

Liverpool John Moores University

National Schools Observatory Evaluation

Final Report: June 2020

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1. Introduction

The National Schools Observatory ([NSO](#)) is a web-based resource developed and run by Liverpool John Moores University (LJMU) that uses astronomy to support the teaching of STEM subjects¹ in UK and Ireland schools. Central to this is allowing teachers and students to make their own observations with the Liverpool Telescope - the world's largest fully robotic telescope. Registration to the NSO is free to schools and there are currently over 11,000 users signed up (with many more using the website resources without registering). Support material and resources are provided for students from upper-primary through to post-16, and for a range of subjects, but the majority of users are secondary or 6th-form science teachers and students.

In 2018 the NSO adopted an internal strategy and evaluation framework guided by a set of Generic Learning Outcomes (GLOs), which address the wider aims of the NSO, primarily influencing attitudes to STEM subjects.

NSO consequently wished to commission an in depth, independent, formal evaluation to see how the project performs against these new outcomes and inform ongoing development. This document is the third and final report, based on this evaluation.

2. Research Objectives

The evaluation had three primary objectives to provide:

- Evidence of impact
- Evidence of the strengths and weakness of the NSO
- A detailed review of current user's attitudes towards the project, and its Generic Learning Outcomes, against which developments in the future can be assessed.

3. Evaluation method and samples

3.1 Method

The evaluation method comprised two elements:

1. Quantitative

An invitation to complete an online survey was sent to all teachers and general NSO users. Teachers were also provided a link to questionnaires to be distributed to, and completed by,

¹ Science, Technology, Engineering and Mathematics

their primary and secondary students. The questionnaires focused on the learning impact of participation as defined by the GLOs in the NSO Evaluation Framework. They also asked about the personal experience of engaging with the NSO resources and activities along with demographics and questions to measure science capital.

The first invitation to take part in the survey was sent out in May 2019 and data analysed in the first interim report was based on responses received up until 1st August 2019. Since May 2019, those visiting the NSO website have been invited to complete a feedback questionnaire, so while there has been no specific further invitation to provide feedback, the opportunity has been there for users. Consequently, since August 2019 additional teachers and general users have provided feedback, along with a handful of secondary and primary students (see Table 1 below).

2. Qualitative

Across Phase 1 and Phase 2 qualitative research was conducted with a total sample of twelve (12) UK and Ireland schools. The qualitative research comprised:

- a. **In-depth interviews (IDIs)** with each lead teacher, teaching assistant or lab technician
- b. **Focus group discussions** with participating students in each school
- c. **Session or lesson observations** of NSO activities either as part of school curriculum (including GCSE Astronomy) or as an out of hours club.

3.2 Sample size and distribution

1. Quantitative

Table 1: Survey responses used for each report

Survey Type	Responses in Report 1	Responses in Report 2	Responses in Report 3
General Users	79	133	145
Teachers	36	51	55
Secondary Students	63	89	117
Primary Students	39	40	45

Student samples

The secondary student survey sample comprised responses from eighteen (18) schools, four of which had also taken part in the qualitative research.

The Primary student survey sample comprised all responses except two from a single school that had also taken part in the qualitative research.

Teacher samples

The distribution of teacher responses is harder to gauge as only around half (24) gave the name of their school. However, based on the school location most were from England (n=33), with further responses from Scotland (n=10), Wales (n=6), The Republic of Ireland (n=2) and one each from the USA, Austria, Turkey and Spain.

General user sample

Just over half (54 percent) of general user responses were from the UK (primarily England) with the remaining responses from the rest of the world and from a range of user types (e.g. students, teaching professionals, amateur astronomers etc.). For more sample details see the relevant section in the main findings.

2. Qualitative

The initial Phase 1 qualitative sample was recruited via an NSO invitation to take part in the evaluation. The response was initially limited and responses predominantly from English private secondary schools. In order to create a more mixed sample NSO subsequently invited schools that had shown a high degree of NSO activity, resulting in a more diverse mix of school types, in particular, better representation from the state sector. At the start of Phase 2 it was agreed that having feedback from additional schools, particularly about the new STEM Club resources, would be useful. To do this, two additional schools were recruited to take part, one in Edinburgh and one in London.

At the same time, when attempting to re-contact the Phase 1 schools for their follow up visit, four out of the original ten were unwilling or unable to take part. In one case this was because they had not used NSO since Phase 1, in one other it was because they no longer use NSO at all, and for two, because a suitable visit could not be agreed. The final sample of twelve (12) schools is as follows:

Table 2: Case study school sample

School	Location: Country	Location: Type	Type	Intake	Visit Phase
1	England – South	Suburban	Private	Secondary	P1
2	England – South	Suburban	Private	Primary	P1 & P2
3	England – London	Suburban	State – Catholic	Primary	P1
4	England – London	Suburban	State	Secondary	P1 & P2
5	England – West Midlands	Urban	State	Secondary	P1 & P2
6	England – West Midlands	Rural	State	Primary	P1 & P2
7	England – Yorkshire	Suburban	State	Secondary	P1 & P2
8	England – North West	Urban	State - Selective	Secondary	P1
9	Wales	Rural	State	Secondary	P1 & P2

10	Republic of Ireland	Rural	State	Primary	P1
11	England- London	Suburban	Private	Secondary	P2
12	Scotland-Edinburgh	Suburban	State	Secondary	P2

Note on samples

The secondary student and general user survey results are presented as percentages. However, the teacher and primary student surveys have samples of less than n=100 and consequently are reported as whole numbers only. Some percentage figures may come to greater than 100% due to rounding.

Note on quote attribution

Where known, students and teachers are associated with the schooling level they attend or work at, either primary or secondary. However, the General User survey data do not make this distinction, consequently teachers or students responding to this survey are simply referred to as Student or Teacher.

4. Summary, Conclusions and Recommendations

4.1 SUMMARY

They love the idea that they are doing something pro astronomers do, that it's real images, and that LTImage is a version of something that is used in a university. It moves it away from it being something in school that their teacher is making them do. Secondary teacher

The Inspirational aspect is that because it is free, I can use it while in Sixth Form. Use bits of it for my EPQ. When before this I never thought I would be able to get access to such a thing. Believing that the only time I might get close to being able to use such technology would be at a University Level. Secondary student

1. Introduction

- NSO is popular with users; teachers, school students and general users. It provides an opportunity not easily available elsewhere, to take and manipulate unique images that can be subsequently used to better understand the universe.
- Use of NSO has a noticeable impact on learning outcomes, particularly among school students, both primary and secondary. This can be measured in terms of enjoyment, acquiring new knowledge and skills and changing awareness, behaviour and attitudes through being inspired.

2. Teacher feedback

- Nearly all teacher feedback was from the UK, most of whom are specialist science teachers at secondary schools. In many cases it is used for teaching Astronomy GCSE or as all or part of after school STEM club activity. Otherwise it is used for teaching other subjects in primary or secondary general science lessons.
- The most cited reasons for using NSO were the opportunity to use a resource not available at school, a professional telescope using real data. Also important was that it was free to use and had a hands-on, practical element to the website that can create a real impact in the classroom.
- While NSO does not completely cover the new England GCSE curriculum it is still considered an invaluable resource to help teach it.
- The most cited resource used was LTImage to view and analyse images along with taking of observations with the telescope. Also well used have been the Learn section and classroom focused activities.

Learning impact

- Teachers agreed very much that their students enjoyed the NSO lessons or sessions, giving a mean score of 4.8 out of 5.0. They also widely agreed that it helped students build their knowledge about STEM and that its use enabled them to apply practical skills to problem solving.
- Conducting astronomy like a professional using real data helps build confidence and ideas around career options for students.
- It encourages team as well as independent working and helps students understand the scientific process and applying research and technical skills. Some teachers stressed its value in helping students who learn in different ways who otherwise might disengage from STEM subjects.
- A number of teachers identified clear career outcomes stemming from using NSO where students have gone on to study related subjects at A Level and university.
- Using NSO has brought personal benefit to teachers; most importantly by enabling them to teach a science and/or STEM subject or topic in a more exciting way.

Looking forward

- Teachers were very pleased with the NSO website and summarised it as an excellent resource that was inspiring, useful and exciting.
- Suggested changes to the **website** included more content relevant to the GCSE curriculum as well as KS3 and A-level, plus more direct pathways to primary level content. More video content, including 'how to' videos on using NSO for both teachers and students and a more simplified way of taking and downloading images, possibly via a web-based software. Having acknowledgement when image requests are received and images are ready for downloading.
- Those who attended **CPD** were very positive about its benefits, but many others did not attend due to a lack of awareness, wrong timing or a lack of time, difficulty in travelling or in finding cover while they are away. Having CPD via webinars was one suggested way to overcome these barriers.
- Suggestions for **increasing use** of NSO focused on marketing to academies (rather than individual schools) via support for regional ambassadors, promoting it at science fairs, teacher summer schools, the Association for Science Education (ASE) conference and other teacher participated events.
- Charging for NSO use was not an option teachers' generally would be happy with, but some appear willing to pay a small subscription or pay for certain value-added services.

STEM Club resources

- Based on qualitative feedback from six schools, the response to the new resources was universally positive.
- It provides the flexibility to provide astronomy in secondary schools which might not otherwise be available but also accessible to older primary school pupils.

- Teachers liked the pick ‘n’ mix nature of the resource booklet for varying ability levels, providing ideas but not lesson plans or being too prescriptive.
- Having everything in a single package was appreciated – rather than having to create your own resources.
- Having the certificates for each level, and the bronze, silver and gold levels, all help to instil a sense of recognition of effort and a sense of progression for students.
- Being a free resource is essential for some schools.
- Can be used both in STEM clubs and science lessons.
- Could fit well with new Welsh curriculum.
- Also works well across different year groups and abilities.

Issues encountered were:

- Slow download speeds for images, leading to hold ups in class.
- A request for tasks that require less photocopying.
- A request for better guidance for primary pupils.

NSO branding

- Teachers are aware of LJM’s role in running NSO but don’t think their students are, but as long as the resources are good, the source is less important to know.
- However, if LJM wish to raise its profile, gain credit and potentially attract students then higher visibility would be a good idea

3. Student feedback

- Most of the secondary students who complete the survey self-identify as liking STEM subjects at school, with many wanting to work in a STEM related job in the future.
- Secondary students have two primary motivations to study astronomy; either through an interest in astronomy or using it as a way to enhance their study and career prospects.
- Primary students were less likely to self-identify as ‘science people’ or aspire to work in a science related job.

Learning impact

- **Enjoyment:** For nearly all students the most enjoyable aspect of using the NSO was being able to take and manipulate images that are unique to the user. Primary students also enjoyed the combination of requesting/manipulating images alongside activities and quizzes targeted at their age group.
- Using NSO provides both secondary and primary students inspiration and a sense of doing something special not usually available at school or home.
- **Knowledge:** All secondary students in the survey said they had learnt something from their NSO session; about the moon, universe and space, about astronomy as a science and using the NSO website, telescope and LTImage.

- **Skills:** Secondary students were most likely to say they'd developed their computing skills as a result of using the NSO website. Secondary and primary students at the case study schools reported learning a number of specific skills such as classifying galaxies, measuring, using Excel, team and presentation skills.
- **Changes in attitudes and behaviour:** Just under two-thirds (61 percent) of secondary students felt more interested in STEM after using NSO. Some students said they didn't particularly enjoy STEM subjects but doing astronomy and using the NSO gave them an interest in science they didn't think they had before.
- 57 percent of secondary students in the survey agreed very much that they wanted to find out more as a result of using NSO. 55 percent agreed very much that the knowledge they have learnt can be used for other activities. Half also agreed very much that they felt more positive about STEM and 52 percent wanted to participate in further STEM activities or study or work in STEM related fields.
- **Longer term impact** manifests itself in growing confidence in using NSO, a stronger connection to the study of astronomy and a closer connection with NSO by feeling part of a 'club' of users.
- **Sharing** their learning and experience took place outside of school through helping their younger siblings learn about space and finding a shared interest with their parents.

Looking forward

- **Website usability:** Secondary students suggested simplifying the image requesting and downloading process. They suggested having a video tutorial on how to use the website and a search function to see specific objects. They highlighted that LTImage doesn't work with Mac computers and can be difficult to download and use outside of school. Primary students identified what they thought were bugs in the quizzes².
- **Website content:** Suggestions on the content that included; more videos and quizzes (particularly for GCSE students), more news content from the world of astronomy and to have a more striking home page with photos of the latest observations.

4. General user feedback

- General users comprise university students and researchers, amateur and professional astronomers as well as some individual school and FE college students. They were most likely to use the Go Observing resource to take observations, as well as the Learn section and LTImage. The most common use for the website is for information only, followed by use of the telescope.
- Their **use** revolves around a general **exploration of the universe** rather than the more science learning focus that teachers reported. The **life cycle of the star** was one topic that many users mentioned using the NSO to find out about.

² Now rectified

Learning impact

- Most general users believed they had learnt something new from using the NSO with this learning primarily new knowledge about the universe; the moon, planets, stars etc. General users were most likely to say that the skill they learnt most from using NSO was the scientific method.
- Over half (59 percent) said they were more interested in STEM as a result of using NSO. The main reported consequences of having used the NSO website are that users want to find out more (69 percent).

4.2 CONCLUSIONS AND RECOMMENDATIONS

NSO is a well-received and highly appreciated resource for teachers, students and general users. The capability to request, take and receive real images from the telescope make it a unique opportunity in the teaching and learning of STEM in general and astronomy in particular. While most teachers said that charging for its use would be a problem and possible deterrent from using it, there does appear to be acceptance of having some chargeable value-added features or a small subscription fee if LJMU choose this route.

For secondary students the website is a valuable resource for self-led learning as well as team activities. For primary students working on images with their teacher's help or self-led activities and quizzes are popular options. The fact that the NSO has this capacity to provide for different age ranges and learning styles is important. This could be enhanced by having clearer signposting to where primary students and their teachers could find easier to use content and resources as well as videos on 'how to' for different aspects of the website. NSO also appears to open up learning for those who do not easily engage with STEM. This could be enhanced by having signposted content for SEN students and their teachers.

The evaluation demonstrates that NSO delivers a range of learning outcomes, both immediate, such as enjoyment, new knowledge and skills, as well as longer term changes in attitudes and behaviour. Learning could be enhanced by additional content such as the history of astronomy and news updates on astronomy stories. NSO also appears to successfully encourage young people to follow a STEM path in their education and career. To support this more, signposting for more information about studying and working in astronomy, astrophysics or other related subjects and industries might prove useful.

Changes to the England GCSE Astronomy curriculum and the removal of continuous assessment have meant that NSO does not provide full curriculum coverage and its use as a coursework tool has been reduced. Closer alignment with the new curriculum and providing teaching resources that enhance the course would ensure continuing relevance for this qualification. In the meantime, looking at areas where NSO can align with current UK (separate nations curricula) and Ireland science teaching can help ensure its continuing use by teachers in class rather than solely an enrichment resource or for after school clubs. The new STEM Club resources provide flexible solutions for teachers keen to see astronomy in formal and in-formal sessions and lessons. Continuing to develop and promote this aspect of NSO's work will be widely welcomed by teachers.

The big draw of being able to take, receive and manipulate images is a big part of NSO's success. While teachers and secondary students can use the necessary tools, including LTIImage, fairly easily, it could be enhanced and/or changed to make it easier for teachers and more accessible for younger users; possibly by being a web-based tool rather than the

current software that doesn't always sit easily on school platforms and is not Mac OS compatible.

There is evidence of schools both wishing to collaborate with other schools on experiments or other shared experiences and in running local networks of schools, both vertically (i.e. with primary schools) and horizontally. Can a wider network of NSO users be established to work on joint experiments and projects? Can NSO better facilitate local NSO secondary school ambassadors to support the teaching of astronomy in primary schools?

LJMU isn't easily recognised as the source of NSO – raising its brand profile would deliver credit where due and possibly instil an interest in studying there among students and teachers.

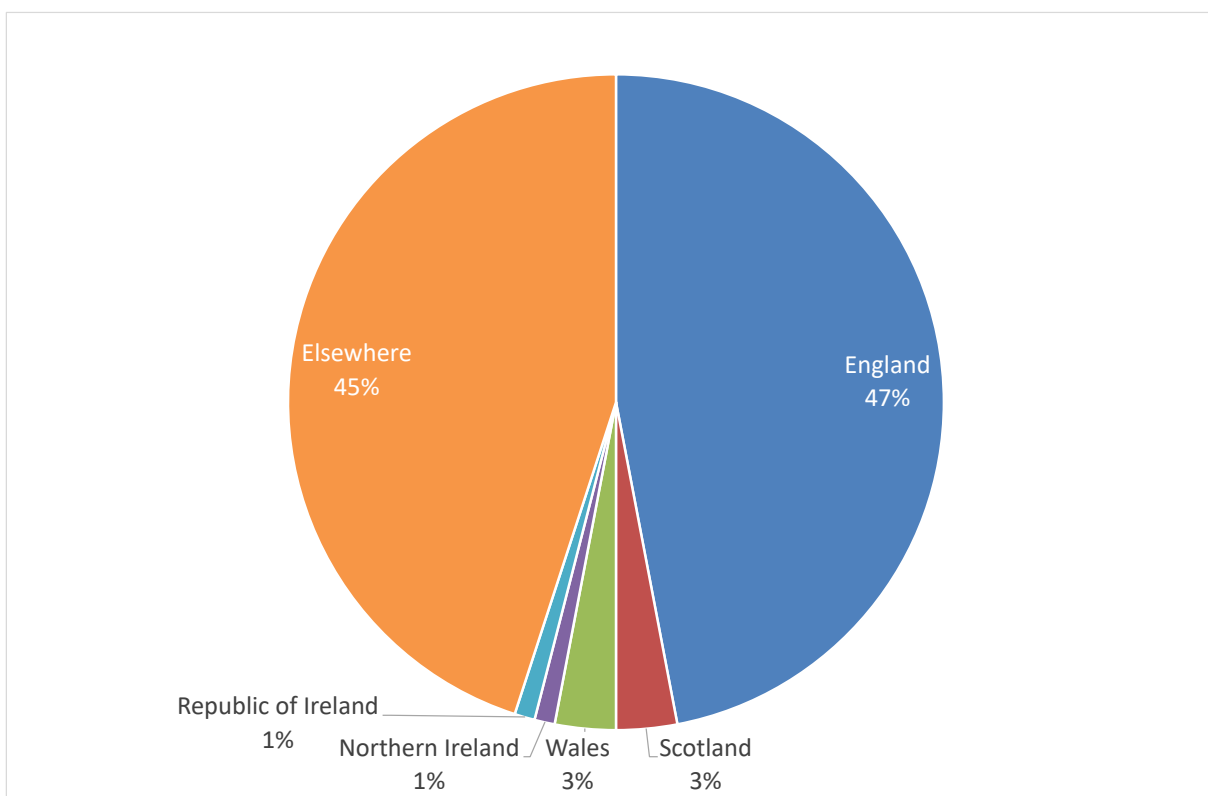
As a result of the Covid-19 pandemic, for the foreseeable future, online teaching and learning tools are going to play a much bigger role than before and NSO can and should be part of this adjusted approach. Promoting it as an ideal home school and distance learning tool should help ensure a continuing loyal and large user base. It may also present itself as an opportune moment to introduce some charging for value added elements, for example ordering of HD printed images.

5. MAIN FINDINGS

WHO IS USING NSO: SURVEY SAMPLES

Location: The teacher and general user samples point to a majority user base in the UK, in particular, England, but with a substantial number based outside of the UK or Ireland (particularly the USA)³.

Figure 1: Distribution of general user survey respondents n=145



³ This is broadly consistent with current self-reported NSO user country of origin (As of 21/05/2020 from 1360 NSO users who report a country):

- 63% GB + NI
- 3% Republic of Ireland
- 10% US
- 5% India
- 4% Spain
- 1% Canada

Table 3: Location of general users in sample (n=145)

Location	% of responses	Number of responses
England	47%	68
Scotland	3%	4
Wales	3%	5
Northern Ireland	1%	1
Republic of Ireland	1%	2
Elsewhere:	45%	65
	USA	18
	India	15
	Canada	5
	Spain	3

Additional countries include: Argentina, Colombia, Brazil, France, Turkey, South Africa, New Zealand, Morocco, Malta and Kazakhstan.

Among **teachers** the geographical distribution was predominantly from England (33). Along with teachers based in Scotland (10), Wales (6) and the Republic of Ireland (2) and one each from the USA, Spain, Turkey and Austria.

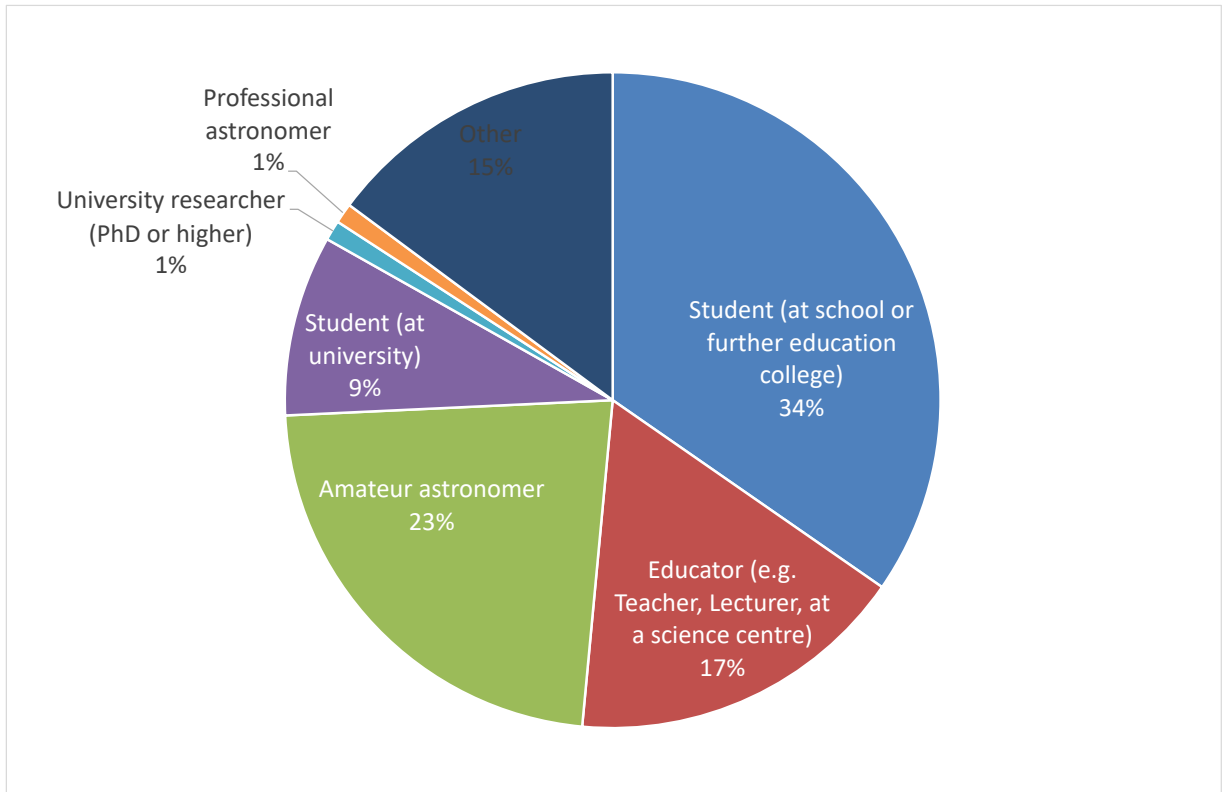
Table 4: Location of teacher respondents (n=55)

Location	% of responses	Number of responses
England	60%	33
Scotland	18%	10
Wales	11%	6
Northern Ireland	-	-
Republic of Ireland	3%	2
Elsewhere	8%	3

Types of general user (See Fig.2 below): Those answering the general user survey were roughly split between:

- Students, (43 percent), comprising mostly (34 percent) at school rather than university (9 percent).
- Educators, two thirds of whom were teachers, with the remainder being lecturers (21 percent of educators), technicians and one physics network coordinator
- Astronomers, primarily amateur (23 percent) with one professional. Among those indicating 'other' many were also amateur astronomers.

Figure 2: Types of general user (n=141)



The remainder of report is divided into three sections that provides feedback, both quantitative and qualitative, from the three primary user groups; educators, school students and general users (including university students and researchers and school students responding individually).

