

# Cosmic Curiosity: Why collaborating with libraries results in impactful family engagement with astronomy

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Outreach, Public Engagement, Community, Children, Storytelling, Co-creation

The University of Hertfordshire Department of Physics, Astronomy and Mathematics (PAM) Outreach and Public Engagement (OPE) Team offer wide-ranging and impactful activities and events. The Team's goal is to support and maintain the science capital of young people in underserved and underrepresented communities in physics, astronomy and maths with the hopes they will one day study one of these subjects at a higher level. A young person's decision to choose to continue with the physical sciences is a complex one, but their parents or carers have a great deal of influence. However, in astronomy, we often leave parents and carers out of our outreach. Public libraries, on the other hand, often specifically target families and offer a welcoming and informal setting to learn. For example, they often run storytelling sessions for young families, though these are rarely focused on STEM (Science, Technology, Engineering and Math). Therefore, libraries promise enormous potential for STEM and astronomy outreach with young children aged 4-7 and their parents and carers. From this realisation, Cosmic Curiosity: Stories that Spark the Imagination was created in collaboration with the Hertfordshire Library Services. In this article, we will demonstrate how engaging families in libraries results in impactful and sustainable engagement.

## Introduction

Cosmic Curiosity is a collaborative project between the University of Hertfordshire's Department of Physics, Astronomy and Mathematics (PAM) and Hertfordshire Libraries in the United Kingdom (UK). For this project, we collaborated with four partner libraries located in the top 20% of the Index of Multiple Deprivation rankings in Hertfordshire ("*Index of Multiple Deprivation Herts Rank,*" 2019). The IMD takes into account various factors such as income, employment, education, health, and crime rates to assess the relative deprivation of different areas.

The project was funded by a Science and Technology Facilities Council (STFC) Spark Award and targeted children aged 4-7 and their parents and carers. We ran four sessions in each library and themed each session around a career in space science (Table 1). During the sessions, one of the librarians read a story that was linked to the space career featuring diverse gender and ethnicity role models, which was followed by an astronomy activity (Figure 1) and concluded with an additional activity which participants were able to take home with them. We also purchased multiple copies of 25 STEM books for the project that were related to the careers that participants could borrow from the library and ran a STEM book loyalty card scheme so that every time a library member took out a STEM

book, they received a stamp. After filling the card with four stamps, the participant received a bookmark as a reward (Figure 2). The 25 STEM books were given to a total of 11 libraries, four of which were our specific partner libraries where we ran the Cosmic Curiosity storytime sessions, three were where we just ran the STEM book loyalty card scheme, and an additional four libraries were used as a control comparison which had no specific engagement. We interacted with a total of 218 participants (including parents, carers and children). In total, 69 families gave demographic feedback in the questionnaire. Of the 69 parents and carers, 81% identified as women. Of the 77 children, 44% of them identified as girls.

With these sessions, we aimed to increase the interest of the local community in astronomy and STEM in libraries, to create a long-lasting partnership between the Department of PAM and Hertfordshire libraries, and to broaden families' awareness of the possibilities in astronomy and STEM fields.

We utilised a mixed-method approach to evaluation. For the attending families, we collected data through short questionnaires asking for feedback and demographic data. We gauged participants' opinions of scientists by drawing a scientist at the start of each session. Then, participants placed themselves on a scale of comfortability with science that we depicted with different chairs.

Session and linked career	Linked Book Title	Linked Activity	Linked at-home Activity	NUSTEM STEM Attributes (NUSTEM, 2020)
You could be an... Astronaut	Astro Girl	Astronaut Glove Box	Eating like an Astronaut	Collaborative, Communicative, Hard-working
You could be an... Aerospace Engineer	Meet the Planets	Straw Rocket	Bottle Rocket	Creative, Passionate, Tenacious
You could be an... Astronomer	Look Up	Constellation Tube	Galaxy Model	Open-minded, Self-motivated, Patient
You could be a... Planetary Geologist	Moon	Make a Moon Crater	Tracking the Moon Phases	Observant, Curious, Creative

**Table 1.** Summary of Each Session



**Figure 1:** An outreach practitioner demonstrates to children how a rocket takes off before they make their own straw rocket. NUSTEM career characteristics are visible in the background. Image Credit: Hertfordshire Library Service

The least comfortable chair was a stool, and the most comfortable chair was a large armchair. We used two snap-shot interviews, a short form of interviewing in which one or two questions are incorporated into a general conversation with participants. We used these to find out if we were meeting the needs and expectations of families. For those who returned for more than one session, we additionally asked if they carried out science activities after the sessions. We had post-session meetings and feedback forms for event facilitators that looked at ways to improve sessions and boost staff confidence in the practice of STEM delivery. We also tracked the number of participants attending and how many of our project STEM books were issued from the libraries.

