HOW DO CHILDREN EXPERIENCE PRIMARY SPACE EDUCATION?

Lynda Dunlop, Jeremy Airey, Maria Turkenburg and **Judith Bennett** look to the stars as they research children's learning about space

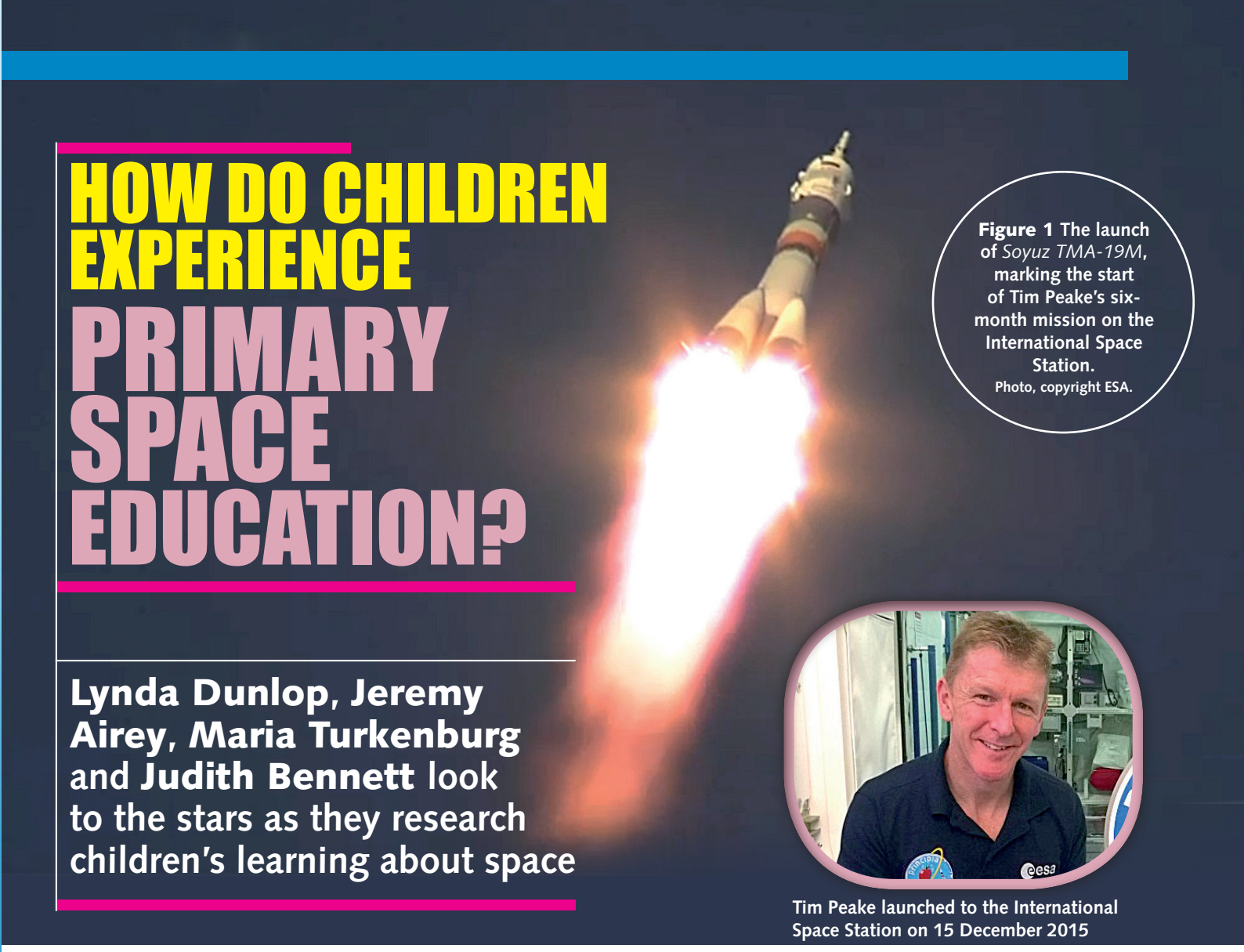

Figure 1 The launch of *Soyuz TMA-19M*, marking the start of Tim Peake's six-month mission on the International Space Station.
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Tim Peake launched to the International Space Station on 15 December 2015

In December 2015, the Principia mission was launched. This sent the first UK government astronaut to the International Space Station to maintain the weightless research laboratory and carry out scientific experiments for researchers on Earth. Many schools took part in local or national activities associated with the Principia mission.

Researchers at York undertook a three-year study to find out about the influence of human spaceflight on children's attitudes towards STEM subjects. Along with a large-scale survey, between November 2015 and July 2017, we interviewed children and teachers in primary schools across England to find out what their experiences were and to identify factors that facilitated or impeded engagement with STEM subjects (science, technology, engineering and mathematics), and space in particular.