5.1 PART ONE: TEACHER FEEDBACK

[NSO is an] *Inspirational resource. A unique opportunity for children to take images of space. It's very motivational, they can use it to see themselves as a scientist. Primary teacher*

5.1.1 WHAT TEACHERS USE NSO?

Teaching subject: Among teachers answering the general users survey the majority (12) were physics teachers but most of whom also taught another science: chemistry (8), biology (7). Among those stating 'other' two taught GCSE Astronomy. All except three were secondary teachers.

Among teachers completing the teacher survey who responded to the question, most (28) said they taught physics with eight (8) teaching astronomy.

Table 5: Types of teachers using NSO

Type	General user survey (n=16) Number of responses	Teacher survey (n=34) Number of responses
Primary	3	-
Physics	12	28
Maths	3	5
Chemistry	8	4
Biology	7	1
Engineering	1	1
ICT/Computer Science	0	4
Geography	0	1
Education not specified	2	-
Astronomy	2	8

Most teachers responding were specialist science teachers, again suggesting they work in secondary rather than primary schools. See Table 6 below.

Table 6: Type of teacher responding in teacher survey (n=53)

Teacher type	Number of responses
Specialist subject teacher	34
General science teacher	7
Technician	4
General class teacher	4
Teaching assistant	1
Other	3

Teaching location: Most (43) completing the teacher survey are based at a school but with some also teaching at FE college (2), home school (6) or adult education college (2).

Teaching level: Among school-based teachers, most (36 of 53 responding) teach secondary students from 11-18 years old. Among those stating they taught other categories it was a mix of teaching SEN students, primary and secondary students and adults.

Table 7: Teaching level among teacher survey respondents (n=53)

Teaching level	Number of responses
Secondary (11-18 years old)	36
Secondary (11-16 years old only)	3
Primary (Up until 11 years old)	7
16 + only	3
Other	8

Deprivation levels: A third (17) of teachers said their school had 20% or more students entitled to free school meals⁴.

5.1.2 LESSONS AND SESSIONS USING NSO: FREQUENCY AND AGE OF STUDENTS

Frequency of using NSO: Most (41 of 49) teachers in the teacher survey said they had used NSO resources in lessons or sessions, while a third (5 out of 15) educators in the general user survey had done so. (See Table 8 below). Most (in both surveys) had last done so within 6 months of completing the survey. Frequency of running lessons or sessions was fairly high

⁴ More than 20% of students entitled to free school meals is one measure of deprivation among student intake

among teacher survey respondents; around a third said they had used NSO resources more than five times in the previous 12 months, with most of the remainder having done so more than twice. Use among educators in the general user survey was less frequent.

Ideally, I would use it two or three weeks every half term – if we set it up in September then we have a look at how the images are changing throughout the year. i.e. pick the moon, a galaxy or planet that you want to look at. Primary teacher

Table 8: Frequency of using NSO resources for teaching in the past 12 months

Frequency of use	All teachers (n=50)	Teacher survey (n=44)	General user survey (n=6)
Just once	8	7	1
2 or 3	13	10	3
4 or 5	8	7	1
More than 5	16	15	1
Don't remember	5	5	0

Use by age: The highest use of NSO in school is with students in England Years 8-11 (aged 12-16). Primary use is more limited, as is use with older (Year 12-13/ 6th form) students.

Table 9: Age of students using NSO

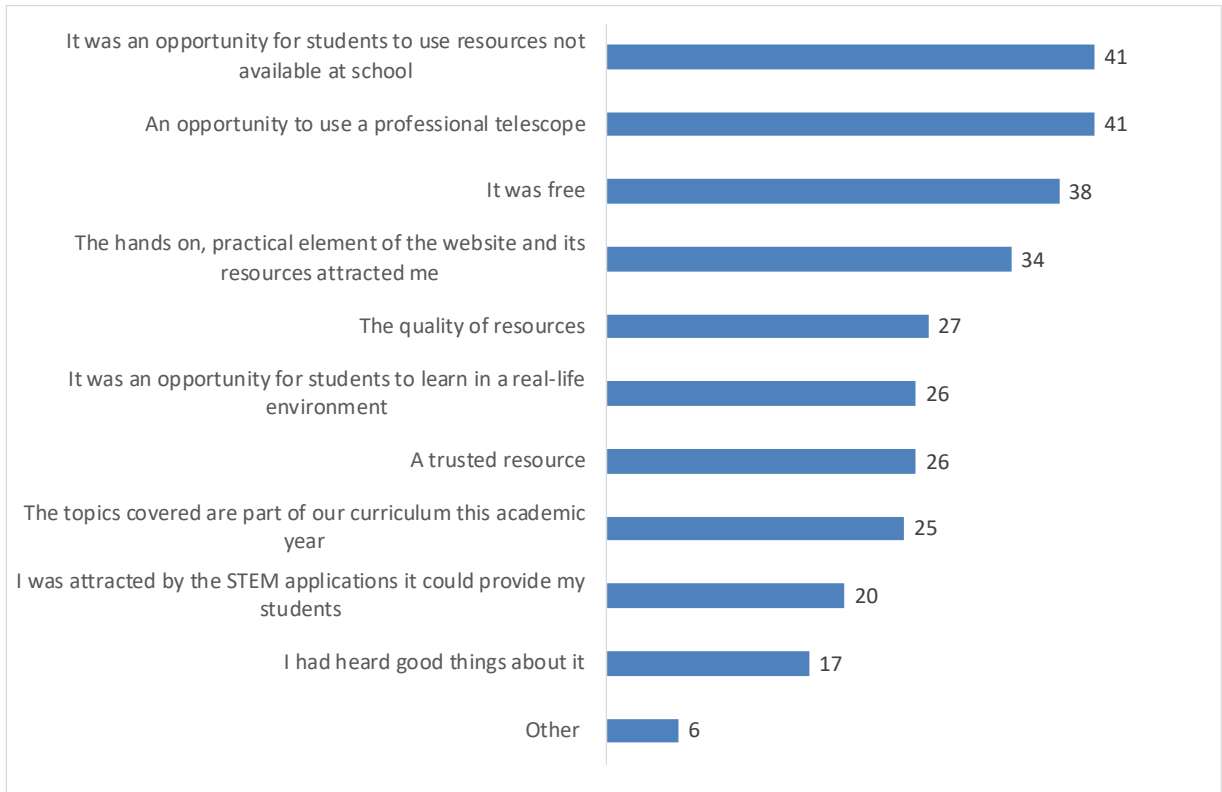
Age of students	All teachers (n=49)	Teacher survey (n=43)	General user survey (n=6)
Under 5s	1	1	0
5-7	2	1	1
8-11	7	6	1
12-14	31	28	3
15-16	25	21	4
17-18	13	9	4
Other	1	1	0

5.1.3 REASONS FOR USING NSO

The most cited reasons in the survey for using NSO were the opportunity to use a **professional telescope, a resource not available at school**. Also important was that it was

free to use and the **hands-on, practical** element making it an appealing resource for teaching. See Fig.3 below.

Figure 3: Reasons for using NSO at school. (Number of responses. All teachers responding n=50)



NSO gives the staff access to real life data to teach with, which is great. Primary teacher

Further drivers for use emerged from the qualitative research...

Some primary teachers use it as a way of starting a **space-based topic** around the earth, moon and sun. While not particularly user friendly for primary students the idea of taking your own image has such a unique draw it makes NSO worth persevering with.

And then I discovered about doing observation using the camera and I thought they [the children] are gonna be really excited about the idea of getting the telescope to take a photograph for them and they were, very excited about doing that. Primary teacher

I generally use it to create a sense of awe and wonder. Use it for inspiration at the start of a space centred topic. Secondary teacher

Even though other teachers didn't see it as fitting with the curriculum they still liked to use it as an **enrichment** resource.

Sadly, it doesn't fit to any particular topics in the curriculum, but we use it as an enrichment tool, using it for additional information and to engage the children with science. Primary teacher

At schools teaching **GCSE astronomy**, running astronomy clubs for younger students was a valuable way to introduce the subject and the NSO plays a critical role in enabling this, when access to dark skies and a telescope are not possible. For GCSE, NSO is essential for students to carry out unaided and aided observations as part of the course and more broadly using NSO was considered really helpful in teaching students how to learn independently.

I couldn't run a group astronomy club without it. Secondary teacher

Before NSO, in the club there was nothing for them to do other than watch Brian Cox videos. Secondary teacher

The fact that they can go online and do observations makes it possible in a school like this to run GCSE Astronomy. Secondary teacher

Teachers pointed out the advantage of running a STEM Club that develops into the GCSE Astronomy course, with the exam to be taken in Y10, before the pressure of other GCSEs builds up.

When it's the only exam they've got to worry about. Secondary teacher

Additionally, starting as an informal club helps ensure students first and foremost enjoy the subject developing a love of astronomy rather than just being seen as another exam to be passed.

NSO is considered a **trusted** source, with a known provenance that can be relied on was also important, rather than students Googling sources and using whatever they found first.

A lot of students treat everything on the internet as being of equal merit. Secondary teacher

Two teachers ran GEMS (Girls in Engineering Maths and Science) lunch-time clubs (in one case against a lack of enthusiasm from the senior management team despite it being a girl's school).

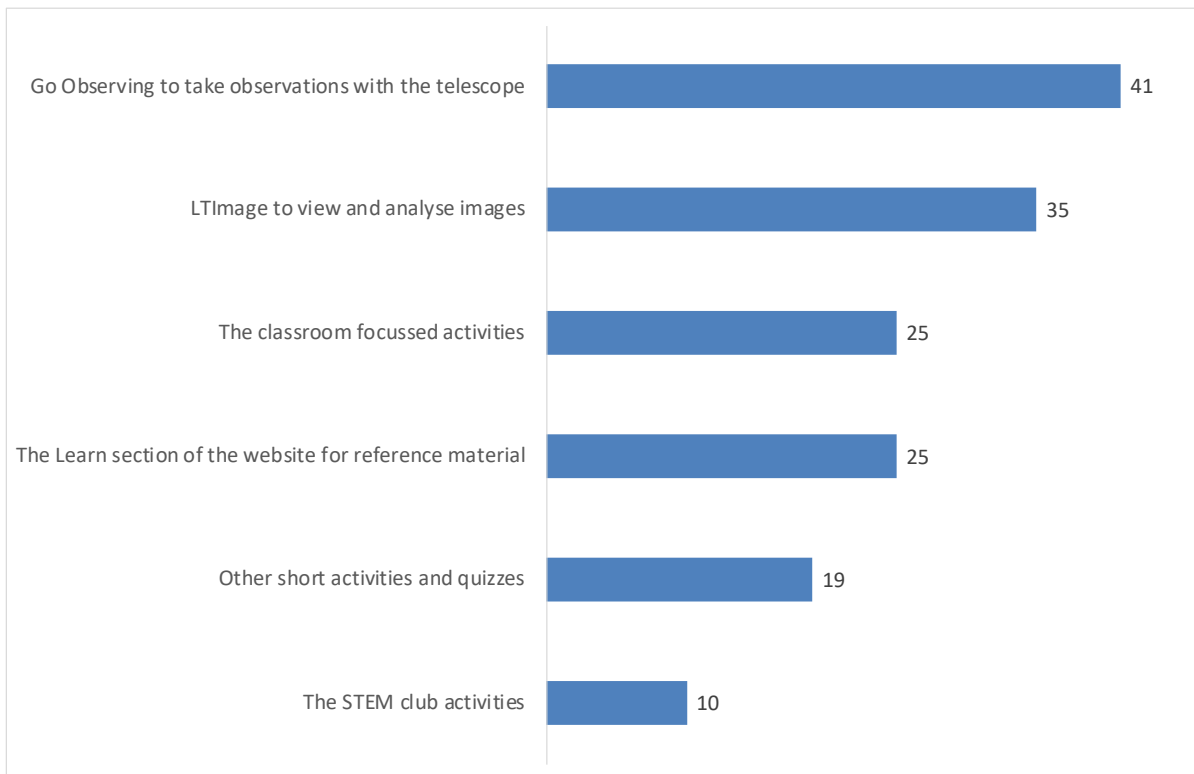
Interestingly, one state school teacher highlighted the potential marketing value to their school in running an NSO based STEM Club/ GCSE, as it can create a good impression on prospective students and their parents.

It's good as a competitive school to have Astronomy going on ... makes the school look good for prospects... at open evening we always have the telescope out. Secondary teacher

5.1.4 RESOURCES USED

The most cited resource used was LTIImage to view and analyse images along with taking of observations with the telescope. However almost as well used are the Learn section and classroom focused activities. Least used are the STEM club activities⁵.

Figure 4: NSO resources used. (Number of responses. All teachers responding n=48)



Teachers were asked if there were any further parts of the website or resources that were particularly effective for learning and teaching. Those cited were:

- The Night Sky

The Night Sky - a live update on the sky to prepare for observations. This was part of the planning for night sky observations, it helped with taking the practical steps to agreeing a celestial target to observe. Teacher

⁵ The new STEM Club resource booklet was not available when most of these responses were given.

- The Moonsaic

The Moonsaic - as all the student could take part in putting images together, it was then extended for some in identifying features. Teacher

- GCSE astronomy guides including images
- Archived photographs through the telescope
- Masquerade option

The "Masquerade" option is invaluable to help me track a student and understand what they see when they use the website. Teacher

- Resource databases in the "Learn" section

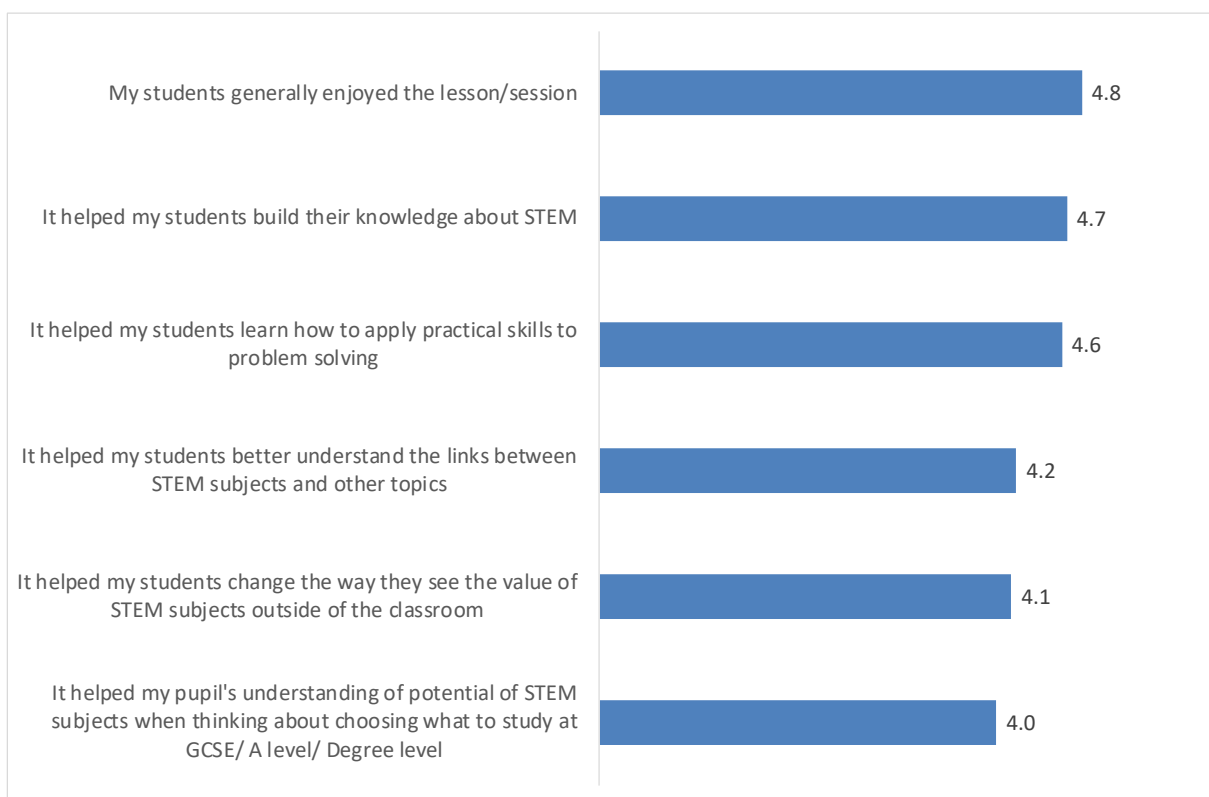
5.1.5 LEARNING IMPACT ON STUDENTS

As soon as the kids realised they could take pictures using the telescope, they wanted to discover more and more. As soon as the images come back, they are even more curious about [it]. Secondary teacher

Teachers agreed very much that their students enjoyed the NSO lessons or sessions, giving a mean score of 4.8 out of 5.0. They also widely agreed that that it helped students build their knowledge about STEM and that they learn to apply practical skills to problem solving. Of lesser perceived impact was it helping students to understand the potential of STEM subjects when choosing what to study at their next level (i.e. GCSE, A level, degree) although even in this case, the mean score was 4.0 out of 5.0. See Fig.5 below.

They love the idea that they are doing something pro astronomers do, that it's real images, and that LTImage is a version of something that is used in a university. It moves it away from it being something in school that their teacher is making them do. Secondary teacher

Figure 5: Impact on students (Scale Agree very much =5, Disagree very much =1 Mean score out of 5. All responding teachers n=45)



When given the option to explain in more detail what benefits they felt the NSO could bring to their students in both the surveys and qualitative research, teachers highlighted the following:

- Enables students to conduct astronomy in the same way **as professional astronomers**

Being able to use/have access to a telescope that is used by professional astronomers for free and learn how to plan observations and process images requested. Teacher

They are learning how data is collected in a real scientific community. Primary teacher

This is about doing what astronomers do and I think that's absolutely brilliant. Secondary teacher

Doing measurements is just a real sense of achievement, how a real astronomer would do it ...then they're saying it gave them a real buzz. Secondary teacher

Understanding of "real" astronomy - for example, the difficulty of linking the image taken of a section of the Moon to the features on our Moon map; independent problem-solving with the LT image processing; a chance to link our visit to telescopes at La Palma (where we saw the Liverpool Telescope) to actually using that equipment - a wonderful opportunity: thank you! Teacher

- Students can conduct science using **real data**

My students are doing real science. Teacher

Being able to link their learning to real observations. Teacher

- It makes an otherwise abstract subject **practical**

The children really appreciate that they can make real observations. It's another way of being practical for a subject which is generally abstract. Primary teacher

The relevancy of science to the everyday environment. Teacher

- Helps build student research and technical **skills**

I think an understanding of the technical skills involved in making and analysing astronomical data. Teacher

I like the fact that it raises questions and makes the children keen to find the answers. Primary teacher

- Provides access to **high quality resources**

Access to information and skills not normally available in school. Teacher

Access to professional standard measurement data enabling investigation of otherwise inaccessible projects. Teacher

Children in school don't actually get to do any astronomy as a rule. We have a nice 130 mm Celestron at school and when we have tried to arrange an observation session in the winter it never works. By the time you have picked a date to go out, completed the paperwork and organised it with everyone, it turns out to be cloudy on the day. NSO solved that problem. Teacher

- Helps to build ideas around **career options**

Link to a career that they could see themselves doing. Aspirations for pupils who had not considered STEM subjects. Teacher

Inspiring them to consider astronomy/astrophysics options in the future. Teacher

- Builds **confidence**

The confidence to learn to do something completely new and quite complex from scratch, whilst using their combined skills from other subject areas in order to achieve it. Teacher

Confidence and pride at the unique techniques they are using and how they have gained skills that the other science students have not had the opportunity to experience. Teacher

Those who had time and interest explored the resources and built an interest to want to take further images. Teacher

- Supports **independent learning**. One teacher pointed out that the NSO is valuable in enabling students to strike the right balance between self-led research and support from the teacher or website.

NSO has the balance right of how much autonomy [students] have and how much gets done for them. Secondary teacher

Knowledge: When asked what specific knowledge their students had gained from using NSO resources. They can be categorised into knowledge about:

- Space; the planets, the moon and stars

About moons of Jupiter, galaxies, nebulae and lots more. Teacher

Knowledge of our solar system, interactions between Earth Moon and Sun, our place in the Universe from a planetary perspective and a galactic perspective. Teacher

Understanding that they would weigh different amounts on different planets. Teacher

Understanding of the earth in the solar system and why they see what they see. Teacher

- The process of astronomy and how real astronomers work

Understanding filters, how to produce 3 colour images, how images are produced from data, how to plan observing sessions, how latitude and longitude of observatories affect what celestial objects can be seen, different exposure times are needed for different celestial objects. Teacher

How to plan an observation, how to execute observations using a robotic telescope. What constitutes good exposure times for messier objects, being able to compare celestial objects that they can see with binoculars with that to the professional telescope i.e. comparing resolution and the light pollution that affects their amateur observations. Some learnt how to use filters and how to enhance their images. Teacher

A better understanding of how real astronomers use telescopes to gain images and the importance of IT in the processing of those images. Teacher

A greater understanding of how professional astronomers make observations and interpret data. Teacher

It's not science in a 'gobbledegook' way, it's real life the way you look up at the moon every night, its instantaneous, something related to everyday life. Primary teacher

- The scientific process

Extended ICT skills and a different understanding of how data can be collected and used in a scientific context. Teacher

The practicalities of big science i.e. using big / expensive pieces of apparatus. Teacher

Wider appreciation of science and cross-curricular links. Teacher

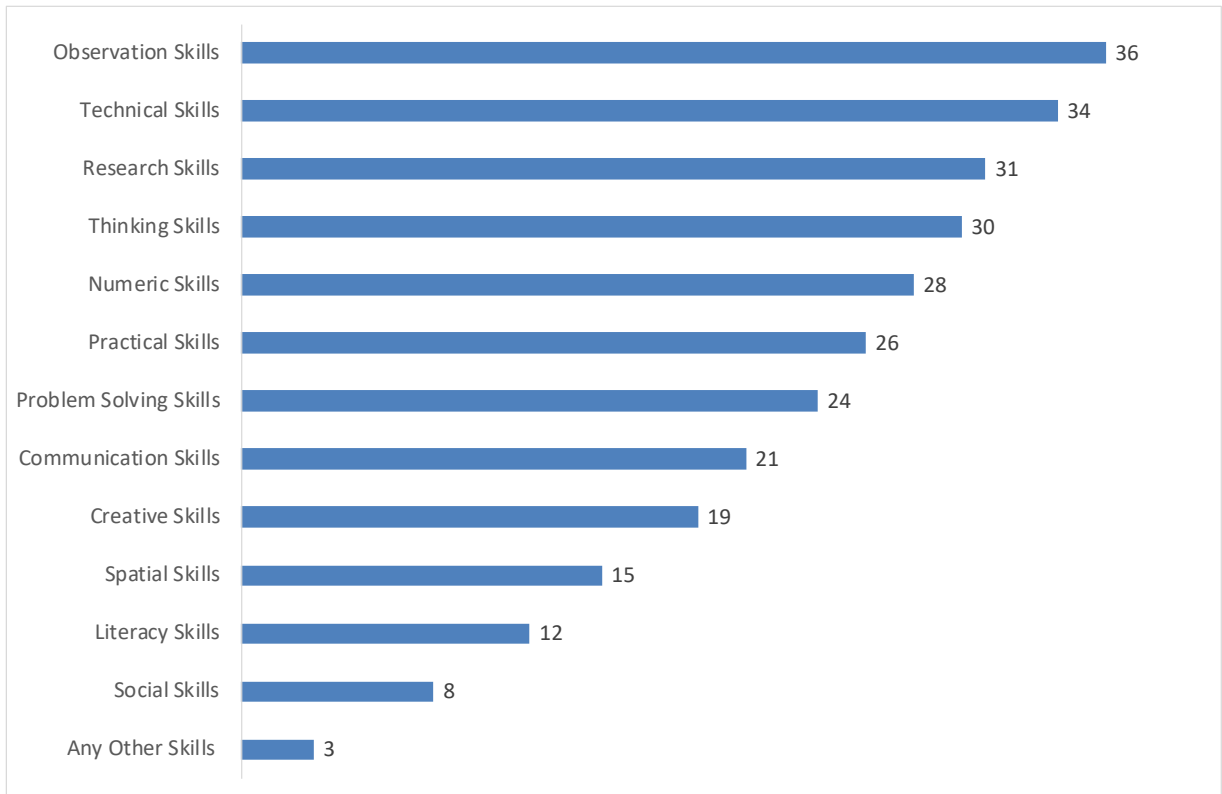
Science is not easy and planning is important. Sometimes things like weather affect the outcome and you have to try again. Teacher

Young people have a natural curiosity about space issues and using NSO resources they are able to improve their knowledge of science, technology, engineering and maths (STEM). Teacher

Skills: The skills that teachers most agreed their students had gained from working with NSO were observational and technical skills. Most other skills were also seen to be supported but

with spatial, literacy and social skills being the least likely to have been gained. See Fig.6 below.