It has been shown that public libraries are a successful and beneficial partner for universities (e.g., *Pekacar, 2017*) and, specifically, astronomy/STEM outreach (e.g., *Percy, 2017*). The inverse is also true: these collaborations have proven to be valuable to the library partner as it boosts their STEM offerings (e.g., *Shtivelband et al., 2017; LaConte, 2019*). However, higher education as a sector does not commonly partner with libraries. In this article, we will outline the importance and benefits of co-creating projects with libraries, why it is crucial to include parents and carers in

outreach, why discussing and highlighting STEM careers is vital, and how to sustain engagement in a library setting.

### Benefits of a university-library collaboration

The Department of PAM's OPE team initially reached out to Hertfordshire Libraries with the project idea of STEM/astronomy storytime sessions for families, and we found this idea aligned with many of their and our strategic aims.

Hertfordshire Libraries follow the Universal Library Offers (*Libraries Connected, 2018*), which aims to build a literate and confident society by developing and promoting creative reading activities in libraries. This project also supported the information and digital offer, ensuring local communities have access to quality information and access to creative and innovative technology. Finally, underpinning the Universal offers is "The Children's Promise", developed by The Association of Senior Children's and Education Librarians (ASCEL), which aims to ensure that children are inspired and have access to a range of inclusive and diverse books, and other information resources to support their literacy, learning, health and wellbeing, as well as imaginative cultural opportunities.

Therefore, this project aligned well with some of Hertfordshire Libraries' strategic aims.

One of our strategic OPE goals in the Department of PAM is to support and maintain the science capital of people in underserved and underrepresented communities (*O'Flynn & Burningham, 2020*). Libraries are familiar and trusted learning spaces, free to all, and often located in the centre of cities and towns (e.g., *Shtivelband et al., 2017; UK Government, 2017*). Additionally, libraries also remove barriers around inconvenience and intimidation that a participant may feel in having to come onto a university campus. For this project, we collaborated with four libraries located in the top 20% of IMD rankings in Hertfordshire, with local surrounding areas of the library being mostly 20-40% (*"Index of Multiple Deprivation Herts Rank," 2019*). Therefore, partnering with libraries enabled us to meet our strategic aims and reach these target communities, with which we otherwise would not be engaging.

We also found that although libraries offer wide-ranging programmes of events that provide exciting opportunities for co-created projects, there was a gap in the libraries' offerings for STEM storytime sessions. Hertfordshire libraries have a history of running successful STEM-themed activities for the community using VR, 3-D printing and Lego. Through the existing storytime programme for families with 0-8 years old children, the libraries had an established relationship with a diverse public and offered a welcoming and informal setting to learn. However, their storytime activity sessions did not have a science focus, as staff did not feel confident running science-related activities. The University was thus able to offer its expertise and training, and the Libraries provided an engaged public and safe third space (e.g., *Elmborg, 2011*) for learning to occur. By building upon pre-existing knowledge and learning from both the University and Library and considering our strategic goals, we were able to create a mutually aligned project.

Once we established this project, the OPE team worked with the Senior Librarian for Children and Young People to write the funding bid and design the in-session and at-home activities (Table 1). We selected this based on their creative elements, age appropriateness for 4-7 year-olds and

material cost, so families would be able to carry out activities on their own if they wished. In addition, together with the Early Years Librarian, we chose 25 books for the project that adequately showcased diverse role models, were age-appropriate, and accurately discussed science topics. We developed one list for children, and one list for their parents and carers. A Service Development and Project Librarian worked with us for the duration of the project's delivery and was invaluable in organising the library-specific logistics of all sessions, such as selecting appropriate event spaces and coordinating library staff.

In addition to the services and skills the library staff provided the University, we were able to share skills with the library staff. The University staff ran workshops on how to deliver and run the sessions, created training videos on how to run the activities, provided session scripts that were posted on the Hertfordshire Libraries cloud platform, and supported library staff throughout the project. Based on library staff feedback, we found that the library staff gained a breadth of skills, including presenting, communicating, managing events, and improving participants' engagement. Prior work (e.g., *Fraknoi et al., 2004*) has shown the mutual benefits of similar partnerships. In fact, two of the partner libraries will continue to run these sessions without a representative from the University, perhaps demonstrating that this programme became more sustainable as a result of skill sharing.