We identified factors within four spheres of influence: the national and cultural, home and community, school and individual. This article focuses on school-level factors, which are likely to be of interest to those involved in primary science education.

At three times between November 2015 and June 2017 (before the launch of Principia, during Tim Peake's mission on the International Space Station, and after the return to Earth), we interviewed children, teachers and other school staff about their experiences of STEM education (and specifically space education). The interviews followed children from the Autumn term of year 5 (ages 9–10) until the Summer term of year 6 (ages 10–11). We spoke to a total of 62 children and 22 members of staff, including head teachers, subject coordinators, teachers and teaching assistants. The interviews were transcribed and analysed to identify themes that related to engagement with STEM subjects, and specifically space.

Findings

In the nine case-study schools we visited, five main school factors shaped how children experienced learning about STEM, and space in particular. These were school leadership, the role of teachers and other key educators, how the curriculum was taught, extracurricular opportunities and relationships with STEM experts.

School leadership

Leadership teams were important in shaping the curriculum and securing support and funding for additional activities, such as external continuing professional development (CPD), trips and hosting STEM-related activities. A supportive head teacher was seen to be valuable in helping to drive initiatives in schools and to raise the profile of STEM subjects and of the school. However, the influence of leaders was not always seen as positive on all STEM subjects: one teacher described how teachers felt

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under pressure from senior leaders to prioritise mathematics and English to secure good assessment results at the end of key stage 2 (age 10–11) and positive Ofsted inspection outcomes. As one teacher noted:

Maths and the English are our priority, according to the big bosses. So we have to get the maths and English done, and if they don't get done, then nothing else is important.

Middle-level leadership was also important. For example, subject coordinators played a key role in driving innovation, and their initiative in generating and pushing ideas forward was recognised by senior leaders.

Recruiting staff with STEM expertise was also seen as important in some schools, although it was recognised that teachers developed much of this in-post.

Teachers and other educators

Teachers were seen by children as important positive influences on their learning of, and attitudes towards, space and STEM subjects, both in and out of school. For example, one child reported:

I put 'teacher' as positive, because when we're learning about space in school, I think it's really interesting, and it makes me ask questions, as well, so that's why I've put that.

In addition to teaching the curriculum, teachers and other members of staff did a lot of work outside formal curriculum time, such as running clubs or taking the lead on space-related activity, which competed with other demands on non-teaching time including residentials, data analysis and monitoring, planning trips and managing curriculum change. Extracurricular STEM clubs often depended on colleagues with a particular 'drive'. These clubs were vulnerable to staff illness, staff changes and periods of increased workload, as a science coordinator noted:

Figure 2 Watching Tim Peake's launch live

National Science Week is in March and there was a reason we couldn't do it. We had moderation – not writing moderation but we couldn't do it that week.

Teachers saw a need to cover a broad and balanced curriculum, within and beyond science. For many, this was a reason for not doing more work on space, particularly in year 6. Teachers reported the need for curriculum links to be strong, and that it was important to avoid tenuous links to shoehorn topics into their teaching.

Curriculum implementation

Teachers in the study reported a range of approaches to teaching about space. Likewise, there was diversity in the ideas that children recalled learning. Many teachers taught space as part of a broader cross-curricular topic or theme area, or as part of a creative curriculum, such as 'out of this world', which lends itself to space and science more broadly.

Examples were given of space learning occurring across the curriculum, including religious studies, philosophy, art, design and technology. There were further examples of using space and STEM more broadly as a context through which children could practise learning habits such as perseverance, initiative, collaboration, creativity, and originality. Table 1 organises a non-exhaustive set of reported space-related teaching approaches according to the key purpose discernible:

- **space as a stimulus for creative or physical engagement;**
- **space as a stimulus for teaching science;**
- **space as a stimulus for practical work or working scientifically;**
- **space as a stimulus for teaching English and mathematics.**

Approaches to teaching and learning science were important to children. For example, children reported that they enjoyed watching the launch but that follow-up work (particularly factual writing) was not as interesting. This negative view about writing was common across schools, and some teachers were critical of the use of science as a vehicle for English and mathematics:

One of the things that we've had in a recent inspection was that we were not using enough maths and literacy within our science. Now, I'm of a different opinion. To me, science is hands on because you often find children who … have this interest, this fascination for science and I actually think that the way science is going now, it's knocking that out of them. (Science coordinator, school A)

Against this background of diversity in approach, some teachers were critical of the place of science in the curriculum:

So much of this stuff gets pushed to the side, sadly, because maths and English are our focuses; and it's so sad, because this is the stuff that really engages the kids. (Y5 teacher, school B)

Extracurricular experiences

Visits to universities, science centres, space centres, power stations, planetaria, local secondary schools, the

Figure 3 Primary children speaking to Dr Gerhard Gritner (left, in blue) from the European Astronaut Centre, who trained the Principia crew

Greenwich Observatory, the National STEM Learning Centre, The National Railway Museum and an aeronautical society were all important positive influences on the children. For some children, practical or interactive experiences were an important feature of this, for example seeing meteorites, programming, calculating space-related costs, or hearing the stories behind constellations. As one child reported:

I also enjoyed going to London to wear the spacesuit. It feels heavy, and they didn't like fully operate it, but it told us that there's water inside the spacesuit, to keep the astronauts cool.