Figure 6: What specific skills you do feel your students have gained from working with NSO resources? (Number of responses. All teachers responding n=43)



Team working was a skill that teachers in the case study schools additionally identified as an important aspect of using NSO.

Yeah, using the iPad today, means that kids work in teams and they use them to work together and help each other. Swapping planets and comparing with classmates around you creates the wow factor. It lends itself to collaboration. Primary teacher

Reaching different learning styles: Teachers were able to feedback further benefits to their students. For two teachers it was a good way to engage their SEN or disengaged students, who found that looking at the moon or working in a different way really engaged them in a manner that other teaching approaches do not.

The students I work with are SEN from an inner city, most of the time the only object they can see is the moon. Teacher

Perhaps not an immediate benefit to the university, but I really found that this helped re-engage disengaged pupils who were having a lot of problems in school. They really got behind this and took a lot from it. It was transformational for some. Teacher

5.1.6 EMOTIONAL IMPACT ON STUDENTS

Teachers were asked what they felt their students were most:

- Surprised by...
- Interested in...
- Inspired by...
- Disappointed by...
- Bored by...
- Enthusiastic about...

Positive associations: There was a degree of overlap between what surprised, interested, inspired and created enthusiasm all of which centred around being able to create such good images using a real, and very large telescope. This led to being excited by what they see and find out about the universe, through their own, rather than just teacher led, research.

Surprised by...

- Being able to use a real telescope, and take their own photos but how easy this was

Ease of access to telescope. Teacher

The fact they could use a real telescope. Teacher

- Being able to gather data about the universe

The distances between the planets. Teacher

Being able to count craters on the moon. Teacher

- The difference between real and published images

Difference between real data and published (HST standard) pictures. Teacher

- The difficulty of taking a good image

How complicated things still were to get the correct exposure times and filters.
Teacher

- The size of the universe

How much is out there. Teacher

Interested in...

- Observations of the moon, planets and other celestial bodies and activity

The vast range of objects in the universe. Teacher

Observing the moon. Teacher

Information about the planets. Teacher

- Accessing data that isn't otherwise available, such as their own rather than stock images

Manipulating their very own images, rather than just viewing stock images from.
Teacher

Otherwise inaccessible raw data. Teacher

Seeing beyond what is normally possible. Teacher

- Doing their own rather than teacher led research

Exploring what they wanted to look at rather than being told by a teacher. Teacher

Using the resources to further their own research. Teacher

Practical observations. Teacher

Inspired by...

- Using a real telescope to observe things they otherwise cannot see

The size of the telescope and that they could use it themselves. Teacher

I call it the Portal to the Universe and the kids are wowed by that. Secondary teacher

- Taking their own photos and using them to present their research

Taking their own photographs then making presentations about what they could find out about that star / part of the moon etc. Teacher

- The resources available on the website
- Travel to other planets

The idea that other planets could be visited. Teacher

CASE NOTE:

A normally quiet and subdued girl has been hugely inspired by the NSO, she now wants to be pilot. She said “can girl’s be astronauts?” and her dad took her to science fair, then she decided that she wants to be the first female Red Arrows pilot. The NSO has been a big part of building her confidence.

Now there is 50/50 female/male split in the enrichment club which is great.

Most enthusiastic about...

- Working independently to create their images and for some, being on Image of the Month

Using the software to process their images. Teacher

Finding unexpected objects or features in their images. Teacher

When they first see an image they requested appear after processing in LTImage. Teacher

Being on Image of the month! Teacher

- Using the telescope and requesting their own images

The chance to use such a complex piece of apparatus. Teacher

Being able to request their own images from a professional telescope. Teacher

- Using physics and maths in a real-life context

The physics and mathematics behind the observations. Teacher

Negative associations: These focused around having to wait for images or images being unavailable due to poor weather or other reasons. On receipt of initial images there was also disappointment until they had been enhanced via LTImage. Using LTImage was also felt to be difficult for some.

Disappointed by...

- Images that couldn't be taken due to weather or other reasons

When images couldn't be taken due to poor weather. Teacher

Not getting all of their requested images taken. Teacher

Not seeing the 'dark side' of the moon, we had to have a long chat about this one. Teacher

- Waiting for images and not receiving all that they took

Time they had to wait for images! Teacher

Not receiving all their observations [they understood why though]. Teacher

The delay in receiving images especially the 3 colour one. Teacher

- Limited number of projects available

Limited number of projects available, no updates to existing projects e.g. Barnard's Star tracking. Teacher

- Initial images (prior to using LTImage)

Not seeing an amazing image come straight out of the telescope. Teacher

- LTImage software usability

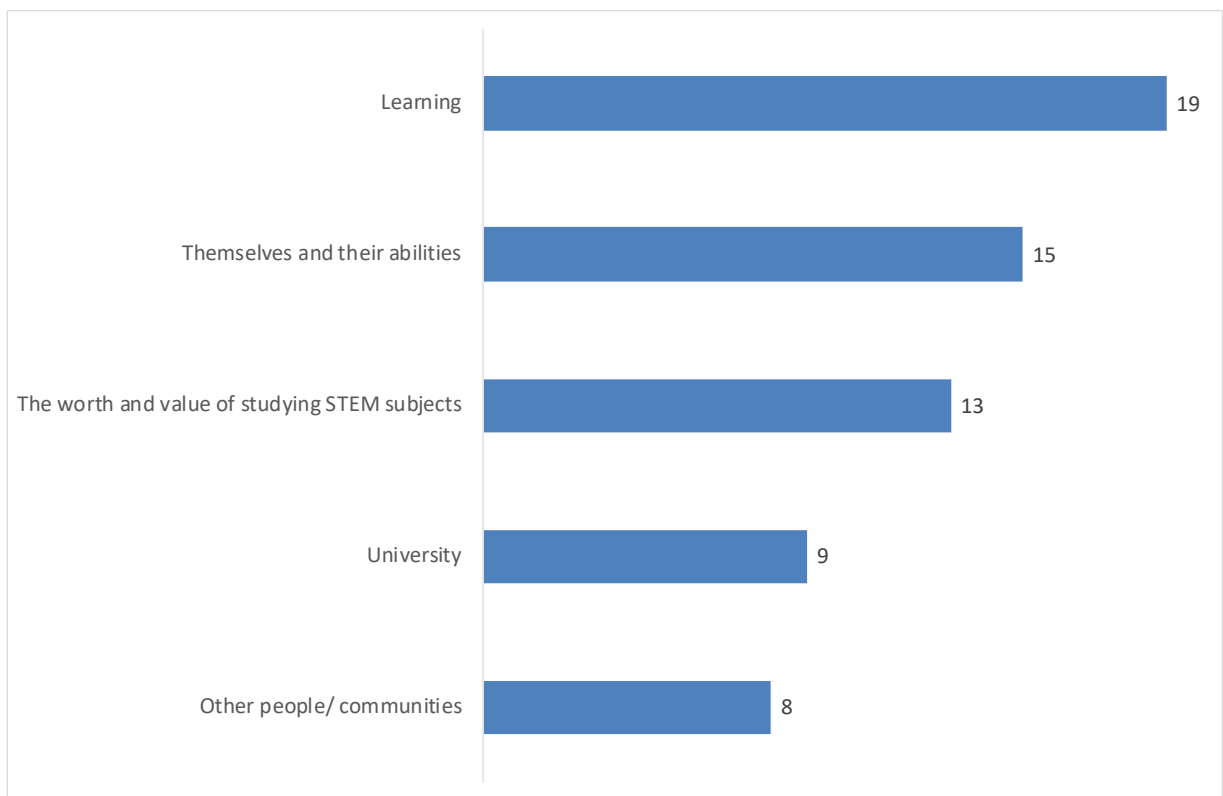
LTImage software. Please update this! Teacher

No NSO person came to give us a crash course on using LTIImage. Teacher

Bored by... feedback was similar to what students were disappointed by; having to wait for images, if images couldn't be taken or in one case, some of the quizzes in the bronze STEM Club booklet.

Inspiring Students: Teachers were asked if by taking part in NSO led lessons or sessions, that their students were more positive about various aspects of their life and learning. The aspect teachers felt their students became most positive about was learning in general, followed by their own abilities and the worth and value of studying STEM subjects. See Fig.7 below.

Figure 7: To what extent do you think using the NSO website and resource has enabled your students to feel more positive about any of the following? (Number of responses. All responding teachers n=36)



The qualitative research feedback from teachers suggested that exposing primary students to the content that NSO provides can sow the seeds of interest in STEM well before they start to make decisions about what subjects they choose or career path they opt for.

I think it's the perfect age to sow those seeds. You give the facts and the knowledge in such an explosive fun way. At this age they are like sponges and they take everything

in, and their imagination is starting to open, it's really the age to sow the seeds of anything. Primary teacher

This continues for secondary students who have low interest in science, something that NSO is seen to help overcome through its relatable and hands on approach to STEM.

But I think they can with NSO... a real purpose...with a lot of our kids that's really important and the activities give a sense of worth and you can't say that for most curriculum activities. Secondary teacher

In another case the teacher believed the nature of astronomy lent itself not just to those good at mainstream STEM subjects but also those who struggle with science and maths. She gave an example of two students who had special educational needs who took GCSE Astronomy, and both achieved good grades.

Future student activity: Teachers were asked what their students might do or have done as a result of taking part in an NSO based lesson or session. Teachers were hopeful that at least some would take a further interest in astronomy; join a club, do it at home, study at university and indeed some students had gone on to do some of these things.

On a very limited number of occasions it has helped create the interest to join an astronomy club. Teacher

Follow NSO activities themselves. Two students (15 & 13 years old) taking GCSE. Teacher

Some have already spent time on the more advanced aspects, gaining and manipulating their own images and producing 3-colour images. One student actually visited the Liverpool Telescope while on holiday. Teacher

Several students are starting to get their own telescopes and attend local astronomy groups. As far as further study, careers are concerned - it's our first year so time will tell! Teacher

Pursue their interest in astronomy by using the NSO website independently. Teacher

I've had students that have gone home and done things then brought them in to show me. They have looked at something and done their own report. They've done it off their own back because they're interested because it's an exciting topic. Primary teacher

One teacher hoped some students would engage with other similar projects using data, such as CERN.

Engage in other projects that allow the use of data from big experiments for example CERN. Teacher

CASE NOTE:

At the beginning, one older Year 13 student who did the GCSE in a year, ended up going to study physics and astronomy at University and achieving a 1st. The brother of this boy, who was just 15, was invited to represent schools in a select committee on particle physics and astronomy. He went to London to speak in Parliament, this is when he was doing the Astronomy GCSE. I went with him and the Royal Astronomical Society and met the crew of the Discovery Space Shuttle.

In every year group since then, one individual from each cohort has gone on to a physics/astrophysics/astronomy at degree levels including a number of girls.

One boy, as a result of the space academy, was able to go and meet the astronaut, Tim Peake. One of the questions that he asked Tim, was put into Tim Peake's 'ask an astronaut book'

It has had a significant impact, it has inspired siblings of students within the club and they have then gone onto join.

5.1.7 IMPACT ON TEACHING

Virtually all teachers said they'd be highly likely to use the NSO website again.

Value to lessons: Teachers were highly appreciative of the value using NSO brought to their lessons. Those in the teacher survey gave a mean score of **9.6 out of 10** for how well it has supported topics they taught during the academic year. For some it appears well adapted for use with GCSE Astronomy.

It matches the GCSE syllabus, helps to inform students on the requirements of the controlled practical's and helps to build their understanding of the skills required for observational astronomy. Teacher

I would not be able to deliver GCSE Astronomy without it, nor to extend student learning in science to new and exciting contexts - the new GCSE and A level

examinations are geared towards this set of skills now and these experiences are essential for the students. Teacher

For those teaching other subjects, NSO is also seen as a valuable resource.

The NSO resources help link topics in Physics with observational astronomy. Teacher

Value to teaching: Using NSO has brought personal benefit to teachers; for most, by enabling them to teach a science and/or STEM subject or topic in a more exciting or different way along with supporting their STEM teaching more generally. For around half the teachers responding it also increased their confidence in teaching STEM subjects. See Table 10 below.

Table 10: What value, if any, has using the NSO website and resources brought to your teaching? (Teacher survey n=29)

Benefit to teacher	Number of responses
It has enabled me to teach a STEM subject or topic in a more exciting way	22
It has enabled me to teach science in a different way	21
It supported my teaching of a STEM subject or topic	21
I am now more confident about teaching STEM subjects	10

Learning value: NSO also plays a useful role in keeping teachers up to date with new information about astronomy.

I love learning myself and I'm learning continuously from it, about planets and about Apollo. That's the key to teaching is to keep fresh and keep learning. I enjoy trying to think outside the box a bit in different subjects and subject areas. Primary teacher

CASE NOTE:

I am now a lead educator for the national space academy (at Leicester University) and at a lot of my masterclasses I use the NSO, the images, as part of that.

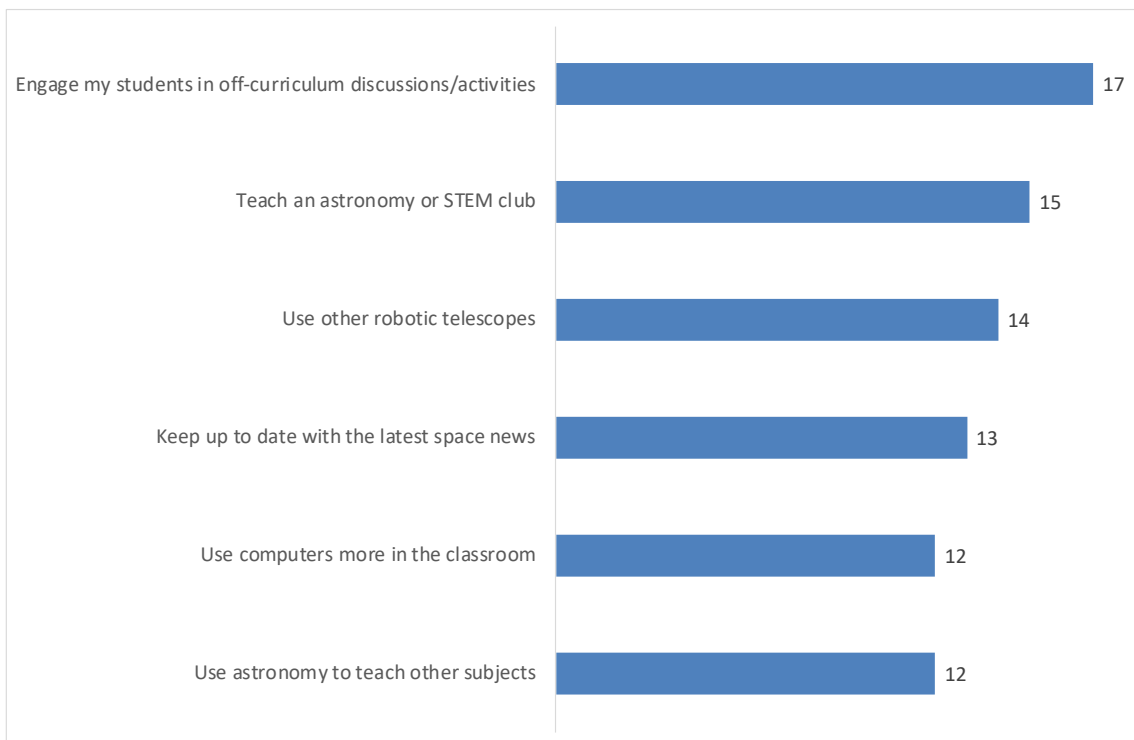
It has had an immeasurable impact on myself. I have developed relationships with teachers from other schools through the training courses and then arranged meetings and talks with them further down the line.

We put together the 'Astro Tour', workshops, school festivals. Motivated me to keep my own knowledge uptake going. I was nominated for the Patrick Moore medal for the Royal Astronomical Society

Secondary teacher

Future teaching: The most cited outcomes having used the NSO website are to engage their students in further off-curriculum activities and/or teach an astronomy or STEM club. See Fig.8 below.

Figure 8: Please indicate anything that is new or different that you are likely to do in the future because of your use of the NSO website and resources? (All responding teachers n=25)



Elements particularly effective: Go Observing appeared to be the leading element of the website that teachers felt was the most valuable in helping them and their students achieve their objectives. Other elements that teachers cited as useful include:

- GCSE Astronomy guides
- Notes on using LTImage
- Masquerade option for tracking student activity
- Moonsaic (Moon puzzle) – but one primary teacher suggested the following to make it more accessible for younger students

A visual, flash type thing similar to the mosaic. A game version of the mosaic with 'drag and drop' that can be compared to the children's own images. The mosaic loses detail when printed especially when there are so many tiles that look similar. A help button would be good. A game element would be very good, kids love games. Primary teacher

- Resources in the Learn section
- STEM club resources

Suggested changes to content:

- Adapted for visually impaired students
- Make it easier to find details of the telescope itself
- Improve KS2 Maths and English content
- More links to other astronomy content
- More or updated analysis projects
- More GCSE lesson plans and activities – in particular updated to reflect the new GCSE Astronomy curriculum e.g. meteor showers images cannot be requested on NSO.
- Closer links to KS3 and A-level
- More source material for self-led student research as well more guided projects for younger students

Guided observation projects enabling students to collect their own data sets from which to analyse changing events e.g. supernova light curve, quasar fluctuations, variable star behaviour. Teacher

Giving students direct access to databases of information (rather than through pre-constructed resources) to allow them to perform their own research based on existing observations. Teacher

- Background content such as the history of astronomy

I think that something about how scientist's opinions have changed would be good on the website. Primary teacher

- Video content – particularly for younger students

So sometimes you want and amazing video or animation to explain it all. Primary teacher

Suggested improvements to format or usability: Most teachers appeared satisfied with the website design but there were a number of suggested changes:

- More advanced observation options

At the moment one has to select from a list of objects. It would be good to be able to name any object and the website to steer the user in choosing when best to observe. Teacher

- Being able to check on the number of completed observations on student accounts without having to switch accounts
- Clearer access to the actual data, optionally by-passing the introductory science background
- Notification of new projects in the analysis project database to by-pass scanning the list of available items
- Users registering an ongoing interest in particular projects so that update notifications can be targeted
- Fewer clicks to download an observation
- A single click to find primary school content

I'd suggest a link initially where you could just click primary and all the resources appear. Primary teacher

- A simple how-to video tutorial for teachers

One of my first thoughts was that it looks very technical (for me). What might be useful is a little guidance video on how to manipulate an image. As a teacher if you aren't comfortable you won't use it to teach the kids. Primary teacher

- Zip files that are easier to use

The zip files for some of the activities were too time-consuming to be worth using.

- In primary schools using LTImage is considered difficult for all but the oldest and most able students, particularly when compared with other software. It is often hard to load

onto school computer systems and is incompatible with Mac OS. Having a **web-based version** would get around these problems.

With the Bradford telescope, the image processing is on the website, and it's simple. Whereas on the NSO website, it's more complicated. LTImage is overly complicated for the younger children. Primary teacher

- Better **communication** – when requesting images, if NSO could let them know and communicate if it's coming back or not - that would really help. When there is no message/image back for important GCSE work e.g. lunar observations that is frustrating.

Feels you submit requests to a black box...they feel a bit lost especially for GCSE it's frustrating. Secondary teacher

Navigation: Despite the above suggestions, teachers in the survey overall found navigation easy, with a mean score of 9.5 out of 10.

Suggested improvements to the overall NSO offer

Teachers gave a number of suggestions to improve the overall NSO offer that included:

- Advance notice or calendar of important solar and space events
- Resources to enable the reproducing ancient experiments such as the angle of the sun at certain days of the year
- Being able to link up schools to create bigger experiments
- Hosting a club or association for Astronomy teachers via the NSO – this would bring them together to help share knowledge, experience and ideas etc.
- Providing links from NSO to the IGCSE or Physics A level
- Taster on NSO of Astronomy or Astrophysics modules of an undergraduate degree
- Relevant articles in short 3-4 page magazine format
- Outreach with 6th form physics students in particular by bringing equipment for them to use would help bring greater credit and visibility to the university. Particularly targeting.
- Opportunities to contact NSO directly e.g. online Q&A with an astronomer
- NSO support and advice on what would be a good telescope for the school to use
- Posters for the classroom, T-shirts, hats and other merchandise.

5.1.9 CPD

Ten (10) out of the twenty-nine (29) teachers who responded in the survey said they had attended an NSO led CPD session. Those who attended found it very useful (mean score of 9.4 out of 10).

Reasons for not attending focused on the practical side rather than anything about the training itself. Primary reasons were; difficulty in being able to travel (and the time and cost this would incur), wrong timing or a lack of time, or in finding cover while they are away.

Getting there [Liverpool] can be very difficult and expensive. If there was one that was local and you could go for a few hours, that'd be good. I don't think you'd need a long time. Much more time would be too long. A visiting one would be useful. Primary teacher

If I lived anywhere near Liverpool I would be there all the time and am envious of the courses they offer. Secondary teacher

A lack of awareness of the CPD offer was a factor for six teachers.

One respondent suggested that running it via a webinar would be the best way to increase participation.

Table 11: What are the reasons you haven't taken part in the NSO CPD? (All responding teachers n=19)

Reason for not attending	Number of responses
Too difficult to travel	10
Didn't have the time	8
The timings didn't work for me	5
Wasn't aware of the CPD offer	6
Couldn't arrange teaching cover	4
It doesn't provide what I want or need	1

Suggestions for **improving attendance** included:

- Advertise the events
- Training via webinar or other distance learning approaches
- Regional or in-school training

It would be great to have an introductory package for schools or trainers who visit the schools and show them how they can use it. Primary teacher

- Pay for the INSET day
- Run it during the summer or other school holidays

5.1.10 OTHER RESOURCES USED

Teachers in the qualitative feedback mentioned a number of other sources⁶ they use in the teaching of astronomy:

- [The Faulkes telescope](#) which allows for live control of the telescope so seen as complementary to the NSO
- [Bradford Robotic Telescope](#)
- Space FM (see student feedback)- considered to have good usability
- [University of Lincoln Nebraska](#) - while requiring small subscription, this was felt to have a more flexible approach in ordering images and greater control in exposures. It also included good image analysis exercises, had flat animations and no software to download i.e. all was web enabled

5.1.11 FUTURE DEVELOPMENT AND PROMOTION

Teachers in the case study interviews were asked what the best way for NSO was to become more widely adopted in schools. Suggestions included:

- More marketing via academies and regional ambassadors

I think the telescope really sells it. Need to say how it's easy and simple for everyone to do that. Primary teacher

If you managed to get it into big primary and secondary school academies, then it could be passed around in the academy group. Primary teacher

- Showcasing at science fairs, teacher summer schools, the Association for Science Education (ASE) conference and other teacher targeted events

Every year [in Ireland] there is a primary science teachers association meeting, and workshops. That would be an ideal opportunity to get the NSO out there. They have local elements and a national thing annually. Science in Ireland is very good. There is a thing called discover primary science which got its third award, and you have to show you are linking with all elements of science and have to prove it across classes. If you could get your link into that, that would be very good. Primary teacher

⁶ See student feedback for further sources

We have summer courses. Getting a mention there would be good. Getting into science fairs, where they show case best practice classroom activities.

Primary teacher

- Targeting heads of science and maths
- In-school champions

You need a teacher in the school who is an 'astronomy nut'. Without that, I imagine it is unlikely that a teacher would take it on.

Secondary teacher

- Content that is applicable across a broad range of subjects

If they broaden what they offer to be more applicable to the stem subjects and syllabi, then it would be more attractive to schools. All the curriculums change over the years, so you have to keep updating and that's difficult.

Secondary teacher

Paying for NSO: Both state and private school teachers said they would find it hard to pay for the NSO, even on an image by image basis.