In addition, running outreach activities in libraries will bring new audiences with which the library and the university can engage. We found that just under 50% of participants had never been to a library event before (Figure 3), meaning that these events brought new patrons into the library. Further, we found that none of the participants had been to a University of Hertfordshire event (Figure 4). Through these events, PAM is able to interact and engage with a completely new audience.

Bringing science outreach into public libraries is also beneficial as libraries can play a major role in exposing children to books and developmental language opportunities (e.g., *Celano & Neuman, 2001*). This is crucial, as access to science requires, at least in part, familiarity with science vocabulary. Through this project we have increased the number of STEM books



**Figure 2:** STEM book loyalty cards and reward bookmark.

borrowed from our partner libraries by 1000 (Figure 5; Table 2). Table 2 compares the number of STEM books borrowed from our sequence of libraries and their STEM offerings. There was no significant increase in the number of STEM books borrowed from the libraries only with the loyalty card scheme compared to the libraries with no additional offerings. This demonstrates the impact of these specific STEM sessions on the promotion of STEM books in libraries.

### Why work with children aged 4-7 and their parents and carers?

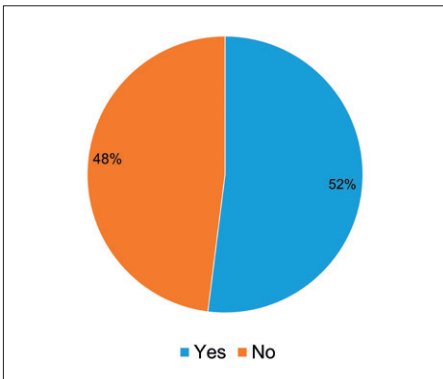
We decided to work with children of this age range as they still typically display positive attitudes about science and their science identity has not yet been solidified (e.g., *Archer et al., 2010*). In addition, in the UK, children under the age of 8 must be accompanied by a parent or carer to attend an event in a library. For this project, it was crucial to include parents and carers as they are a key influence on a child's developmental science capital (e.g., *DeWitt & Archer, 2015*). Parents' and carers' misconceptions surrounding science, scientists, and science careers, as well as

their own confidence in science, can have a large impact on a child's future science aspirations. Further, it is widely recognised that parents are one of the most influential forces in a young person's career and education decision-making (e.g., *Davenport et al., 2020*). Despite all of this, very few STEM interventions include parents and carers (e.g., *Archer et al., 2021*).

In order to encourage more young people to consider science as a possible career path, universities should explicitly involve parents and carers in their science outreach. When parents and carers are engaged and have confidence in science, it contributes to their child's motivation and performance in science (e.g., *Schmidt & Shumow, 2014*). Therefore, we aimed to have a high level of parental participation in our sessions. Library staff additionally shared their past experiences that parents were typically disengaged unless they were explicitly involved in the activities. In all of our activities, we strived to invite the parents and carers into the activities. For example, during the astronaut glove box activity (Table 1), we organised the space such that the adult and child could work

Book issues at libraries offering Cosmic Curiosity sessions and loyalty card scheme (four libraries)	Book issues at libraries only offering loyalty card scheme (three libraries)	Book issues in libraries with no additional offering (four libraries)
1000	463	405

**Table 2:** Comparison of the project linked STEM books issued in Hertfordshire Libraries.



**Figure 3:** Participants (n=75) were asked if they had ever been involved in an activity hosted by Hertfordshire Libraries before.



**Figure 4:** Participants (n=75) were asked if they had ever been involved in an activity hosted by the University of Hertfordshire before.

together. We ensured that the adults would be able to do all activities as well as the children. In order to increase the number of science books parents and carers took out of the library, we included a comprehensive list of adult science books on the back cover of the activity booklet that was designed for our sessions. However, we found this did not have as much impact as we anticipated, as only 2% of the total number of books taken out in relation to the project were adult books. In the future, we will need to do more to promote these books to parents and carers.

As part of our evaluation, we administered a task in which each participant produced a drawing of a scientist and later, rated their comfort level with science on a 5-point scale. We analysed these depictions to gain insight into their perceptions of scientists, which directly influenced how we ran our sessions. For example, we sought to highlight the achievements of scientists



**Figure 5:** Astronomy and STEM children's books available to participants. Image Credit: Hertfordshire Library Service

who identify as women if many drawings depicted scientists with stereotypically masculine characteristics. Similarly, if many depictions featured scientists wearing lab coats, we emphasised the diversity of science careers that are not limited to a lab setting. Additionally, this activity served as a valuable tool to engage those who arrived early to our sessions, and participants enjoyed drawing together as a family.