Teachers also offered STEM-related extracurricular activities, including space ambassadors, explorers, programming, mathematics, design and technology and eco clubs, and in several schools, science week.

Science ambassadors in school A were children with an interest in science and who had volunteered at the beginning of the year to engage the school more in science, for example by speaking at assemblies and running competitions. This was something that the children in the focus group at that school were interested in being involved in, but for which they had not been selected.

Relationships with STEM experts

Another important school influence was relationships with external STEM experts, including astronauts, space scientists, experts in artificial intelligence and rocketry and marine biologists. This was observed in the types of career aspiration that the children reported. In a school where six children in the focus group wanted to become pilots, there had recently been an assembly on an air show for the Queen's birthday. In another, where they had a 'pet explorer' who taught the children about their work on the science of corals, many children wanted to be scientists or marine biologists. This latter relationship had been sustained over an extended period of time, involved different types of contact, including face-to-face and via Skype from the Arctic, and was linked to material on the school curriculum (climate change).

Teachers valued the impact that external experts could have; for example, one year 5 teacher described:

You are not just taking part in something that you yourselves have created, but … it can be like a whole science community experience, and you can have links with quite esteemed people through these sorts of things. And that is great, because it is about the real world, it is about connecting with the real world, and not just living between the walls of your classroom.

However, in one school this presented a challenge due to lack of reliability, where external partners had let the school down.

In addition to STEM experts, schools also engaged the support of science communicators and science educators external to the school who did 'wacky experiments' and science demonstrations with everyday objects.

Table 1 How primary teachers use space in their teaching

Space as a stimulus for creative or physical engagement	Space as a stimulus for teaching science, including space as an object of study	Space as a stimulus for practical work or working scientifically	Space as a stimulus for teaching English and mathematics
Design and make a space-themed bag or mobile.	Present ideas (about planets, or ideas about the universe through time).	Make and launch rockets (paper, water, air and bicarbonate of soda and vinegar).	Read a book about space.
Make a film about space on an iPad.	Work online, e.g. watch videos about space; spot mistakes about space on a teacher's blog.	Experimentally determine the relationship between crater diameter and height of fall.	Write a newspaper report (e.g. about what a probe would see as it passed Pluto), create an information sheet about a planet or an astronaut biography.
Participate in interactive storytelling (e.g. an alien landing site).	Make observations of Moon rocks and meteorites and use telescopes to observe the sky at night.	Compare the growth of rocket seeds that have been to space with those that have not.	Calculate e.g. distances in space, weights on different planets and temperature differences between planets.
Create a house so that people could survive on Mars.	Use Oreo cookies to represent the phases of the Moon; use children to represent planets to model orbital motion.	Make a Moon buggy to carry masses over a surface.	Read a story, or write a story, e.g. about an alien landing.
Space-themed sports day, e.g. using rockets instead of javelins.	Design a nutritious meal for an astronaut.	Make predictions and test hypotheses.	Measure angles and mass of objects.
Sing a song or rap about the planets.	Apply understanding of the water cycle to the International Space Station as a closed system.	Model orbits of planets using children.	Make a scale model of the solar system.

Conclusion

At a school level, teachers use a wide range of approaches to engage children with spaceflight and STEM, often going above and beyond the curriculum, drawing in external STEM experts, organising visits, and leading extracurricular activities. Teachers use space not only as an object of study, but also as a context for teaching English and mathematics and for creative engagement. Children value interactive and practical approaches to learning.

Acknowledgements

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Weblinks

Principia Mission: **www.esa.int/Our_Activities/Human_Spaceflight/Principia/About_Principia**

European Space Education Resource Office: **www.stem.org.uk/esero**

Lynda Dunlop, **Jeremy Airey** and **Maria Turkenburg** are members of the University of York Science Education Group (UYSEG). **Judith Bennett** is the Director of the group, and Salters' Professor of Science Education. UYSEG has a national and international reputation for its research and curriculum development.
Email: lynda.dunlop@york.ac.uk
Twitter: @UYSEG
Web: www.york.ac.uk/education/research/uyseg