Yes, it would stop our use completely. We have no money for it.

Secondary teacher

However not all rejected the idea out of hand. One primary teacher in Ireland thought that having real time access to the telescope might be something some users would pay for.

At the moment there is no way we would be able to ask for resources. The school is happy to pay for them to do the GCSE, but that's all they can afford. A small fee of a few pounds, we could probably swallow, but nothing more.

Secondary teacher

Similarly, one private school teacher was not averse to having a modest subscription up to £100 per year, but again anything higher would require justification of the case to school.

5.1.12 FEEDBACK ON THE NEW STEM CLUB RESOURCES

In September 2019 NSO introduced their STEM Club resource, a printed booklet containing a range of session activities linked to the website but also, many of which could be carried out independently. We identified two new schools to take part in the research that had taken and used these resources, as well as asking previously visited schools if they could try them out and provide feedback during our Autumn term visits.

Feedback was universally positive:

- It provides the flexibility to provide astronomy in secondary schools which might not otherwise be available but also accessible to older primary school pupils

I'm really impressed with the Stem Club resources. They're really easy to follow. I think they'd be appropriate for all of KS2. Primary teacher

Using STEM Club: Case Note One

Fifteen Y11 students taking their GCSE Astronomy as part of an after-school club using the NSO STEM Club resource to measure the sun's rotation. It was the first time the teacher had used it but as it fitted perfectly with one of the curriculum modules she was keen to try it. There were a number of learning points:

- It took a long time for some videos to download. This may have something to do with the time periods selected so having guidance on the best time period to use would be helpful.
- While students took measurements from the screen using tracing paper, taking more accurate measurements using the computer would have been better. However, importing the video files into LTIimage was too hard to do on the spot.
- Skills deployed included use of trigonometry, protractors, maths tools such as COS, plotting and drawing.
- Guidance on what resolution or wavelength to use would also be helpful although the images were very much enjoyed by the students and teacher.
- The task instructions were clear for the more able students but measurements such as WA1 took a little working out as to what it meant.
- Quite a few students didn't get to the end after 90 mins.

- Teachers liked the pick 'n' mix nature of the resource booklet for varying ability levels, providing ideas but not lesson plans or being too prescriptive
- Having everything in a single package was appreciated – rather than having to create resources yourself

- Having the certificates for each level, and the bronze, silver and gold levels, all help to instil a sense of recognition of effort and a sense of progression for students
- Being a free resource is essential for some schools
- Can be used both in STEM clubs and science lessons
- Could fit well with new Welsh curriculum
- Also works well across different year groups and abilities

This is the kind of resource that will really enhance this project-based learning.
Secondary Teacher

Using STEM Club: Case Note Two

This Edinburgh state secondary school has been a user of NSO resources in the past but with very limited budgets and poor digital capacity, having a booklet-based resource to support lunchtime STEM Club was welcomed.

The teacher wanted to start with [Asteroids](#), but the school doesn't have computers for the students, and it didn't work on the iPad. Would be better as an app.

Nothing really happened there...but would be a great activity to do, but it just didn't really work for us. Secondary teacher

[Moonsaic](#) – wanted to do this, but not possible to print the images easily or quickly, just received image files, so didn't do this.

[Night observations](#) – can't be used as they can't keep the kids after school.

[Eggnaut](#): Liked the limited amounts of materials required (a cost consideration) and the challenge really enthused the students

We had some come back for an hour after school to develop their models.
Secondary teacher

What such a resource is seen to deliver for teachers and students is:

- Hands on experiments in a relaxed atmosphere
- The astronomy acts as a draw for some students who originally are not so engaged with STEM but once engaged are then more willing to try other, non-astronomy tasks in the STEM club they attend

- The competitive element it can create
- STEM activities not covered in the curriculum

They get to do things they don't do in class. Secondary teacher

Only used asteroids but It's really good to have it altogether in one place. Secondary teacher

I got the PowerPoint and worksheets from it, it's got extension tasks, far easier than doing it yourself. Secondary teacher

However, teachers did point out that there are lots of other available resources to compete with so it is unlikely that the NSO resource will be the only one used in a general STEM club.

From a primary school perspective a few changes were suggested:

- Better guidance for the pupils

Perhaps for things like the quiz, the children could have a little guidance as to which section of the website to look at to find information. Primary teacher

- Tasks that require less photocopying

Perhaps the step by step guide is maybe a little too step by step. It's a lot of photocopying for each child. Primary teacher

5.1.13 NSO BRANDING

Teachers were generally aware that LJMU is behind the NSO (quite a few knew the LJMU connection through attending CPD events) but could be clearer, and probably not that obvious to their students.

I think it's pretty obvious from the website but how much of that is at the forefront of the children's thoughts, I don't know. Secondary teacher

Like their students they did feel that a higher profile would be a good idea if only to drive some credit and recognition to LJMU. Otherwise, so long as the quality of the materials such as the STEM Club booklet were high, the source was less important.

So long as I have good resources it doesn't matter where they come from. Secondary teacher

Some teachers felt that raising awareness of LJMU as potential future destination for their students could potentially be an outcome of an increased profile, although others felt that choosing university was too far off for the LJMU name to fully register.

There's no sense that the university is a place for them. Secondary teacher

From a slightly different perspective, another teacher from a private school felt that his students were always going to opt for Russell Group universities as this is what they are aware of, despite potentially better courses being offered elsewhere. Given this, any raising of awareness that LJMU provides not only the NSO website but the research behind it, has got to be a good thing for encouraging schools students to consider applying to go there.

5.2 PART TWO: SCHOOL STUDENT FEEDBACK

It was the first time I've been able to look into space...it was really enjoyable.
Secondary student

5.2.1 STUDENT SURVEY PROFILES

Most of the students who completed the survey self-identify as liking STEM/Science subjects at school. While both secondary and primary students similarly agreed that anyone could work in a STEM or science related job, generally secondary students were much more likely to want to work in a STEM related job in the future and see themselves as STEM or science 'people'. See Table 10 below.

Table 12: How much do you agree with each of the following statements? Mean score out of 5 where 5=Agree strongly

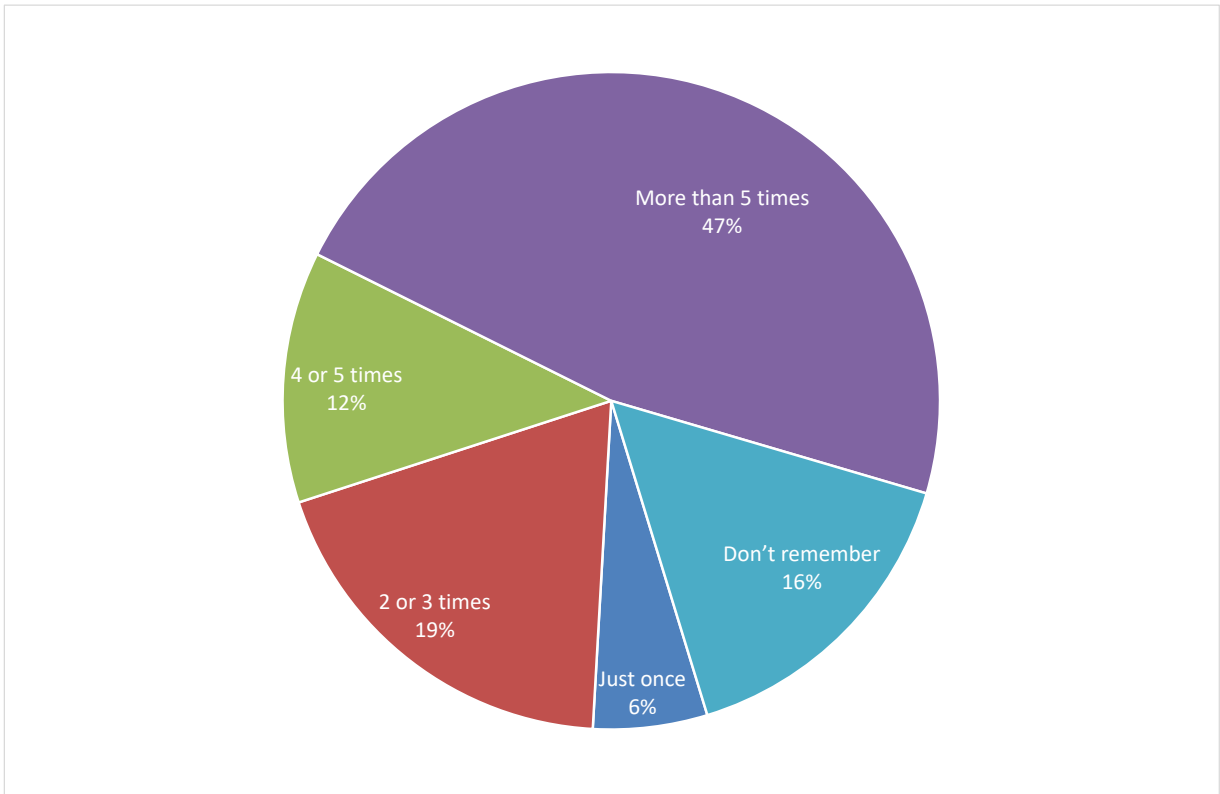
Statement	Secondary (n=103)	Primary (n=41)
I like STEM/Science* subjects at school	4.6	3.8
I want to work in a STEM/Science related job	4.2	2.0
I see myself as a STEM/Science person	4.1	2.3
People who are like me work in STEM/Science	3.9	3.0
Anyone can work in a STEM/Science related job	3.7	3.9

*Secondary students were asked about STEM, primary students were asked about Science

5.2.2 USING NSO

Most (60 percent) secondary students said they had used NSO four times or more in the year before completing the survey, with nearly half (47 percent) having done so more than five times. See Fig.10 below.

Figure 10: How many times in the last year do you remember using the NSO for anything? (Secondary students n=89)



In contrast, few primary students said they could recall using NSO, with 29 of the 39 responding saying they didn't recall doing any NSO based activities. Of those who did recall, most remembered having an NSO based lesson.

5.2.3 REASONS FOR STUDYING ASTRONOMY AND USING THE NSO

Secondary students giving qualitative feedback on the NSO were a mix of those taking GCSE Astronomy and/or part of a school astronomy club. In some cases, joining the astronomy club was a pathway into taking the GCSE, in other cases some continued with the astronomy club after they had completed their GCSE.

After joining the astronomy club through the school, decided to take the GCSE in Astronomy. Secondary student

Students appear to have two primary motivations to take part in astronomy, either as a GCSE or club:

- An **interest in astronomy and/or physics** – a topic that doesn't necessarily come up within the curriculum of the main sciences despite widespread interest in it

Astronomy is really interesting. It's different in comparison to other subjects, it combines lots of subjects – English (lots of reading of big words), maths (measuring and trigonometry), science, altogether. Secondary student

Always had an interest in astronomy from a young age. Secondary student

I've been interested in theoretical physics – I have a lot of unanswered questions, this was a good place to start. Secondary student

To see if I wanted to do Astrophysics at university. Secondary student

We don't really learn about astronomy anywhere else, well maybe in physics. Secondary student

- Using it as a way to **enhance their study and career prospects**

Looks good on a CV, an extra qualification. Secondary student

If you wanted to study Physics at university, or a career around the subject, it felt like a good idea to have a qualification in Astronomy. Looks good on CV. Secondary student

I can talk about it in my personal statement. Not many schools offer it, and so it's a unique talking point and opportunity. Secondary student

Joining an **astronomy club** in particular was popular because it offered a chance to learn in a different, more relaxed and less curriculum driven way.

It's something to do. I'm bored at home and it's a good way to learn stuff because it's fun and you get to do project and trips. You don't have to be particularly clever to be in the club. You can ask loads of questions. Secondary student

I come to club to help me improve on my other science subject in school. In lessons we don't get to do as much varied activities and I love being able to do the independent working. Secondary student

The clubs aren't like normal lessons, very enticing, you are exploring further into topics. Secondary student

I like that I come to do something that we don't normally do, something different.
Secondary student

Curiosity about the universe as well as 'coolness' also encourages some younger secondary school students.

So I can have an idea of what's beyond our earth. Secondary student

Brian May does astronomy. Secondary student

Unlike the secondary students, **primary students** had no choice in whether they use NSO or not as all their interaction was during regular lesson time.

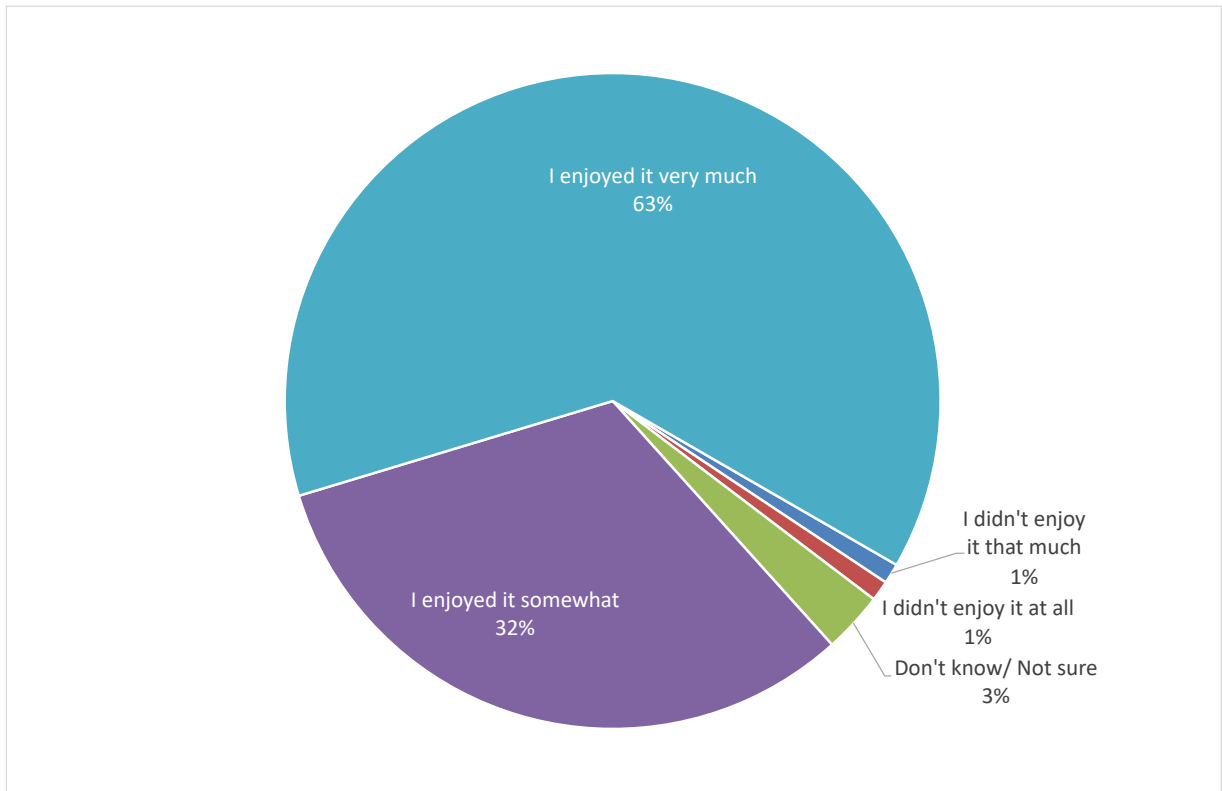
5.2.4 LEARNING IMPACT

Enjoyment: Secondary students appear to enjoy their NSO lessons or sessions with 63 percent saying they enjoyed the last one they took part in 'very much' and further 32 percent enjoying it somewhat. See Fig.11 below.

I absolutely love it, it's so fascinating. Seeing the images of all the stars was incredible, there's got to be more life in other galaxies. Secondary student

It was the first time I've been able to look into space...it was really enjoyable.
Secondary student

Figure 11: How much did you enjoy your NSO lesson or session? (Secondary students n=76)



For secondary students the most enjoyable aspect of using the NSO was being able to take and manipulate images that are unique to the user.

Getting to see the pictures that you have taken on the NSO website. Secondary student

Using the LTImage software to visualise Messier objects and then comparing these with professional, Hubble-esque type images. Secondary student

Being able to design my own observing programme and using the robotic telescope to take images of jaw dropping celestial objects. Secondary student

Being able to see the stars from observations you have chosen, not just pictures off the internet. Secondary student

Some enjoyed the challenges set in the lesson or session.

I love the challenges that the lesson provides. Secondary student

While others enjoyed discovering new things about the universe.

How there is so much to discover. Secondary student

Primary students: Of the seven (7) students who responded in the survey, five (5) said they enjoyed their NSO lesson or session. As with secondary students, primary students also enjoyed requesting and manipulating images.

I enjoyed getting the pictures and changing the colours. Primary student

Additionally, given their age, they were also more likely to use some the quizzes and other activities aimed at primary students. For example, calculating how old they would be on another planet.

I liked seeing how old I would be on other planets. Primary student

Figured out my age on another planet – on the moon I was three years older. Primary student

Primary students also liked the combination of the observations alongside the activities and quizzes.

It was fun to use the website because there was a place where you could observe stuff and then a place you could do activities. Primary student

What using NSO also appears to help deliver for **both secondary and primary students** is **inspiration** and a sense of **doing something special** not usually available at school or home.

I feel like a proper astronomer [when I do this]. Secondary student

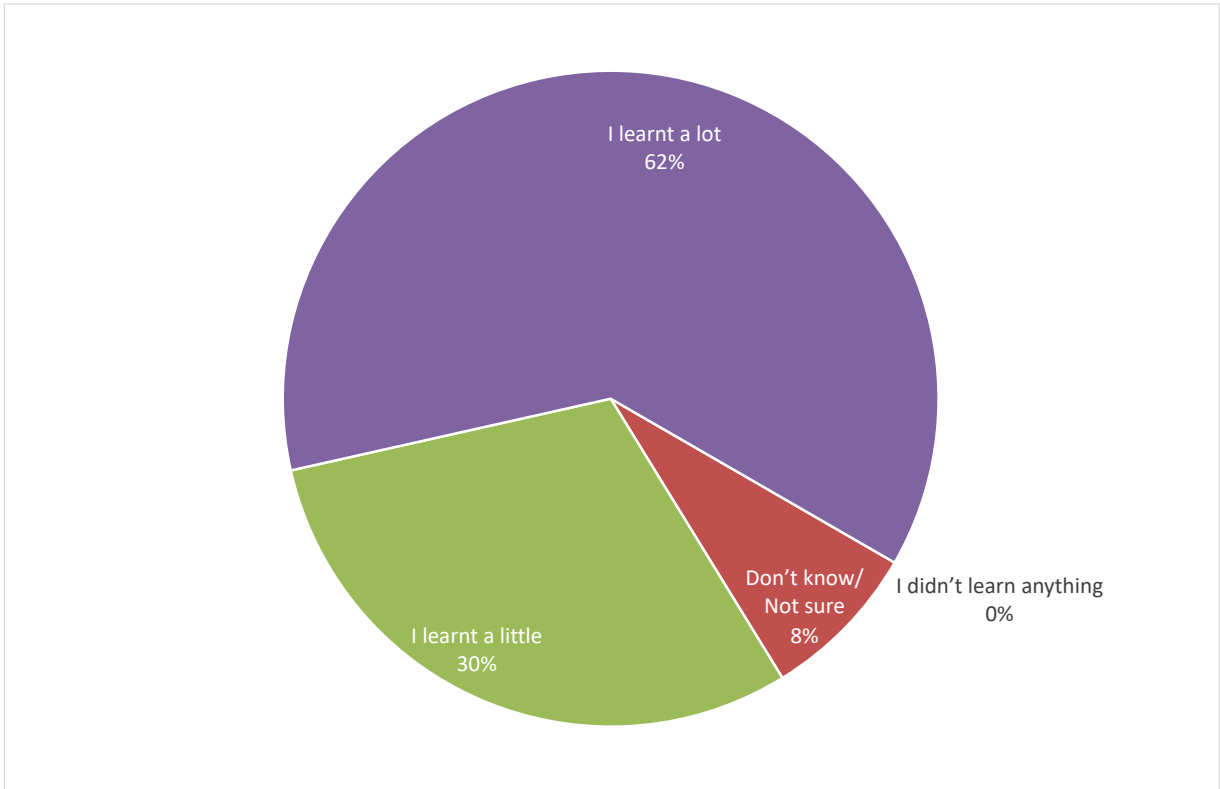
One pixel would be worth so many light years and that's really mind boggling. Secondary student

I was looking at how many stars there are in a galaxy and it was amazing. Primary student

On the NSO website it's inspiring that you can see so much in space. I would like to try with my own telescope. Primary student

Learning something new: Most (92 percent) secondary students in the survey said they had learnt something from their NSO session, 62 percent said they had learnt a lot. See Fig.12 below.

Figure 12: How much do you feel you learnt during your last NSO lesson or session? (Secondary students n=76)



Of the eight (8) primary students who answered in the survey, five (5) felt they had learnt something with the remainder not being sure.

Both secondary and primary students cited a wide range of things they felt they had learnt, both about the universe and about using the NSO and telescope.

- Using the NSO website, telescope and LTImage

I learnt how to render pictures after taking them on the NSO website, also I learned the areas of the moon. Secondary student

How to take a 3-colour image of galaxies and nebulae and processing them in LTImage and photoshop. Secondary student

How to use the robotic telescope. Secondary student

How to find asteroids from photographs. Secondary student

How to compare an object in space with other photos of the same object with different exposure times. Secondary student

Challenges associated with imaging of deep space objects and lots of info about nebula, clusters and galaxies. Secondary student

Finding distances using blinking and pixels, as well as "calibration" and "spacing" tools. Secondary student

- About astronomy as a science

The NSO introduces you to a more practical side of astronomy. Without the resource we would have just taken images from google, which is not the same. You learn a whole lot more. Secondary student

I have gained an understanding of the messier catalogue through the use of the National's School Observatory, which not only helped with my GCSE but was interesting in general. Secondary student

We were able to calculate the orbit of a meteor. Secondary student

How the distance travelled by an asteroid can be calculated by using the number of pixels are on the screen going across and up from the starting position to the final position. Secondary student

- About the moon, universe and space

I've learned loads about our solar system from the planets, to our moon to our sun etc. Secondary student

I learnt about how big they [craters] can be on a piece of paper versus if you actually went on the moon. Primary student

I learnt where different gases were on the spectra e.g. hydrogen. Secondary student

That there is a name for every galaxy and star even if it is not a word name and just NG4789. Secondary student

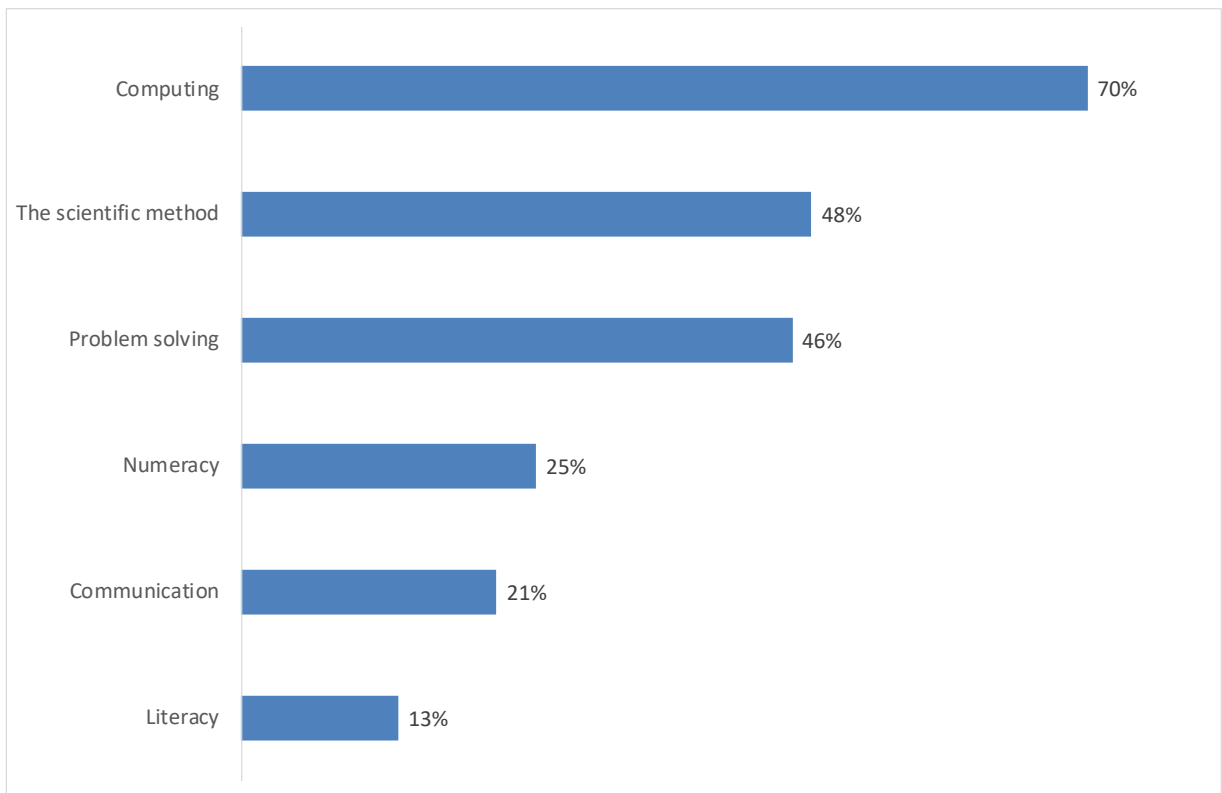
I learned how far away certain objects were and I learned how stars were formed. Secondary student

I was able to find a photo of an exploding star. Secondary student

We found out about moon particles on earth. We would never have found that without the NSO and it was amazing. Secondary student

Skills: As well as knowledge, secondary students also felt they had developed their skills as a result of using the NSO website. Most likely were computing skills, mentioned by 70 percent of students, followed by problem solving and learning the scientific method. See Fig.13 below.

