?

Marc (12 years old, child): Yes.

José (45 years old, teacher): Let’s give a score for each one. If it was from one to four, or are we going to give a score from one to three? Or how would we do it?

Marc (12 years old, child): From 0 to 3.

Participants have shared diverse knowledge while participating in the co-creation of the video game. Some attendees noted that the Science Game Jam had created a unique space for learning and creating science-based cultural elements. Judith, 44, reports

how the creation of social science-based video games is a new model she had not seen until the Science Game Jam event.

“There’s the whole open line of video game creation where people can access programmes like Scratch and create their own video games. But none of those models have seen what happened this weekend. This is ground-breaking and based on scientific evidence. This has never happened before” (Judith, researcher).

Discussion and conclusion

The evidence gathered in this study indicates that the active engagement of children, alongside family members, teachers, and researchers, in participating in science activities and collaboratively creating science-based products is advantageous for the research project. This involvement proves beneficial not only for the children themselves but also for the other adults who took part in the event. It facilitated their learning about scientific evidence related to concerns that children find troubling, and it enabled them to jointly develop a video game grounded in scientific evidence aimed at addressing and preventing bullying. This result is consistent with what Powell and Smith (2009) point out: participation in science provides the opportunity to be active social actors. Moreover, children participating in the study were considered as a key element in the research, especially in those in which they are the object of study, as the Science Game Jam offers them the opportunity to learn about the scientific evidence on a subject that concerns them and to be able to apply it through a video game. Mayne et al. (2018) pointed out that “engagement in scientific activities” allows children to better experience science while being valued as citizens and considered as social actors, overcoming the passive and welfarist conceptualisations of children in society (Doná, 2006). Similar results were obtained in the study discussed here: children were more engaged with science, with science production (co-creation), and they became active participants and “producers” of situations based on the dialogue with researchers around the scientific evidence on bullying.

Their input into the realm of science not only enhances children’s involvement in scientific activities but also substantially influences both the participants and society as a whole. This resonates with the escalating emphasis on social inclusion in science communication. Recognised for its political significance, such as empowerment, science communication is acknowledged as a crucial instrument for engaging a diverse audience (Massarani and Merzagora, 2014). The present research illustrates how children, through their active participation, not only expanded their knowledge but also crafted a science-based video game with the aim of effecting societal transformation. They shared their experience in defining and creating the contents and situations of the video game. They also further learnt about scientific evidence regarding bullying because they included scientific evidence resources to provide tools to the potential gamers of their video game. Researchers participating in the video game jam provided knowledge about that scientific evidence (through the conferences, for example). Children provided the situations where bullying happens (usually). They thought about strategies to help potential game users identify scientific evidence in opposition to hoaxes when confronted with such situations in the video game. Therefore, this research contributes to identifying successful ways to promote inclusive science communication to transform society and forms of knowledge (Dawson, 2022).

Previous research (Idema and Patrick, 2019; Sonnenschein et al., 2022; Ma, 2022) has pointed out that when children participate in science events, they tend to perceive themselves as active participants. The engagement in such episodes also makes them (the children) increase their interest in science learning. In this study, we have found some evidence suggesting that the children participating in the Video Game Jam also developed a motivation towards science, as during the creation of the video game, children

were very active and motivated in looking for scientific evidence in bullying to include them in the design of the game. According to Jacques-Avino et al. (2020), there are five types of children’s participation in science. Our study further develops this classification, adding a new type: children co-creating scientific knowledge with researchers and other stakeholders when sharing their experience through egalitarian dialogue episodes.

It should be noted that children are a vulnerable population; it is therefore important to establish control so that they can play a role in the decision to participate in this research (Powell and Smith, 2009). However, in this project, this barrier was overcome because the families of the participating children were also involved in participating and co-creating the video game. In addition to the children, it is good to involve their families and other community members interested in actively participating in the research. We should also point out that in this research, we have used a video game as an element of co-creation because it is a motivating element for the youth population (Barko and Sadler, 2013; Morozova, 2019) and because it is an element that increases scientific literacy (Morris et al., 2013). However, we consider that other cultural elements with the same or more properties than video games can also be used to be involved in scientific research and increase children’s scientific knowledge.

This study has been conducted with limited data but marks an initial stride towards comprehending the impacts of children’s active engagement and collaborative contributions in science. Nevertheless, due to the limitations of this research, such as the need for more girls in this type of research and the fact that the researchers would have liked to carry out another similar event to deepen the types of scientific knowledge acquired by the children. More research should be carried out on this topic related to children and inclusive science communication to find out strategies and future benefits for citizens.

Data availability

The datasets generated during and/or analysed during the current study are available in the Zenodo repository, accessible with the reference number: 10177372. <https://zenodo.org/records/10177372>.

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Author contributions

Conceptualisation: CG-Y, data curation: AOM, formal analysis: BVC, JD-P, methodology: BVC, supervision: CG-Y, validation: CG-Y, writing—original draft: JD-P, AOM, BVC, writing—review and editing: CG-Y.

Competing interests

The authors declare no competing interests.

Ethical approval

ALLINTERACT project has been approved by the Ethics Committee of the University of Barcelona. The study was also approved by the Ethics Committee of the Community of Researchers in Excellence for All (CREA) under number 173 20210117. Ethical requirements were addressed following the Ethical Review Procedure established by the European Commission (2013) for EU research, the Data Protection Directive 95/46/EC, and the Charter of Fundamental Rights of the European Union (2000/C 364/01). All data have been anonymized following Regulation (EU) 2016/6791 and the EU General Data Protection Regulation (GDPR).

Informed consent

All participants agreed to provide the researchers with information relevant to the purpose of the study and signed an informed consent form. Family members of the

children also signed the informed consent to allow data collection regarding their children's participation in the Science Game Jam.

Additional information

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