To understand parents' and carers' motivations for attending the session and to evaluate whether those needs were met, we conducted a snapshot interview with parents and carers. This resulted in valuable insights into the families with which we engaged. As research suggests (e.g., Gilligan et al., 2020), several parents expressed they felt unable to support their children's interest in space, which was initially sparked early in their education, due to their lack of knowledge of the subject. Furthermore, they struggled to find events catering to this age range. Thus, our findings reinforced that we were serving a need within the local community. We interviewed returning participants to determine their level of confidence in engaging in astronomy-related tasks with their child(ren) and whether or not they completed the at-home activities. Despite the limited number of individuals who returned for subsequent sessions, our interviews revealed that those who did were found to have gained confidence in carrying

out astronomy activities with their child(ren) and took out more science-related books as a direct result of our sessions.

### Why theme sessions around careers?

Research shows that career interests are relatively fluid until ages 5–6, when a child's view on what careers are appropriate for them begins to shrink (e.g., Bian, Leslie, & Cimpian, 2017). The factors that influence these decisions include perceived gender-appropriateness of careers, social level of careers, accessibility, and concepts of self-efficacy (e.g., Davenport et al., 2020). We thus decided to theme each session around a different career in space science, some of which would be familiar to participants and others that would not. We chose to use an astronaut, astronomer, aerospace engineer and a planetary geologist (Table 1).

We used The NUSTEM (Northumbria University STEM) STEM attributes (NUSTEM, 2020) for this project which were created by NUSTEM, a collective of STEM outreach practitioners and researchers based out of the University of Northumbria looking to increase diversity within STEM. Their research has shown that focusing on counter-stereotypical attributes such as creativity provides audiences with a new understanding of the skills needed to be a scientist and reduces children's stereotypes

of science and scientists (e.g., *Davenport, 2020*). In each session, we picked three of these STEM attributes that matched the career of the session (Table 1) and highlighted these to the families by displaying them and discussing how one would use these skills in the career. Children were also congratulated for using these skills throughout the session and were recognised for their achievements on the session certificate (Figure 6). All of the skills were on the back of the bookmark linked to the STEM book loyalty card scheme so children could tick them off as they went through the activities.

By working with children around this age range and their parents and carers, there is room to challenge or prevent what may be a child's misconceptions about themselves and their ability to pursue a science career. We based the activities on careers and framed them around career characteristics, and in doing so, created a space where children and their parents and carers could authentically experience being a scientist.

### How to sustain engagement in libraries

An astronomy intervention in a library setting presents an exciting opportunity to engage with parents and carers. However, free events in libraries often result in one-off

engagement, which may not be as effective as a multi-intervention engagement (e.g., *Archer et al., 2021*). Though we recognised it may be difficult for participants to attend every session due to other commitments, we utilised methods that would ensure families would continue to independently engage with astronomy at home and continue coming to the library to borrow STEM books.

To encourage participants to come back, we created specific certificates and badges for each session for attendees, a tactic which proved successful in previous outreach activities we have run with children of this age group. To continue engagement with astronomy at home, we provided the resources for the participants to carry out the activity, including an activity booklet containing each of the four sessions' activities, so even if participants could only attend one session, they could do all activities at home (Figure 7). To encourage them to take out more books, the activity booklet contained a reading list for adults and children, all of which were available in the libraries. Additionally, we gave every participant a STEM book loyalty card and subsequent bookmark as a reward if they loaned four books at the session (Figure 2). We made this into a small ceremony at the end where each child would come up and collect their activity booklet, resources for the at-home activity, certificate, badge and STEM

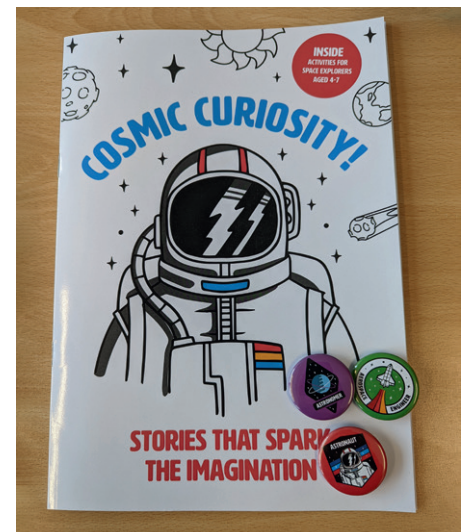


Figure 7: Activity booklet and badges available to participants.

book loyalty card. We congratulated them for being Aerospace Engineers (or Astronauts, Astronomers, or Planetary Scientists) and utilising the STEM attributes skills highlighted during the session. We then encouraged them to pick out as many STEM books as they liked from our display (Figure 5). We found this worked incredibly well to get every child to take out a STEM book at the end of the session. If we did not specifically highlight and direct the children to the books, they took out far fewer STEM books from the library.