Figure 13: What new skills, if any, do you think you learnt when using the NSO? (Secondary students n=61)



Of the six (6) primary students responding to the survey four (4) said they have learnt computing, three (3) numeracy and three (3) communication skills.

Secondary and primary students at the case study schools reported learning a number of specific skills such as classifying galaxies, measuring, using Excel, team and presentation skills.

Doing the presentation in front of the head teach was scary, but once we had done it, it really boosted our confidence. Secondary student

Learnt how to take measurements. Secondary student

I didn't know how to categorise nebulae. Secondary student

It's taught us how to use Excel. Secondary student

On this sheet, we learnt to measure the craters. We times by 1.93 then we got the real size of the craters. Primary student

We've been working well as a team together. Using rulers, using calculators. Primary student

Students in the case study schools also pointed that using the telescope as a skill learnt, as well as conducting linked research using other websites.

Programming the telescope – variables such as: moon phase, weather time, location in relation to the sun. Secondary student

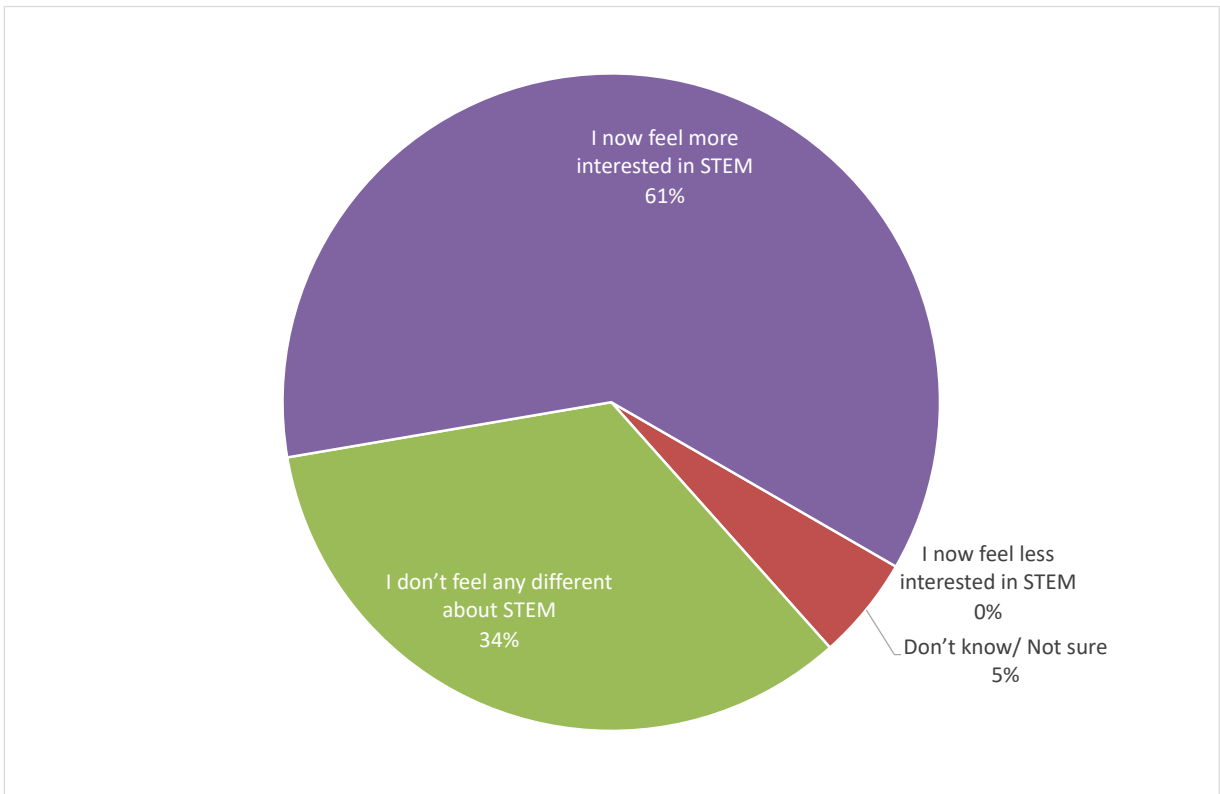
The resources were there on the website, but we also had to do fact checking on other websites. Had to do a lot of planning ahead. Secondary student

Creating professional images

That anyone can create a professional-looking image of an object in space without buying expensive equipment. Secondary student

Understanding the value of STEM: Just under two-thirds (61 percent) of secondary students felt more interested in STEM after using NSO. None said they felt less interested as a result. See Fig.14 below.

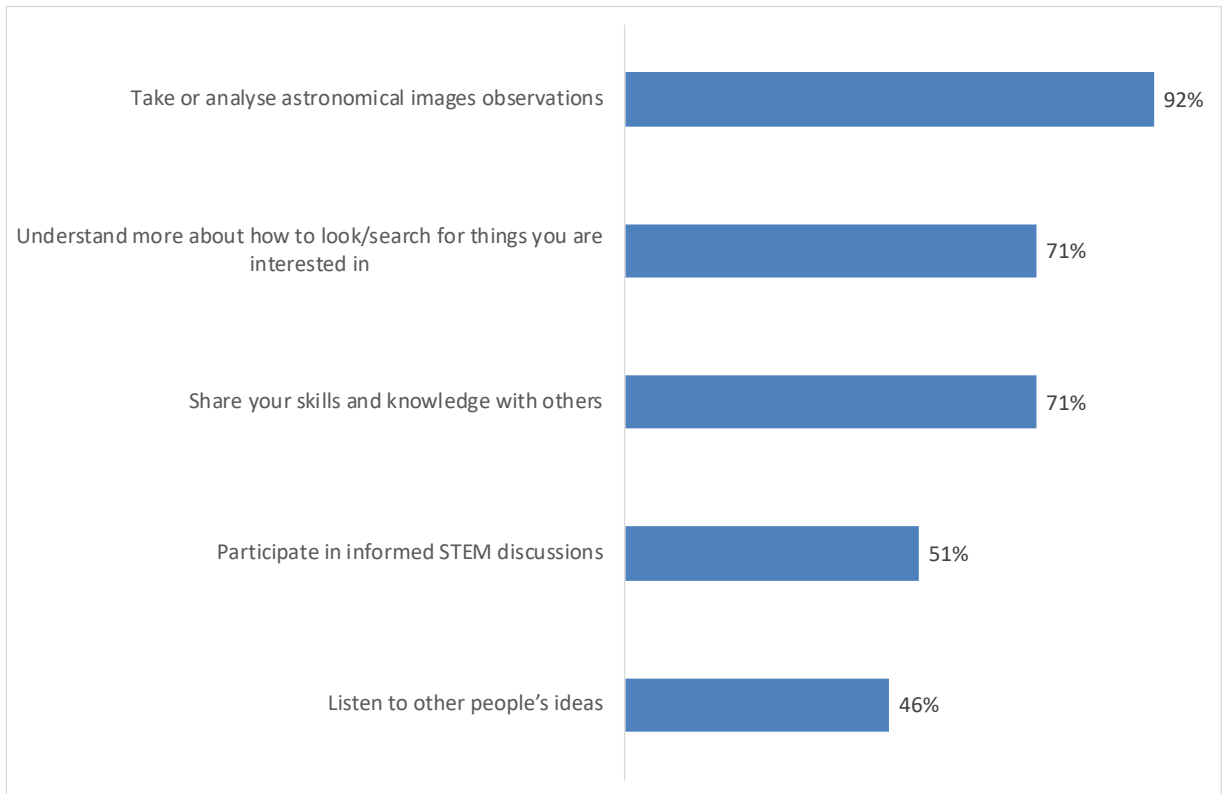
Figure 14: Which of the following best applies to you? (Secondary students n=59)



Responses from the six primary students who answered were more mixed; one each said they were more or less interested, with three saying they felt the same.

Building confidence: Secondary students in the survey expressed considerable confidence in being able to both do more connected with the NSO and to talk about and understand STEM and other science research topics. Nearly all (92 percent) said they were more able to take or analyse astronomical images, and over thirds felt more able to share their skills and knowledge with others as well as participate in STEM discussions. See Fig.15 below.

Figure 15: Do you feel more able to... (Secondary students n=59)



Qualitative feedback also points at greater confidence around science as a result of taking part in NSO based lessons or sessions.

In school lessons we had to do a project on space. If it wasn't for the NSO and the enrichment club, I wouldn't have known half of what I knew about the planets.
Secondary student

I now feel more equipped for more complicated topics. Secondary student

Then, more recently, when we did the Orbits Project with UCL we felt like we had a head start. Secondary student

When in later years we came across astronomy topics in Physics A level, we felt more confident because we had already studied the subject in the club. Secondary student

Students in the qualitative case studies spoke about the empowerment that using NSO brought them, a relatively simple interface opening up a new world of discovery.

To be able to access the images so easily was exciting. The images were also helpful because they had additional information, like date and time the image was captured already there for you to access, and that made the GCSE a lot easier. Secondary student

The usefulness of the NSO telescope feature was obvious when we did the Orbits Project (UCL partnership) because the telescope we used with that, was a lot harder use. Had to plan a whole lot more, was more complicated. Secondary student

NSO was really simple to use, especially for a young person getting into astronomy. Secondary student

For a young person getting into astronomy, The NSO was like an open door. It didn't hold us back, made us feel like we were smart enough. Secondary student

The value in being able to **talk knowledgeably** about the stars was something also mentioned in the qualitative case studies. Some said that before participating in the course they couldn't look up at the sky and say 'that's x constellation', but now they can. Some said they had used this to impress parents and they sometimes share this knowledge with friends.

Others saw the value in learning not just about the universe but the thinking, theory and maths behind it, mentioning the history of astronomy and learning about development of the planets, or how humans developed their minds to understand galaxies and the universe

It's really interesting, not just about stars but also the maths behind it, exoplanets and the ancient Greeks. Secondary student

Wider science value: Using the NSO has in the eyes of some students, been useful in apply what they been learning in maths and physics.

I think astronomy is a great way to apply the skills you learn in sciences especially Physics and Maths. Secondary student

These students found that it helps and motivates them in physics e.g. electromagnetic spectrum as well as inclusion in syllabus e.g. with GCSE Physics (life cycle of stars).

If I hadn't done [Astronomy GCSE] I wouldn't have seen it before. Secondary student

Some were able to identify areas that overlapped like gravity, distance to objects and formulae involved and that astronomy also has relevance for Geography, Biology, Chemistry and Geology.

We're getting aspects of Maths before everyone else. (reference to inverse squares, law of universal gravity) Secondary student

At another school, students saw that astronomy has much broader links than just those with other sciences. For example:

- History e.g. use in agriculture and determining flooding of the Nile
- Philosophy and Religious Studies
- Classics regarding the constellations
- Geography regarding earth's composition

Finally, some students said they didn't particularly enjoy STEM subjects but doing astronomy and using the NSO gave them an interest in science they didn't think they had before.

I am thinking in future I could be part of the science industry, even though science I didn't really like. But now I do because astronomy interests me. Secondary student

5.2.5 LONGER-TERM ENGAGEMENT WITH NSO

Part of the qualitative approach to evaluating the impact NSO has on students involved a return visit to schools in the Autumn 2019 term to see how the same students were progressing. We were able to do this in three schools; Tormead, Wednesfield and Brooksbank. The most noticeable outcome of this extended use of NSO has been an increase in confidence in the technical side of using NSO and handling parts of the process, where they saw themselves as being beginners at using NSO last year now they can set the time period of observation by the telescope to get more detailed images.

One image took me a couple of weeks to get that perfect. Secondary student

There was also a sense of ownership, expressed by students at Wednesfield when talking proudly of NSO's provenance.

We should celebrate its success. Secondary student

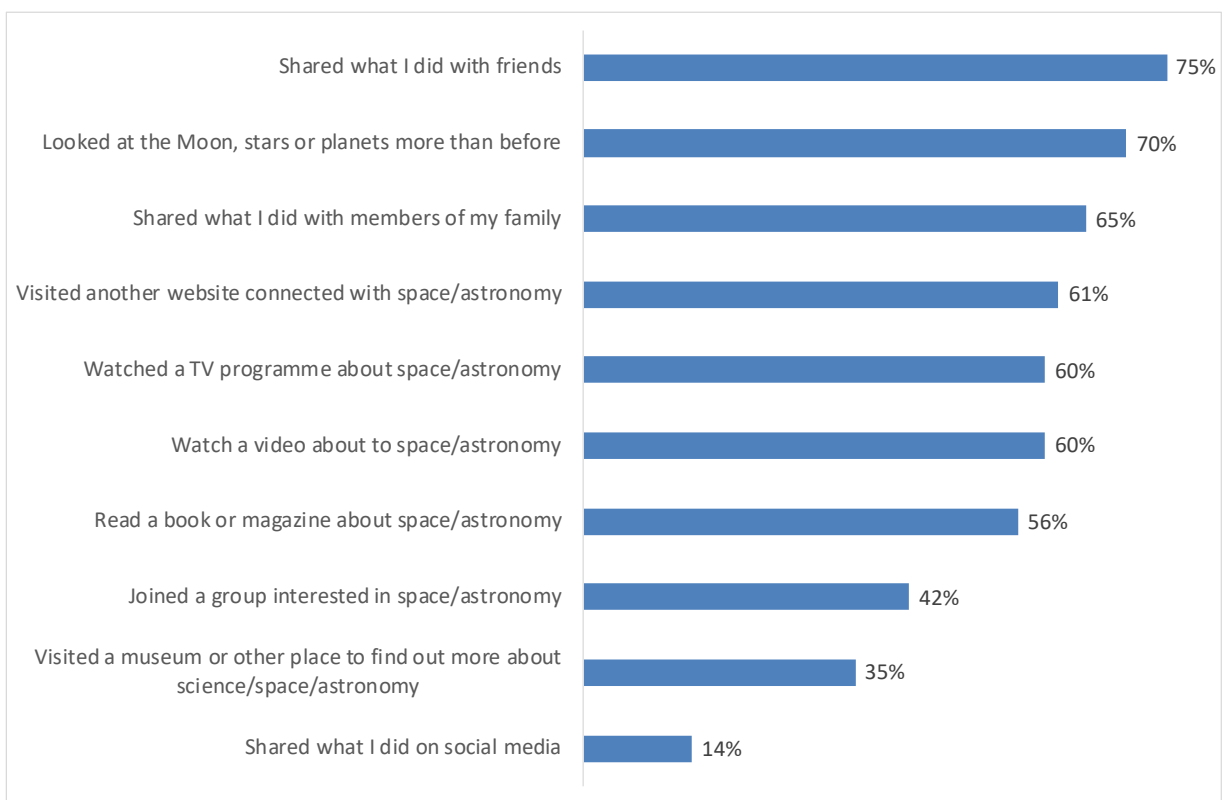
And moving on from simply studying a subject, to something more enjoyable and engaging. We observed that the subject has become like a nice hobby to pursue, not just a qualification. The sense of enjoyment among the group of identifying images through looking up at night is palpable.

You can see Orion really well at the moment. Secondary student

5.2.6 FURTHER ACTIVITY AND FUTURE PLANS

Further activity: The most mentioned further activity as a result of using NSO in the secondary student survey was to share what they did with their friends (75 percent said they had done this). Other frequently mentioned further activities included looking at the moon, stars or planets more than before (70 percent) and sharing what they had done with family (65 percent). See Fig.16 below.

Figure 16: What, if anything, have you done as a result of your lessons/sessions/use connected to the National Schools' Observatory? (Secondary students n=57)



Primary student feedback (albeit limited) was similar; with those responding in the survey (6) saying they shared what they had done with friends and family, and looked at the moon, stars or planets more. Additionally, they also mentioned re-visiting the NSO and visiting other astronomy websites and watching or reading content about astronomy.

Additional feedback from the qualitative case study schools confirmed some of the survey findings.

I also went to the cinema to watch a documentary on Neil Armstrong and the events that led up to the historic moment of the first moon landing. Secondary student

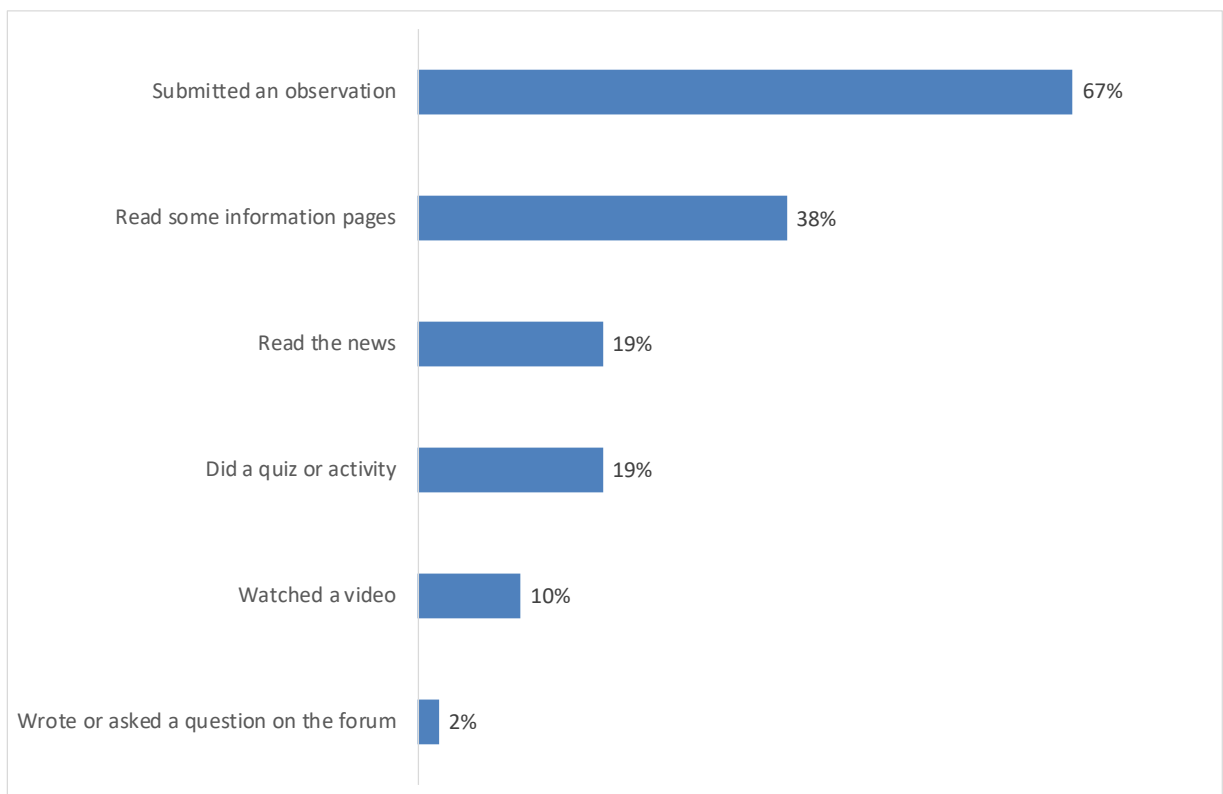
Me and my brother share a telescope at home and now we like to use it together and look at the stars. Secondary student

For parents who don't do Astronomy you can show off and use big words, point and say which stars are in the sky...Cassiopeia, Orion. Secondary student

Used the website at home and my dad became really interested too and we looked at it together. Primary student

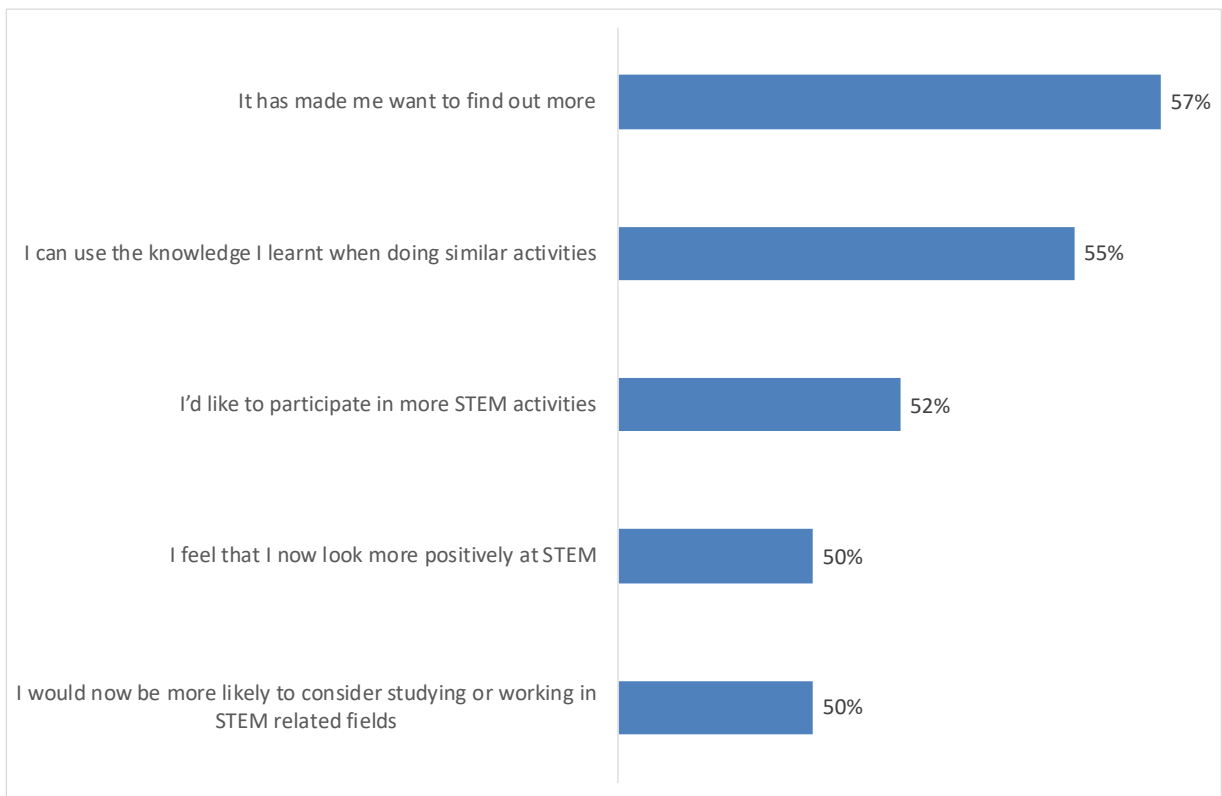
Eighty-three percent of secondary students in the survey said they had revisited the NSO since their last lesson or session, primarily to submit an observation (67 percent). See Fig.17 below.

Figure 17: What did you do when you revisited the National Schools' Observatory website? (Secondary student n=48)



Future plans: Over half (57 percent) of secondary students in the survey agreed very much that they wanted to find out more as a result of using NSO and that the knowledge they have learnt can be used for other activities (55 percent). More than half also agreed very much that they felt more positive about STEM and wanted to participate in further STEM activities or study or work in STEM related fields. See Fig.18 below.

Figure 18: As a result of taking part in lessons or sessions connected to the National Schools' Observatory please tell us how much you agree or disagree with the following statements. (Secondary students n=56)



Among those **primary students** responding to similar questions (6), two said they agreed very much that as a result of using NSO they are now more likely to consider science in secondary school, while another two said it made them want to find out more.

Sharing: Qualitative feedback supports the finding that many students **share** their experience with family members. Some found astronomy as a way of doing something with their parents.

My Dad has a telescope at his house, so we do use it quite a lot. Secondary student

*Really nice, me and my Dad, bonding time because I don't see him that much.
Secondary student*

While students at Wednesfield School said they had helped younger siblings who are interested in astronomy.

Students in the qualitative case studies also expressed some of these changes and the impact using NSO has had on their thinking about future study and work.

I have always wanted to be a lawyer, but since using the NSO, I really like science now and I'm thriving. Secondary student

NSO has given me a greater perspective about science and I am inspired to do other projects. Secondary student

After doing the Astronomy GCSE, I decided to take on more science and maths at A level, and I am now really enjoying these subjects. Secondary student

I wasn't thinking of doing a Physics degree in Year 10, but when I got into astronomy, I realised how interesting it was and now I'm looking to peruse a degree in Astrophysics at Oxford and UCL. Secondary student

Doing astronomy early on, encouraged me to go forward with it. Secondary student

The NSO website gives you examples of people who have made successful careers in astronomy and it gives you some advice on how to get onto this path. Secondary student

However, NSO's value in supporting GCSE has changed somewhat when the course work element of the GCSE was removed, thus reducing the value of using the telescope.

The GCSE syllabus has drifted away from the content on the website because now coursework is not mandatory. It's only graded on exams, so the telescope is less used because there is less coursework. Secondary student

Future university or career plans: Some students we spoke to were beginning to think about future study and possible careers and kinds of advantages studying astronomy and using NSO could bring them.

At Tormead School, the Y12-13 group we spoke to were all taking STEM subjects for A level, alongside astronomy GCSE they were each taking combinations of 4 A levels; including Physics, Further Mathematics, Mathematics, History, Computer Science. Interestingly the

student studying history and considering this for university still saw the benefit of astronomy as it demonstrated wider interests that universities might like to see.

In university applications it shows I have other interests, than just creatives. Secondary student

At Castell Alun School, one boy wants to do theoretical physics while another is interested in aeronautic engineering and both saw astronomy as helpful for these subjects when the competition for places on these courses is high.

5.2.7 OTHER SOURCES OF INFORMATION

Media and digital sources: As well as using NSO, students also accessed a number of other sources, either out of general interest in the subject or as part of their GCSE work. Sources mentioned included:

- [Stellarium](#)
- [Universe Sandbox](#)
- [Google Moon](#)
- [BBC / OU The Planets](#)
- YouTube videos about Space
- TV programmes such as Big Bang Theory, Blue Planet and those presented by Brian Cox and Dara O’Brian
- [Space FM](#) website
- [New Horizons](#) probe (reference Pluto)
- [Starlearner](#) which covers all GCSE course and useful for revision
- Cambridge University observatory
- Astronomy 161 podcast (resource from Ohio State University) e.g. piece about measuring distances

Museum and visitor attractions: Visits with the school or family to related venues were frequently mentioned, particularly by students attending private schools and included:

- Jodrell Bank
- Science Museum London
- Natural History Museums
- The Royal Observatory
- Herstmonceux observatory (where they were told about adjusting the telescope and about sightings made)
- National Space Centre
- Kennedy Space Centre

Some had attended talks from academics at the University of Sussex and University of London.

5.2.8 SUGGESTED CHANGES TO THE WEBSITE

By and large, secondary students said they found NSO easy to use, allowing them to access the information and activities they wanted without having to learn too much about the website.

Didn't have to master the website before you could get really into the Astronomy...about scientific fact discovery. Secondary student

That said, students giving feedback in the qualitative case study schools made a number of suggestions as to how the website could be more interesting to them, in particular around simplifying the image taking, downloading and manipulating process.

Usability: There were a range of ideas about making it easier to use. Secondary students suggested having fewer clicks to download an observation or to simplify the downloading process altogether. One suggestion was to have a video tutorial on how to use the website, another was for more information on different filters and exposure times. Being able to have a search function to see specific objects along with greater interactivity for younger students were also suggested.

The website doesn't really make it clear how to use it. Secondary student

Make one have to click through less buttons to download an observation. Secondary student

Add Memes - it would make it much more interesting to children. Secondary student

Increases tutorials on how to use the software to view the observations taken by the telescope. Secondary student

I would make it easier to download files so that they open straight away, rather than downloading it, opening the software and then finding the file to open. Secondary student

Create a tab at the side, so when you hover over it, it displays the different things you can observe. When you click on something, it shows a picture and information. Secondary student

Some students mentioned that LTImage doesn't work with Mac computers and can be difficult to download out of school. Another suggestion was to have a way of being told time has run out on submitted observations (that have not been received).

Among primary students some thought they'd identified some bugs in the quizzes⁷.

On some of the memory games, there were glitches and some of the quizzes don't have the right answers. Primary student

Content: There were also suggestions on the content that included; more videos and quizzes (particularly for GCSE students), more news content from the world of astronomy and to have a more striking home page with photos of the latest observations.

I would have quizzes and more videos for students studying astronomy GCSE. Secondary student

To be honest, it is a very well-rounded website with many good features, so there isn't much that I would change, however, maybe placing slightly more focus towards the current GCSE Astronomy specification would be very useful. Secondary student

I'd like to see some fact files on there because that would be really useful for revising topics on space. More stuff that's targeted at a young age group. Secondary student

More interesting news about astronomical discovery's such as black holes. Secondary student

Add a search function to look directly for certain objects to observe. Secondary student

I would probably have the latest photographs that the telescope has taken on the homepage. Secondary student

In the second wave of school visits a number of both teachers and students felt the website could be enhanced by having content specially about future academic and **career options** linked to Astronomy. Given this information is already available on the website, lack of awareness or use rather than missing content is the issue.

More information on how to get into STEM careers. Try and get more girls involved as I was the only girl in my STEM group doing this. Secondary student

⁷ Rectified since this observation was made

Have a tab for careers. Secondary Student

Further suggestions included:

- Information on the Maths equations e.g. equation of time
- Visualisation of right declination etc./ a celestial sphere with lines of longitude and latitude
- Spinning model of sky to help visualise the earth's procession, accurate with sun and moon
- Be given the correct answers for the quizzes and arrange quizzes in order of difficulty or age appropriateness
- Being able to compare two different planets on one page
- Create your own solar system
- Software so it is possible to move a planet image around so that you could see it at different angles and hover over labels and learn more about that planet
- Newsletter for students with an NSO account

Despite the above there were, particularly older A level students, in the qualitative study who considered the NSO website something of a life saver when doing their GCSE Astronomy and an easy to use resource.

Because the NSO was so simple to use, it saved us a lot of time during the GCSE, when we didn't have a lot of time to spare. Secondary student

The website has a lot of different links that lead you to different articles, it's right there ready to be used. Written clearly and easy to understand. Secondary student

Lots of different of learning resources and a forum. Organised very nicely. The recent website update is really modern. Secondary student

We always knew the website was there, when the textbook was too heavy and difficult to understand. Secondary student

There were few resources aside from the NSO website for us to use online. Secondary student

5.2.9 STEM CLUB RESOURCES

Feedback from students using the STEM Club resources was very positive, from testing out their designs in the **Eggnaut** challenge, to tracking asteroids and sunspots back in the classroom.

We could see the different times the pictures were taken and if the asteroid had moved in that time. Secondary student

Get to see how everything works...it's really cool. Secondary Student

Getting more women in STEM and it's a really cool, easy resource to access. Secondary student

While there was some frustration in waiting for images to download, students really engaged with the **sun's rotation** task.

Helps with understanding how scientists calculated the rotation of the sun. Student

And appreciated the value of applying other maths and science learning with real data and in a visual format, brings together their skills and interests.

I like how in astronomy you use your science and maths skills in a different application. Student

5.2.10 NSO BRANDING

Students were asked for their awareness of the NSO branding and LJMU's role in running the website. Overall there was little or no awareness of LJMU's role although there was some recognition of NSO's connection with Liverpool as the teacher had mentioned it to them. For the most part students were not that concerned as to who runs NSO but on reflection felt that LJMU should take credit for its work through having a higher profile.

They should get the recognition they deserve. Secondary student

They should be proud of it. Secondary student

Indeed, some students went on to say that users like themselves should be proud it is hosted and created in the UK.

We should celebrate its success. Secondary student

It makes you appreciate more they've done this for school children who don't have the resources. Secondary student

One student at Wednesfield school felt that Liverpool was like Wolverhampton and if it can happen in Liverpool it can happen in their own city as well.

Being close to us, and a local university, makes us respect them more. Secondary Student

And because they helped school students, they may repay the debt by wanting to go to LJMU in the future.

It's really inspiring they chose to help children with this resource...you'd want to go there because they helped us when we were younger. Secondary student

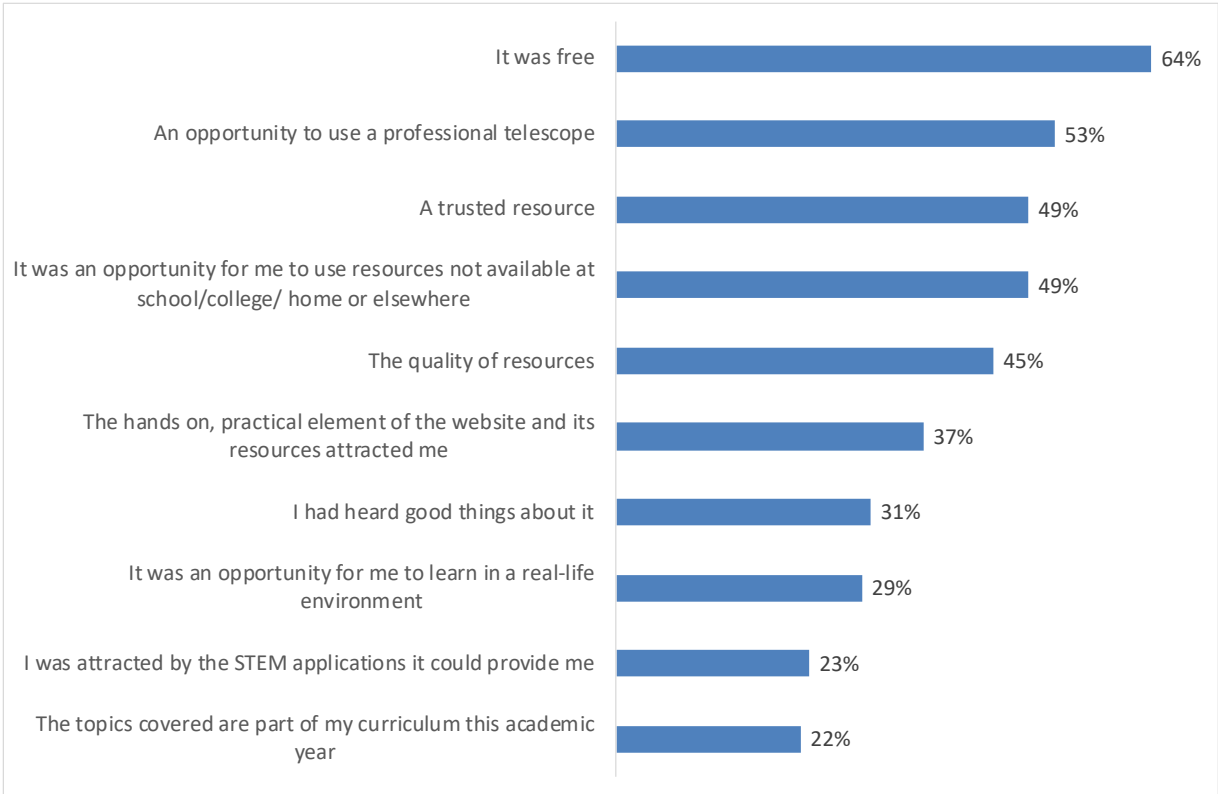
We all feel quite grateful to have it...it gives our country and good name and something we should be proud of. Secondary student

Students at another school saw the LJMU connection very positively once they'd been made aware of it.

At the forefront of their field and it's all research they're submitting. Secondary student

Aside from it being free, the most cited reason to use NSO was to have an opportunity to use of professional telescope (53 percent) using a trusted resource (49 percent) not otherwise available (49 percent). See Fig.20 below.

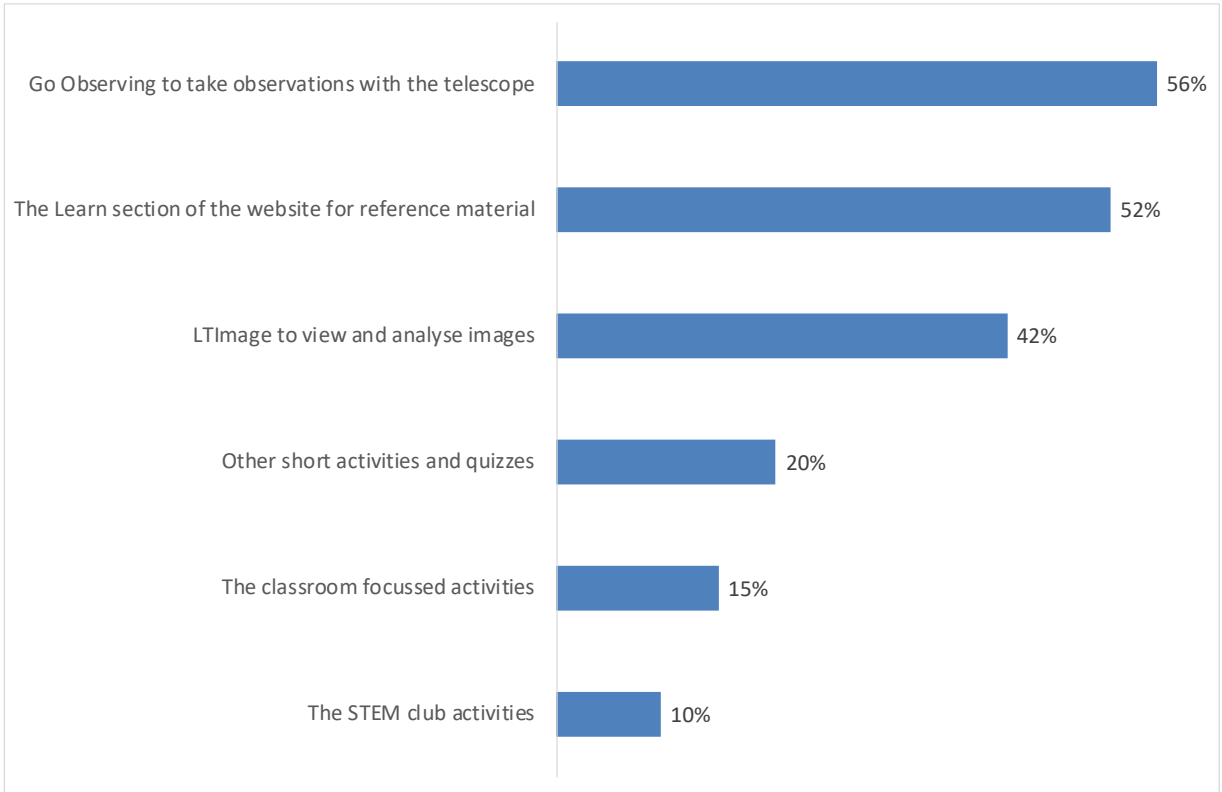
Figure 20: What made you decide to engage with the NSO? (General users n=95)



5.3.3 RESOURCES USED

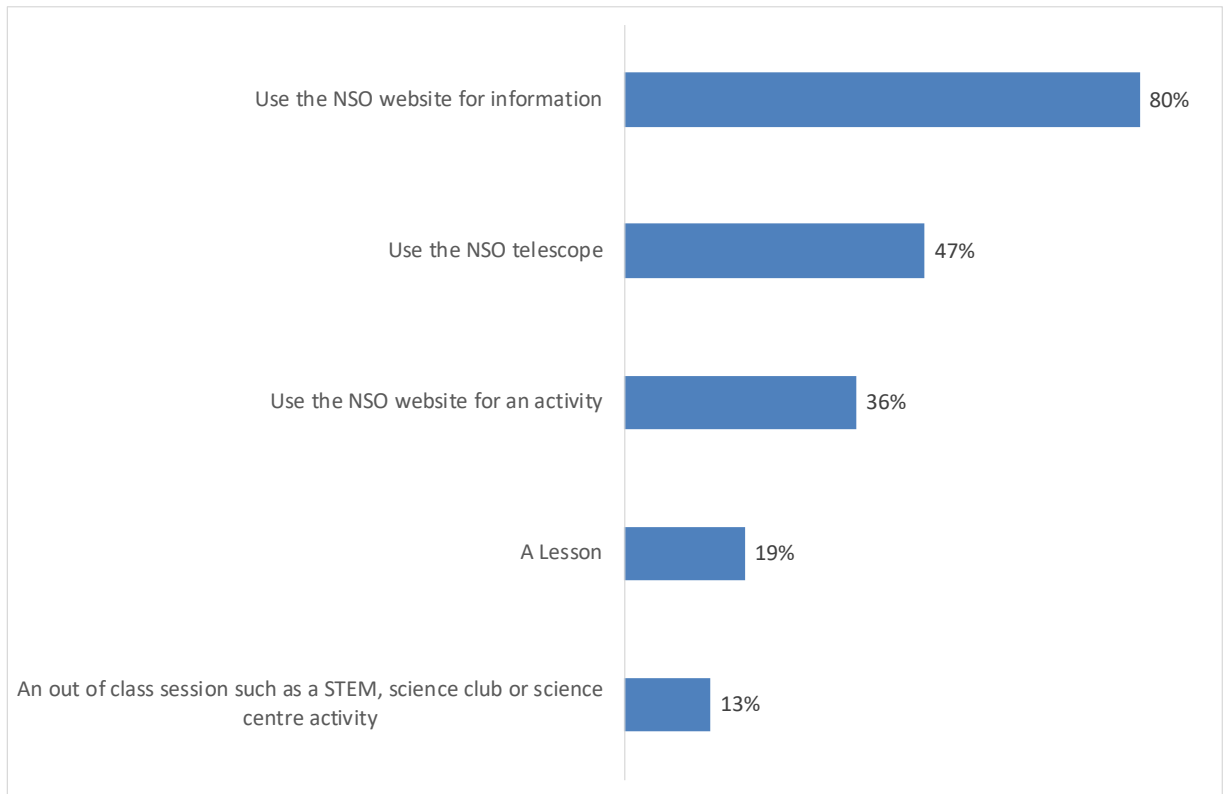
General users were most likely to use the Go Observing resource to take observations, as well as the Learn section and LTImage. See Fig.21 below.

Figure 21: NSO resources used.(General users n=93)



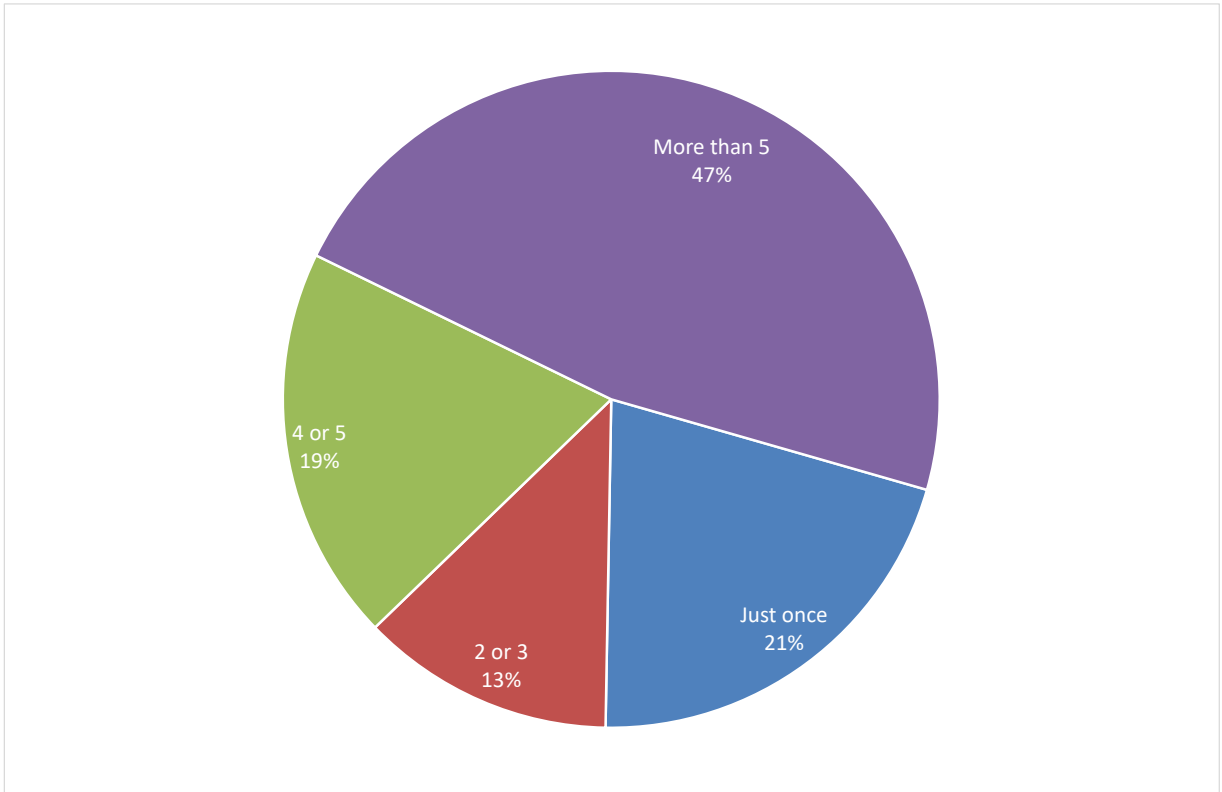
The most common use for the website is for information only (80 percent), followed by use of the telescope (47 percent). See Fig.22 below

Figure 22: Type of use. (General users n=75)



Frequency of use is variable; 47 percent of general users said they had used it more than five times over the past 12 months, while one in five had only used it once. See Fig.23 below.

Figure 23: How many times in the last year do you remember using the NSO for anything? (General users n=80)



The reasons for use are numerous and varied but generally focus on specific **exploration of the universe** rather than the more science learning focus that teachers reported. The **life cycle of the star** was a topic that was repeatedly cited as a reason to use NSO. Examples of topics general users said they accessed NSO for included:

Identifying planets I could see in my telescope.

The life cycle of the Sun.

Use of telescope to study gravitational waves to detect presence of dark matter.

Life cycle of stars.

Estimating stellar density.

The tilt of the Earth.

Hunting asteroids.

Planet and moon positions and times.

Looking to see what the bright 'star' is that I can see.

Exoplanets.

To take images of planets and nebula.
Finding visible planets.
Star sizes.
Checking which planets are visible that night.
Moon phases. Taking pictures of craters with the telescope.
Measure Lunar Alps.
Extra solar planets.
Distant galaxy.
Observing Jupiter and the bow tie nebula.

Two mentioned obtaining images for the purposes of **artwork**.

Picture and info about a galaxy for my painting of galaxies. General user

Lunar observations for image processing and use in sketching workshops. General user

One said they used it help with their EPQ work.

Researching different Astrophysics Topics looking for Inspiration for my EPQ Essay Question. General user

5.3.4 LEARNING OUTCOMES

Enjoyment: Just over two thirds (71 percent) of general users said they enjoyed their interaction with NSO very much with a further 28 percent enjoying it somewhat. None explicitly said they didn't enjoy it. See Fig. 24 below.