We made continuous efforts to improve the quality of our sessions and enhance engagement levels by conducting post-event meetings and having all facilitator staff fill out feedback forms. These records were essential in improving future sessions and increasing participant engagement. For instance, we noticed that participants who arrived early often completed the Draw a Scientist Task before others arrived/finished and started to disengage. To address this, the library staff suggested incorporating space-themed colouring-in and word searches to keep these participants engaged. We implemented this solution across all future sessions and found that it minimised this disengagement. These insights were also valuable in identifying what worked well in events, allowing us to replicate our successes in future sessions. For example, one library facilitator noted, "The whole event was very successful. The planning was excellent because the order of activities led up to the final exciting event. The joint rocket launch was especially thrilling;

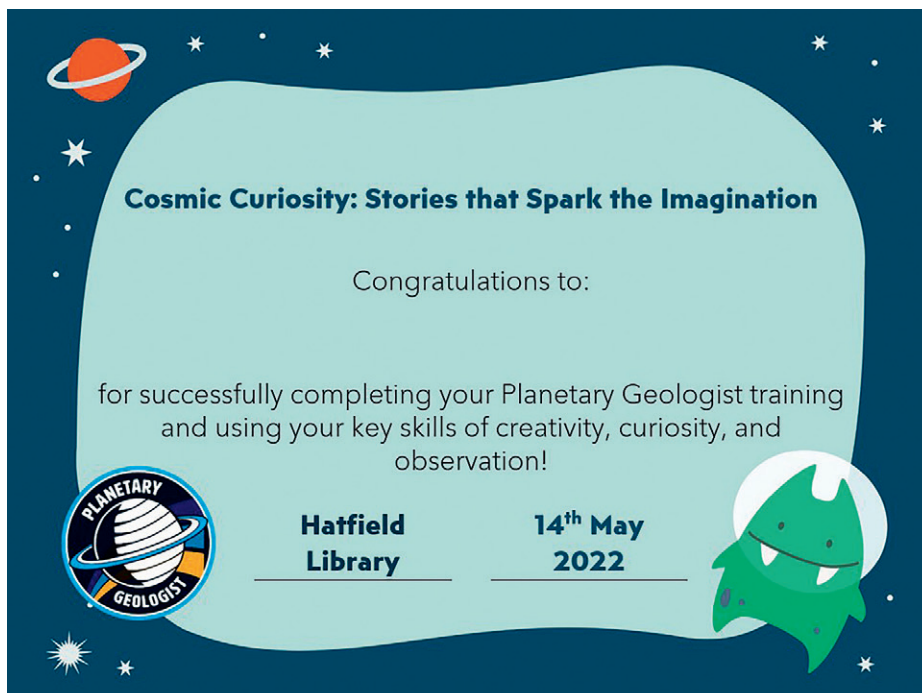


Figure 6: Certificate available to participants for the Planetary Geologist session.

you could feel the excitement in the room.” Launching the rocket together as a full group was not originally part of the session plan, but due to its success, we decided to include it in all future Aerospace Engineer sessions.

By engaging participants in the session and providing a means of sustained engagement, we found that not only was there an increase of almost 1000 STEM books taken out from our four partner libraries (Table 2), but as previously mentioned, through snapshot interviews, we learnt that the parents and carers experienced an increase in confidence to carry out astronomy activities at home with their children.

## Conclusions

Through our partnership with local libraries, we were able to reach parts of the community that are typically underserved by large academic institutions. We created the opportunity for impactful and enjoyable engagements for participants by combining literature and astronomy in a way that was comfortable and approachable. Libraries also provide a natural space to interact with families. We have found that working with families has a greater impact: not only are we shaping the scientific perceptions of the child, but the parent or carer, as well. By considering the sustainability and legacy of astronomy outreach with the participants and library staff, we have created more long-lasting engagement. Specifically, we have improved the confidence of families and library staff to carry out astronomy activities independently. We will continue working on Cosmic Curiosity with the same and new Hertfordshire libraries in the future and incorporate new outreach opportunities, such as our recently launched library exhibit on the James Webb Space Telescope.

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## Biography

**Nuala O’Flynn** is the Outreach and Public Engagement Manager for the University of Hertfordshire’s Department of Physics Astronomy and Maths in the UK. In her role, she runs a STEM school outreach programme for children aged 7-14 from disadvantaged backgrounds and connects a variety of publics with the research coming out of her department.