The kinds of things users said they enjoyed included:

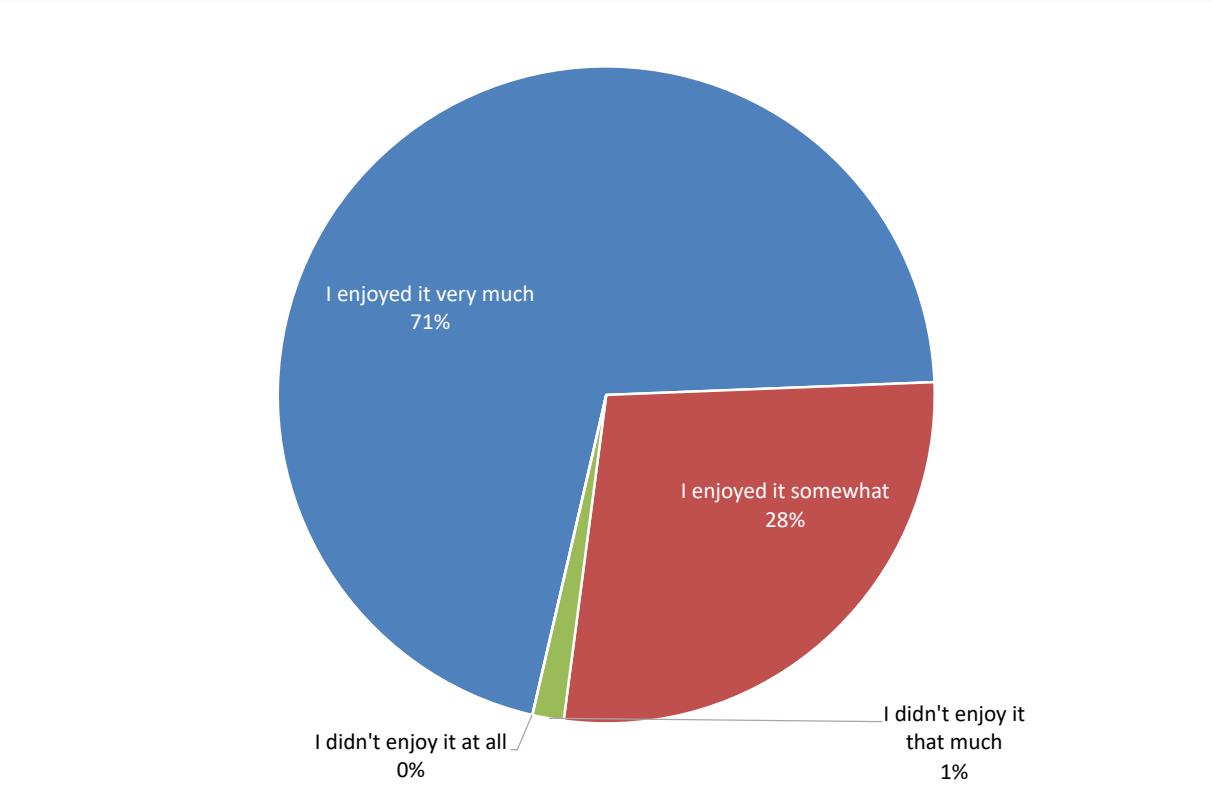
- The ease of which an image can be obtained
- The hands-on approach to using the telescope
- Seeing high resolution images that are unique to the user
- The real-life experience rather than just using stock images

Real experience of the activity and new learning in real life environment. General user

Everything here is presented really simple that even amateurs can understand..:) General user

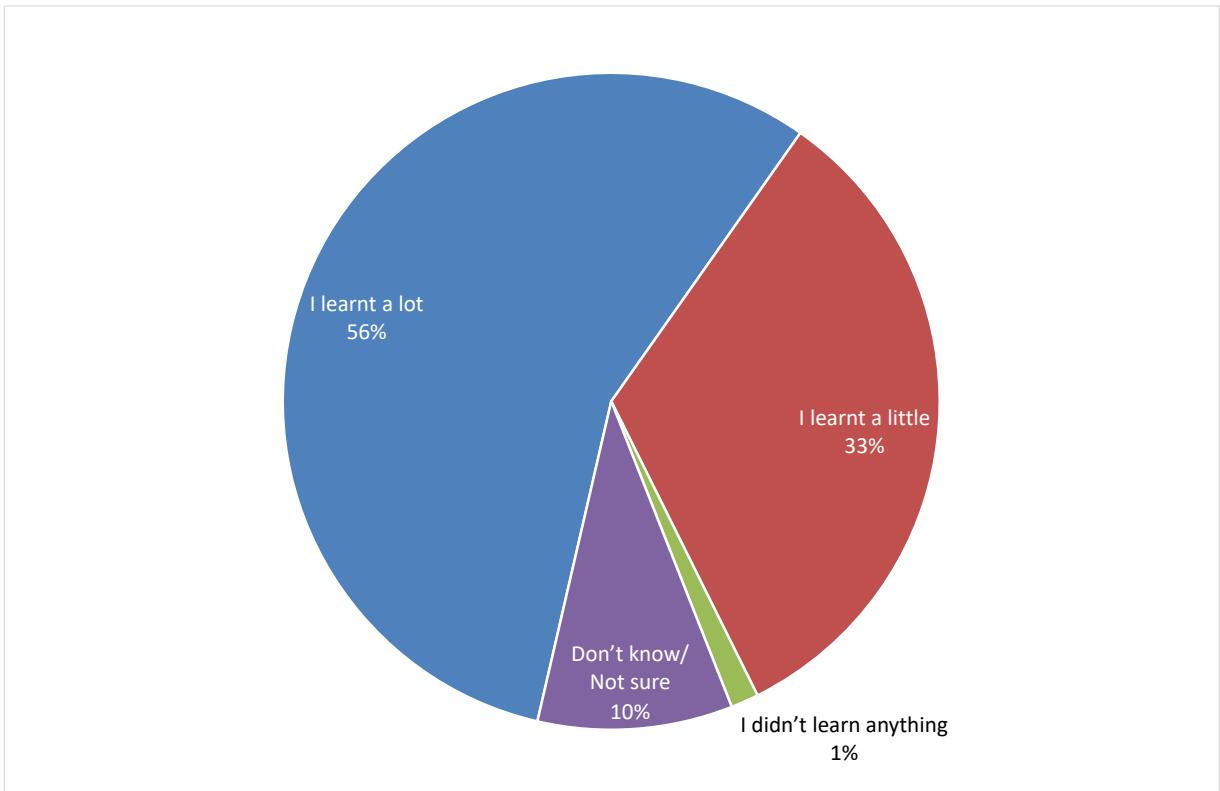
Felt more connected to the real world rather than just images. General user

Figure 24: How much did you enjoy the lesson/session/use? (General users n=72)



Learning something new: Most general users believed they had learnt something new from using the NSO; over half believed they had learnt a lot, only one said they didn't learn anything. See Fig.25 below.

Figure 25: How much do you feel you learnt during your last lesson/session/use? (General users n=73)



Most of what users felt they had learnt was new knowledge about the universe; the moon, planets, stars etc.

Life cycles of stars - particularly the stages of a red giant. General user

Surprising movement of the planets and stars during the course of the night. General user

The rapid spinning and the incredible density of neutron stars. General user

Where planets are in the sky tonight. General user

How to measure stellar density. General user

New knowledge about stars. General user

I've recently figured out how amazing the website is. Your gallery of images and the materials you provide have had a great impact on my studying. As I've just started to learn how to hunt asteroids, it gets even more interesting. Keep up your work. It makes a huge difference for whom desires to discover the mysterious side of the universe. General user

The stages a star goes through. General user

It's not a star it's a planet. General user

How exoplanets are found. General user

How small we are on the earth. General user

The massive variation in star sizes. General user

Another view of what the Sombrero galaxy is like. General user

Information regarding the solar eclipse of 1919. General user

Allied to general knowledge about the universe some also pointed out specific data they had accessed and techniques they had used to obtain it.

The size of the universe. General user

Names of craters e.g. Tycho. General user

Use of shadow to gauge mountain height. General user

The size and distances of the galaxies. General user

The second area of knowledge was how a telescope works and the value of being able to access such a large one.

That the telescope is available and how to submit an observation request. General user

First time a telescope operated according to my wish. I was very happy because I don't own any telescope or even good binoculars. General user

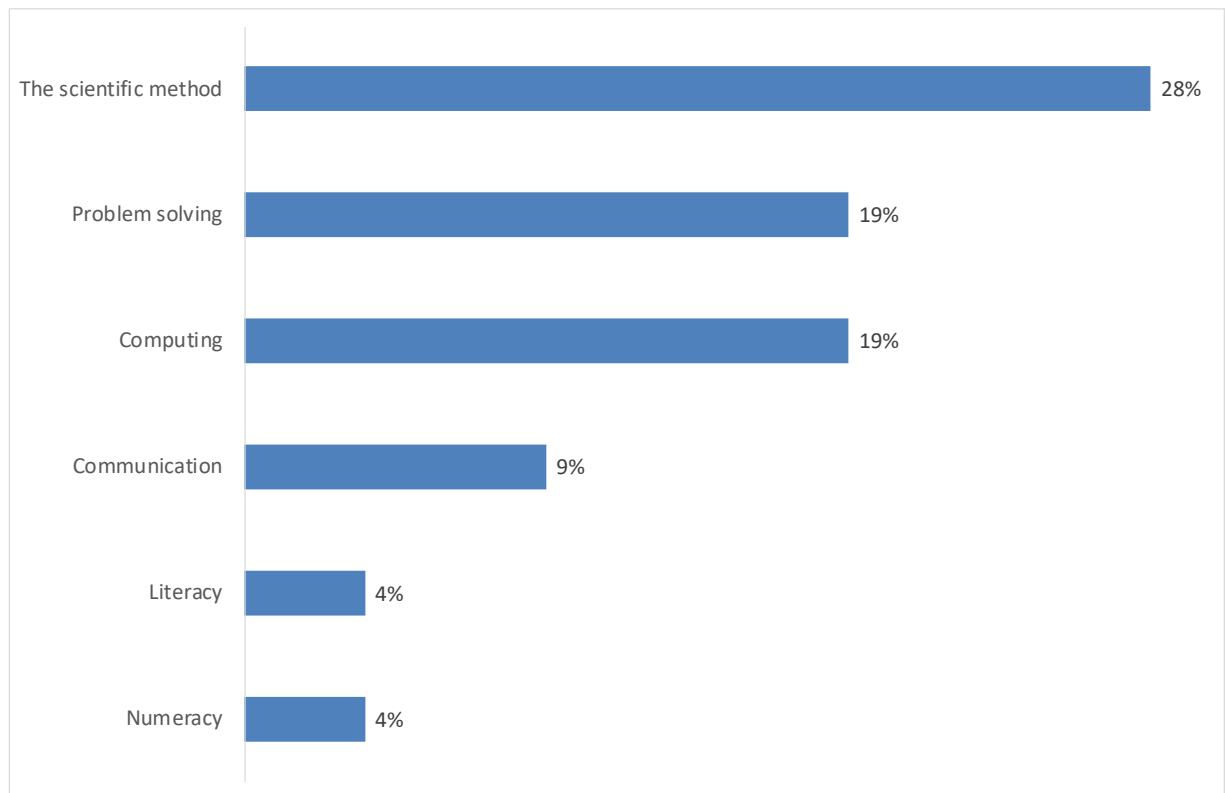
How to use a telescope - it is difficult. General user

Cloud coverage effects the telescope. General user

Clearer observations of specific lunar regions that I can't obtain with my telescope at home. General user

Skills: General users were most likely to say that the skill they learnt most from using NSO was the scientific method, mentioned by 28 percent of those who responded. See Fig.26 below.

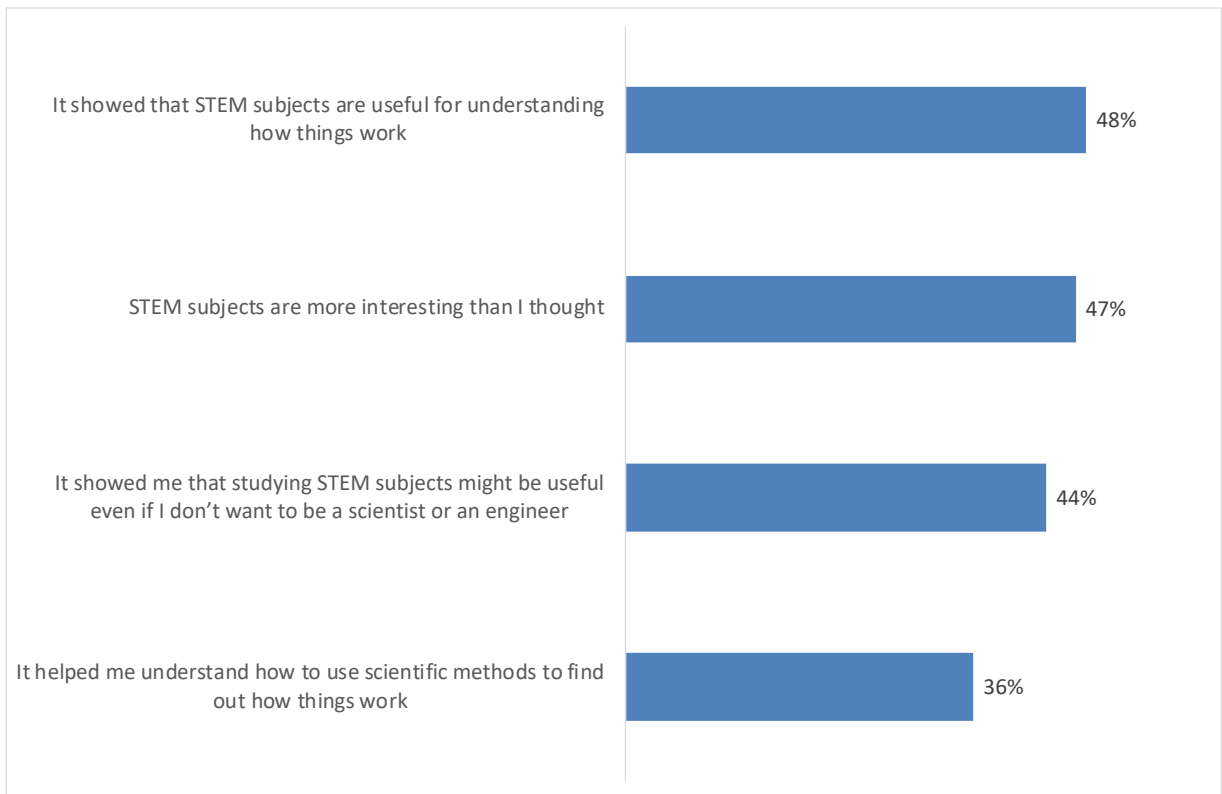
Figure 26: What new skills do you think you learnt? (General users n=53)



5.3.5 FUTURE IMPACT

Just under half of general users strongly agreed that using NSO had helped them better understand the value of STEM in learning how things work and that STEM subjects were more interesting than they previously thought. A similar number strongly agreed that studying STEM subjects might be useful even if they don't want to be a scientist or engineer. See Fig.27 below.

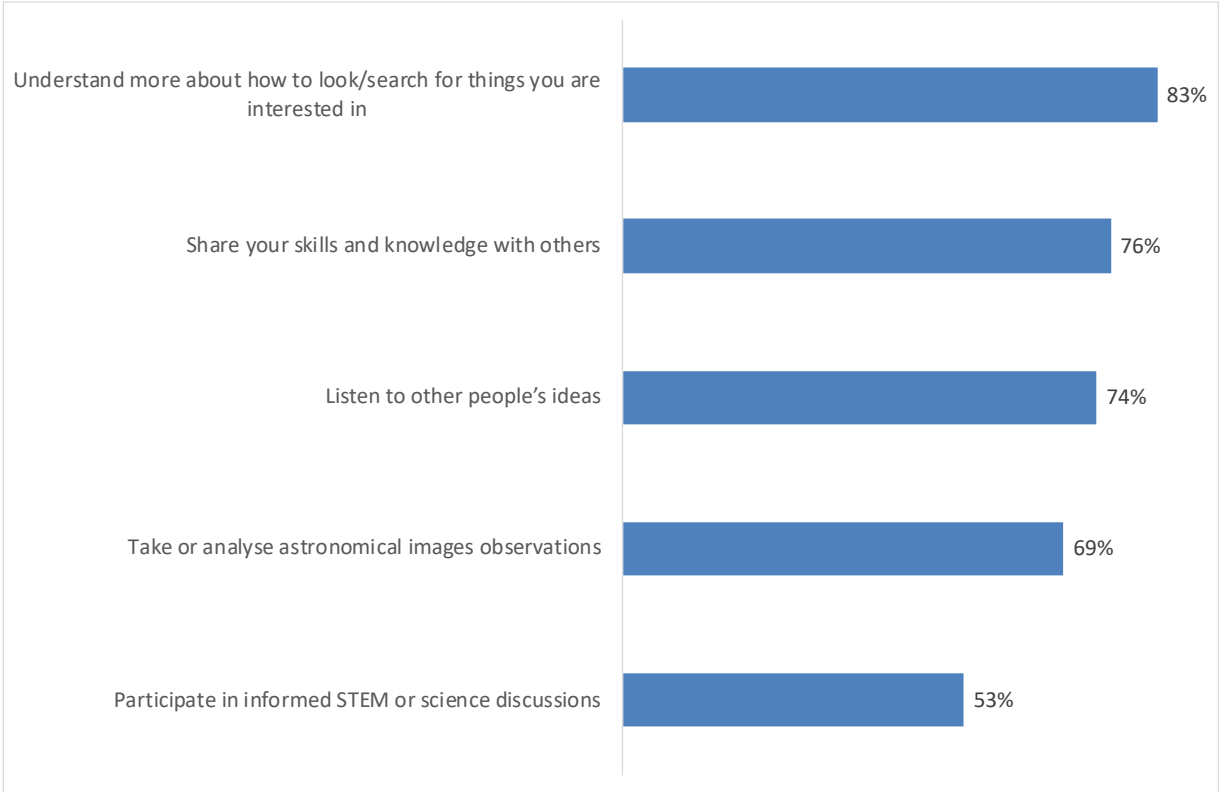
Figure 27: How much do you agree or disagree with the following statements. (% of general users who agree very much n=48)



Interest in STEM: 59 percent said they were more interested in STEM as a result of using NSO.

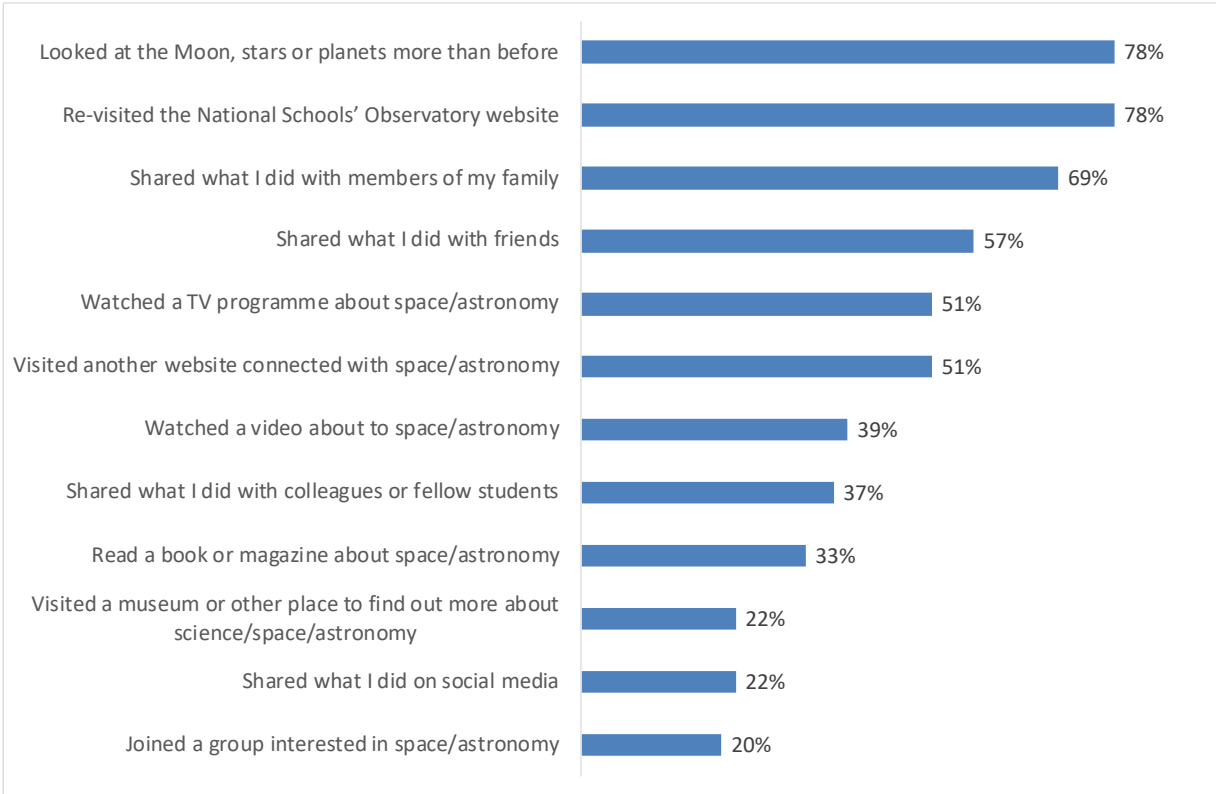
Broader skills: 83 percent of users said they now understand more about how to search for things they are interested in, while 76 percent said they felt more able to share their skills and knowledge with others. See Fig.28 below.

Figure 28: As a result of using NSO do you feel you are now more able to... (General users n=49)



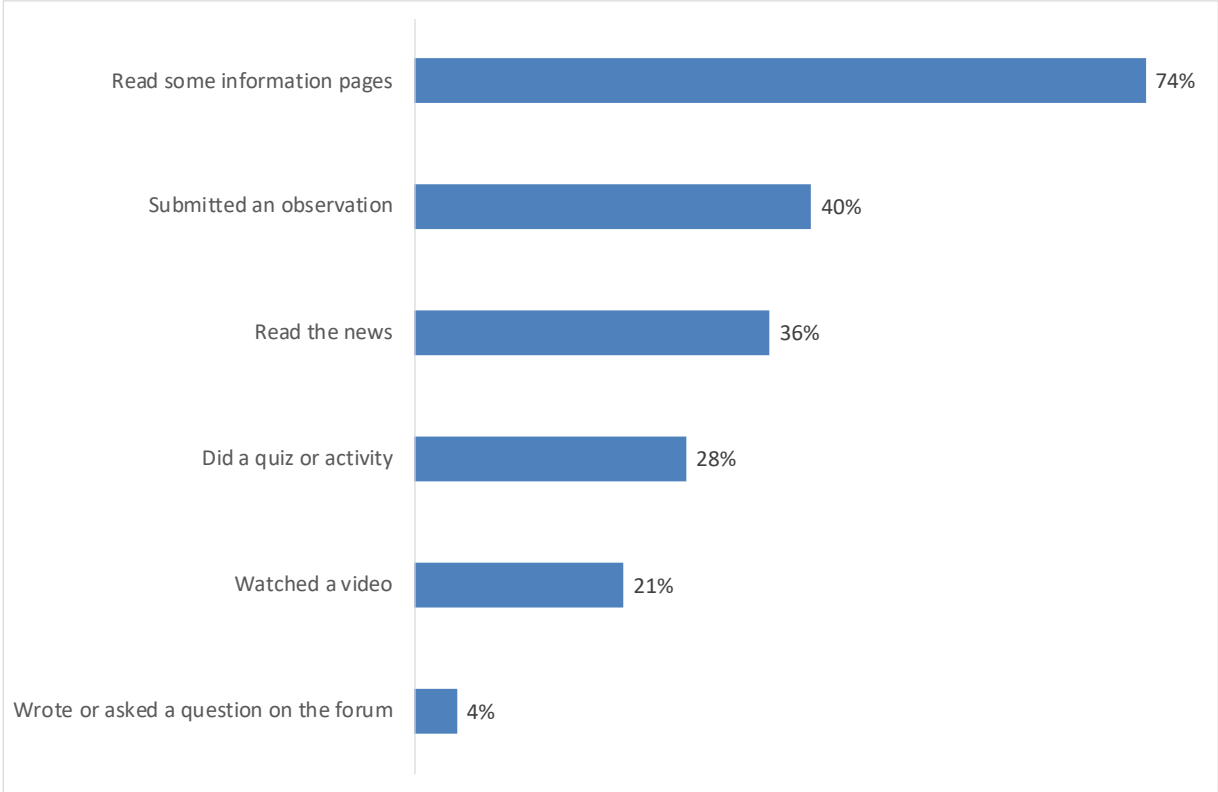
Doing something further: Just over three quarters (78 percent) of general users said they revisited the NSO website, while as many said they have looked at celestial bodies more than before. 69 percent said they shared what they had done with family members, 57 percent shared with friends. See Fig.29 below.

Figure 29: What, if anything, have you done as a result of your lessons/sessions/use connected to the National Schools’ Observatory? (General users n=49)



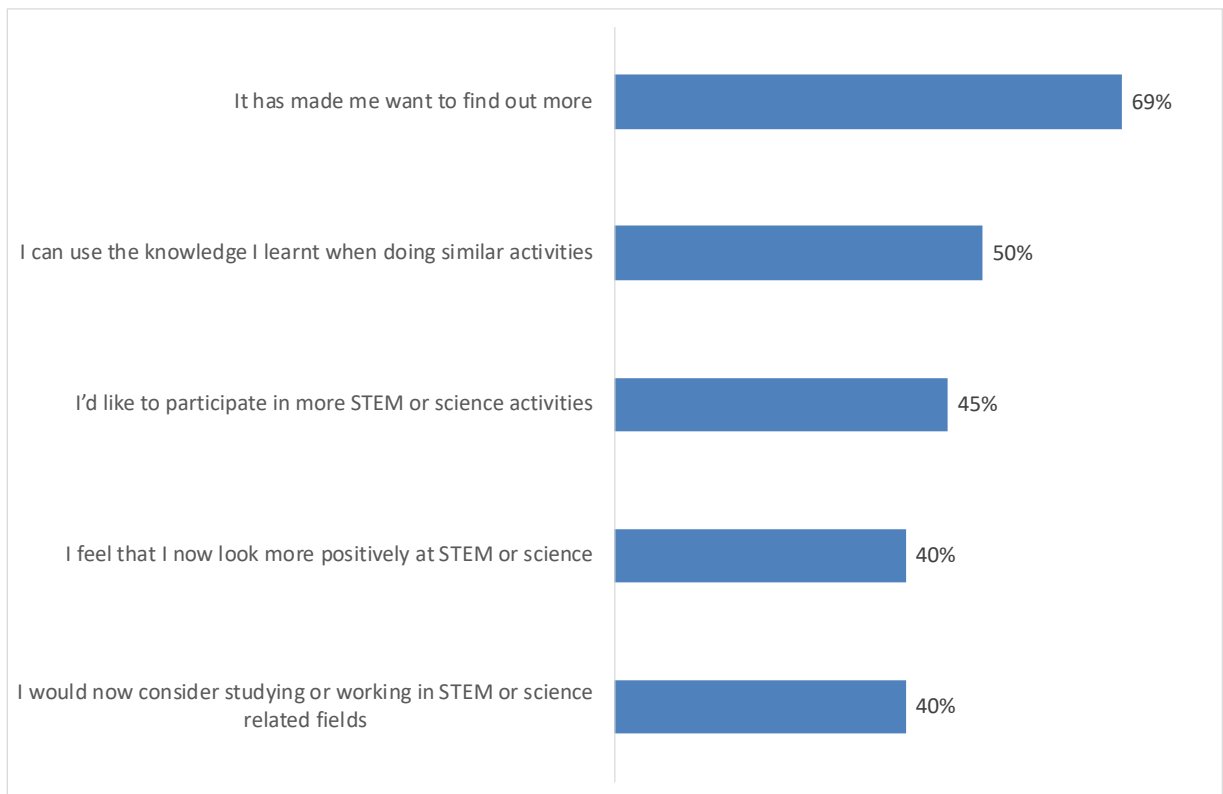
Among those who revisited the website, the most likely activity was to read some more information (74 percent), submit an observation (40 percent) or read the news pages (36 percent). See Fig. 30 below.

Figure 30: What did you do when you revisited the NSO website? (n=47)



The main reported consequences of having used the NSO website are that users want to find out more, 69 percent agreed with this statement very much. Additionally, half agreed very much that what they have learnt will be transferable to other activities, while 40 percent or more wanted to do more STEM activities, feel more positive about STEM and would consider study or work in STEM or related subjects or fields, all as a result of using NSO. See Fig.31 below.

Figure 31: As a result of your activity with the NSO website...(% of general users who agree very much n=45)



5.3.6 SUGGESTED IMPROVEMENTS TO THE NSO WEBSITE

General users made a wide range of suggested changes or improvements to the website⁹.

- Charging for certain value-added services
Allow external users broader access to conduct observations, even at a cost (e.g., subscription, donation, etc.). General user

⁹ Some suggestions may already be features but were not noticed by users.

- A tab for educators
- More video content
- Review access levels

Allow individual accounts the option to request the use of different filters. The account I used when doing GCSE Astronomy had this option but my personal account doesn't. General user

- Tracking capacity for image requests

It would be interesting to know how big the queue is, what the requested targets are, and where my request falls within that listing. General user

- A basic section for people who have no previous experience in astronomy
- Update the social media more regularly, with videos containing quirky facts.
- More external links

Link it to the European space agency (ESA) live telemetry of the ISS. General user

- Greater capacity and functionality including; more materials related to astronomy available in PDF for download and provide the requested images in JPEG and FITS formats.

While appreciating telescope use is a limited resource making the potential to design your own observation programmes would be of use (increased flexibility in the design). In addition, greater capacity would be valuable as many of my submitted observations timed out or just weren't available when needed - it was very much hit or miss. General user

Showing the Moon phase on the Go Observing home page. Also, a map showing all of the regions you can chose on the Moon in one place to help when reviewing previous observations. General user

If possible (although budget and time constraints are always #1), colour observations for all would be amazing. Seeing things like Jupiter or nebulae in full colour might bring even more on board. General user

Add more astronomical objects that can be observable with the NSO telescope.
General user

Improve the search function of the image archive. General user

6. Appendices

6.1 TEACHER SURVEY QUESTIONNAIRE

Thanks very much for taking part in this survey. Your feedback is important to us to ensure that we continue to provide resources that are relevant and useful to our users. The questionnaire should take no longer than 15 minutes and your answers will only be used by NSO for their evaluation. As a thank you there is a prize draw you can enter at the end of the questionnaire. Thanks again, the NSO Team.

About you and your school or college

* 1. Are you a:

- School
- Further education college
- Home school
- Other type of educational establishment (Please say which type)

* 2. Where are you based?

- England
- Scotland
- Wales
- Northern Ireland
- Republic of Ireland
- Elsewhere (please say which country)

3. What proportion of your students are entitled to free school meals?

- Less than 20%
- More than 20%
- Not recorded at our school
- Don't know/ Not sure

4. What level does your school/college teach at?

- Primary (Up until 11 years old)
- Secondary (11-18 years old)
- Secondary (11-16 years old only)
- 16 + only

Other (please specify)

About you

* 5. Are you a:

- General class teacher
- General science teacher
- Specialist subject teacher
- Teaching assistant
- Technician
- Careers advisor
- Other (please specify)

* 6. Which subject or subjects do you specialise in? (TICK ALL THAT APPLY)

- Physics
- Maths
- Chemistry
- Biology
- Engineering
- ICT
- Computer Science
- Design
- Other (please specify)

About your use of NSO resources

* 7. Have you ever run any lessons or out of class sessions connected to the National Schools' Observatory?

- Yes
- No
- Not sure/ Don't remember

8. How long ago did you run the last lesson or session?

- Less than a month ago
- Between 1 and 6 months ago
- Longer than 6 months ago
- Don't remember/ Not sure

9. How many lessons or sessions connected to the National Schools' Observatory have you run over the past 12 months?

- Just one
- 2 or 3
- 4 or 5
- More than 5
- Don't remember

10. What aged students took part? (Tick all that apply)

- Under 5s
- 5-7 year olds
- 8-11 year olds
- 12-14 year olds
- 15-16 year olds
- 17-18 year olds

Other (please specify)

11. What made you decide to engage with the NSO? TICK ALL THAT APPLY

- I had heard good things about it
- The topics covered are part of our curriculum this academic year
- I was attracted by the STEM applications it could provide my students
- The hands on, practical element of the website and its resources attracted me
- It was an opportunity for students to learn in a real-life environment
- It was an opportunity for students to use resources not available at school
- It was free
- An opportunity to use a professional telescope
- The quality of resources
- A trusted resource

Other (please specify)

12. What NSO resources have you used? TICK ALL THAT APPLY

- Go Observing to take observations with the telescope
- LTImage to view and analyse images
- The Learn section of the website for reference material
- The classroom focussed activities
- Other short activities and quizzes
- The STEM club activities
- Other (please specify)

13. Thinking back to your most recent lesson/session or series of lessons/sessions, how much would you agree or disagree with the following statements?

	Agree very much	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree very much
My students generally enjoyed the lesson/session	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my students build their knowledge about STEM	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my students learn how to apply practical skills to problem solving	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my students change the way they see the value of STEM subjects outside of the classroom	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my students better understand the links between STEM subjects and other topics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my pupil's understanding of potential of STEM subjects when thinking about choosing what to study at GCSE/ A level/ Degree level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

14. What specific knowledge you do feel your students have gained from working with NSO resources?

15. What specific skills you do feel your students have gained from working with NSO resources? TICK ALL THAT APPLY

- Technical Skills
- Literacy Skills
- Communication Skills
- Spatial Skills
- Thinking Skills
- Social Skills
- Practical Skills
- Creative Skills
- Research Skills
- Numeric Skills
- Problem Solving Skills
- Observation Skills
- Any Other Skills (PLEASE SPECIFY)

16. What was the single most important benefit you feel the students gained from taking part?

17. Please can you complete any of the following sentences you feel apply to your students who used the NSO resources: My students were:

Surprised by...	<input type="text"/>
Most interested in...	<input type="text"/>
Inspired by...	<input type="text"/>
Disappointed by...	<input type="text"/>
Bored by...	<input type="text"/>
Most enthusiastic about...	<input type="text"/>

18. To what extent do you think using the NSO website and resource has enabled your students to feel more positive about any of the following?

	To a great extent	To some extent	No discernable difference	Don't know/ Too hard to say
Themselves and their abilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other people/ communities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
University	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The worth and value of studying STEM subjects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

19. Are there any other learning outcomes you feel the students gained from the sessions?

20. Was there any part of the website or resources you used that was particularly effective in helping you and your students achieve your/their objectives? If so, what was it and how/why did it help?

21. Was there anything specific about the NSO website and resources that provided learning opportunities for your students that the school is unable to provide?

22. How well have the NSO resources supported topics you have covered or will be covering with your students this academic year?

0-Not supported our topics at all well	1	2	3	4	5	6	7	8	9	10 - Supported our topics really well
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

23. Why did you give this score?

24. Why did you give this score?

25. What value, if any, has using the NSO website and resources brought to your teaching? TICK ALL THAT APPLY TO YOU

- I am now more confident about teaching STEM subjects
- It has enabled me to teach science in a different way
- It supported my teaching of a STEM subject or topic
- It has enabled me to teach a STEM subject or topic in a more exciting way

Other (please specify)

* 26. Have you attended any continuing professional development (CPD) training run by NSO?

- Yes
- No

27. What are the reasons you haven't done this? TICK ALL THAT APPLY

- Wasn't aware of the CPD offer
- The timings didn't work for me
- Too difficult to travel
- Didn't have the time
- Couldn't arrange teaching cover
- It doesn't provide what I want or need

Other reasons (please specify)

28. What would NSO need to do to help you take part in future CPD training?

29. How useful was the CPD for your teaching?

0-Not at all useful	1	2	3	4	5	6	7	8	9	10 - Extremely useful
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

30. Why did you give this score?

31. Why did you give this score?

32. Please indicate anything that is new or different that you are likely to do in the future because of your use of the NSO website and resources? TICK ALL THAT APPLY

- Teach an astronomy or STEM club
- Use other robotic telescopes
- Use computers more in the classroom
- Engage my students in off-curriculum discussions/activities
- Use astronomy to teach other subjects (e.g. maths)
- Keep up to date with the latest space news

Other (please specify)

33. What, if anything, do you think your students might do as a result of their interaction with the NSO resources?

34. How likely are you to use the NSO website and resources again?

0-Not at all likely												10 - Extremely likely
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

35. How easy did you find the website to navigate and find what you wanted?

0-Not at all easy												10 - Extremely easy
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

36. Is there anything about the content of the website that you think should be changed or improved?

37. Is there anything about the format or usability of the website that should be changed or improved?

38. Finally, if you were to summarise the NSO website and resources in three words what would they be?

6.2 SECONDARY STUDENT SURVEY QUESTIONNAIRE

Thank you for answering these questions. Your responses will help us improve the National School's Observatory (NSO). For taking part you can enter a prize draw (see end for details). Your answers are confidential and will not be shared with your school or any organisation other than the NSO. This is not a test, we are just interested in your opinions. Thanks very much.

* 1. Where is your school?

- England
- Scotland
- Wales
- Northern Ireland
- Republic of Ireland
- Elsewhere

Some of the questions that follow will mention STEM. Just to remind you STEM = Science, technology, engineering, maths

* 2. How much do you agree with each of the following statements?

	Agree strongly	Agree somewhat	Neither agree or disagree	Disagree somewhat	Disagree strongly
People who are like me work in STEM.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Anyone can work in a STEM related job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want to work in a STEM related job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like STEM subjects at school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I see myself as a STEM person.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* 3. Do you remember doing any of the following connected to the National Schools' Observatory (NSO)? (TICK ALL THAT APPLY)

- A Lesson
- An out of class session such as a STEM club
- Use the NSO website for information
- Use the NSO website for an activity
- Use the NSO telescope
- Don't remember doing any of these

4. Which of these did you **last** do? (SINGLE RESPONSE)

- A Lesson
- An out of class session such as a STEM club
- Use the NSO website for information
- Use the NSO website for an activity
- Use the NSO telescope

5. How many times in the last year do you remember using the NSO for anything?

- Just once
- 2 or 3 times
- 4 or 5 times
- More than 5 times
- Don't remember

6. When did you last do any of these NSO related activities?

- Less than a month ago
- Between 1 and 6 months ago
- Longer than 6 months ago
- Don't remember/ Not sure

Thinking about the last lesson or session connected to NSO, please answer the following questions.

7. What was the lesson or session about?

8. How much did you enjoy the lesson or session?

- I enjoyed it very much
- I enjoyed it somewhat
- I didn't enjoy it that much
- I didn't enjoy it at all
- Don't know/ Not sure

9. How much do you feel you learnt during that lesson or session?

- I learnt a lot
- I learnt a little
- I didn't learn anything
- Don't know/ Not sure

10. What new knowledge, if any, do you think you learnt?

11. What new skills, if any, do you think you learnt? (TICK ALL THAT APPLY)

- Numeracy
- Literacy
- Computing
- Communication
- The scientific method
- Problem solving

Something else (Please say what)

12. What was the most surprising or interesting thing you learnt during any of the lessons, sessions or other uses connected to the National Schools' Observatory?

13. If different to your previous answer, what was the most enjoyable or inspirational thing about the lessons or sessions connected to the National Schools' Observatory?

14. How much do you agree or disagree with the following statements about lessons or sessions connected to the National Schools' Observatory?

	Agree strongly	Agree somewhat	Neither agree or disagree	Disagree somewhat	Disagree strongly
It helped me understand how to use scientific methods to find out how things work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It showed that STEM subjects are useful for understanding how things work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It showed me that studying STEM subjects might be useful even if I don't want to be a scientist	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
STEM subjects are more interesting than I thought	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. Which of the following statements best applies to you? As a result of the NSO lesson or session...

- I now feel more interested in STEM
- I now feel less interested in STEM
- I don't feel any different about STEM
- Don't know/ Not sure

16. Do you feel you are now more able to...[TICK ALL THAT APPLY]

- Take or analyse astronomical images observations?
- Participate in informed STEM discussions
- Share your skills and knowledge with others?
- Understand more about how to look/search for things you are interested in?
- Listen to other people's ideas?

17. What, if anything, have you done as a result of your lessons or sessions connected to the National Schools' Observatory? (TICK ALL THAT APPLY, MORE THAN ONE POSSIBLE)

- Shared what I did with members of my family
- Shared what I did with friends
- Shared what I did on social media
- Visited a museum or other place to find out more about science/space/astronomy
- Visited another website connected with space/astronomy
- Joined a group interested in space/astronomy
- Watch a video about to space/astronomy
- Watched a TV programme about space/astronomy
- Read a book or magazine about space/astronomy
- Looked at the Moon, stars or planets more than before

Other (please specify)

18. Have you Re-visited the National Schools' Observatory website since your last lesson or session at school?

- Yes
- No

19. What did you do when you revisited the National Schools' Observatory website?

- Read some information pages
- Did a quiz or activity
- Submitted an observation
- Watched a video
- Read the news
- Wrote or asked a question on the forum

Other (please specify)



20. As a result of taking part in lessons or sessions connected to the National Schools' Observatory please tell us how much you agree or disagree with the following statements

	Agree strongly	Agree somewhat	Neither agree or disagree	Disagree somewhat	Disagree strongly
I would now be more likely to consider studying or working in STEM related fields	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that I now look more positively at STEM	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'd like to participate in more STEM activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can use the knowledge I learnt when doing similar activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It has made me want to find out more	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



21. If you were the director of the National Schools' Observatory website what would you do to make it more interesting or useful to students like you?

22. Do you identify as

- Female
- Male
- Neither
- Other
- Rather not say

23. What is your age?

24. Which of the following would you use to best describes your ethnic origin?

- White British
- White other
- Asian
- Black
- Chinese or East Asian
- Mixed
- Other (Please write what you feel best suits you)
- Prefer not to say
- Don't know

25. Are you registered disabled?

- Yes
- No
- Prefer not to say

6.3 PRIMARY STUDENT SURVEY QUESTIONNAIRE

Thank you for answering these questions. Your responses will help us improve the National Schools' Observatory (NSO). For taking part you can enter a prize draw (see end for details). Your answers are confidential and will not be shared with your school or any organisation other than the NSO. This is not a test, we are just interested in your opinions. Thanks very much.

* 1. Where is your school?

- England
- Scotland
- Wales
- Northern Ireland
- Republic of Ireland
- Elsewhere

* 2. How much do you agree with each of the following statements?

	Agree strongly	Agree somewhat	Neither agree or disagree	Disagree somewhat	Disagree strongly
People who are like me work in science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Anyone can work in a science job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want to work in a science job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like science subjects at school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I see myself as a science person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* 3. Do you remember doing any of the following connected to the National Schools' Observatory (NSO)? (TICK ALL THAT APPLY)

- A Lesson
- An out of class session such as a STEM club
- Use the NSO website for information
- Use the NSO website for an activity
- Use the NSO telescope
- Don't remember doing any of these

4. How many times in the last year do you remember using the NSO for anything?

- Just once
- 2 or 3 times
- 4 or 5 times
- More than 5 times
- Don't remember

5. When did you last do any of these NSO activities?

- Less than a month ago
- Between 1 and 6 months ago
- Longer than 6 months ago
- Don't remember/ Not sure

Thinking about the last lesson or session connected to NSO, please answer the following questions.

6. What was the lesson or session about?

7. How much did you enjoy the lesson or session?

- I enjoyed it very much
- I enjoyed it somewhat
- I didn't enjoy it that much
- I didn't enjoy it at all
- Don't know/ Not sure

8. How much do you feel you learnt during that lesson or session?

- I learnt a lot
- I learnt a little
- I didn't learn anything
- Don't know/ Not sure

9. What new knowledge, if any, do you think you learnt?

10. (What new skills, if any, do you think you learnt? (TICK ALL THAT APPLY)

- Numeracy (Maths)
- Literacy (English writing or reading)
- Computing
- Communication
- The scientific method
- Problem solving

Something else (Please say what)

11. What was the most surprising or interesting thing you learnt during any of the lessons or sessions connected to the National Schools' Observatory?

12. How much do you agree or disagree with the following statements about lessons or sessions connected to the National Schools' Observatory?

	Agree strongly	Agree somewhat	Neither agree or disagree	Disagree somewhat	Disagree strongly
It showed that science is useful for understanding how things work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It showed me that studying science might be useful even if I don't want to be a scientist	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science is more interesting than I thought	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13. Which of the following sentences best applies to you? As a result of the NSO lesson or session...

- I now feel more interested in science
- I now feel less interested in science
- I don't feel any different about science
- Don't know/ Not sure

14. Have you done anything as a result of the National Schools' Observatory?(TICK ALL THAT APPLY, MORE THAN ONE POSSIBLE)

- Shared what I did with members of my family
- Shared what I did with friends
- Shared what I did on social media
- Visited a museum or other place to find out more about science/space/astronomy
- Used the National Schools' Observatory website again
- Visited another website about with space/astronomy
- Joined a group interested in space/astronomy
- Watch a video about to space/astronomy
- Watched a TV programme about space/astronomy
- Read a book or magazine about space/astronomy
- Looked at the Moon, stars or planets more than before

Other (please tell us what you did)

15. Have you Re-visited the National Schools' Observatory website since your last lesson or session at school?

- Yes
- No

16. What did you do when you revisited the National Schools' Observatory website?

- Read some information pages
- Did a quiz or activity
- Submitted an observation
- Watched a video
- Read the news
- Wrote or asked a question on the forum

Other (please specify)

17. For each sentence tell us how much you agree or disagree with it: Because I did a lesson or session connected to the National Schools' Observatory...

	Agree strongly	Agree somewhat	Neither agree or disagree	Disagree somewhat	Disagree strongly
I will now be more likely to consider doing science when I go to secondary school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'd like to do more science activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It has made me want to find out more	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

18. If you were the director of the National Schools' Observatory website what would you do to make it more interesting or useful to students like you?

Finally, a few quick questions about you

19. Are you a..

- Girl
 Boy
 Don't want to say

20. How old are you?

21. Are you registered disabled?

- Yes
 No
 Don't want to say

6.4 GENERAL USER SURVEY QUESTIONNAIRE

Thanks very much for taking part in this survey. Your feedback is important to us to ensure that we continue to provide resources that are relevant and useful to our users. The questionnaire should take no longer than 15 minutes and your answers will only be used by NSO for their evaluation. As a thank you there is a prize draw you can enter at the end of the questionnaire. Thanks again, the NSO Team.

About you and your school or college

* 1. Where are you based?

- England
- Scotland
- Wales
- Northern Ireland
- Republic of Ireland
- Elsewhere (please say which country)

* 2. Are you a:

- Student (at school or further education college)
- Student (at university)
- University researcher (PhD or higher)
- Educator (e.g. Teacher, Lecturer, at a science centre)
- Amateur astronomer
- Professional astronomer
- Other (please specify)

* 3. Are you a:

- Teacher
- Lecturer
- Teaching assistant
- Technician
- Careers advisor
- Other (please specify)

4. What do you teach? TICK ALL THAT APPLY

- Primary
- Physics
- Maths
- Chemistry
- Biology
- Engineering
- ICT/Computer Science
- Design/Technology
- Education
- Other (please specify)

About your use of NSO resources

* 5. Have you ever run any lessons or out of class sessions connected to the National Schools' Observatory?

- Yes
- No
- Not sure/ Don't remember

6. How long ago did you run the last lesson or session?

- Less than a month ago
- Between 1 and 6 months ago
- Longer than 6 months ago
- Don't remember/ Not sure

7. How many lessons or out of class sessions connected to the National Schools' Observatory have you run over the past 12 months?

- Just one
- 2 or 3
- 4 or 5
- More than 5
- Don't remember



8. What aged students took part in the lessons or sessions you have run? TICK ALL THAT APPLY

- Under 5s
- 5-7 year olds
- 8-11 year olds
- 12-14 year olds
- 15-16 year olds
- 17-18 year olds

Other (please specify)

9. Have you ever directed your students/other learners to use the NSO website or resources for homework or other activities?

- Yes
- No
- Don't remember

Using the NSO

10. What made you decide to engage with the NSO? TICK ALL THAT APPLY

- I had heard good things about it
- The topics covered are part of our curriculum this academic year
- I was attracted by the STEM applications it could provide my students
- The hands on, practical element of the website and its resources attracted me
- It was an opportunity for students to learn in a real-life environment
- It was an opportunity for students to use resources not available at school
- It was free
- An opportunity to use a professional telescope
- The quality of resources
- A trusted resource

Other (please specify)

11. What NSO resources have you used? TICK ALL THAT APPLY

- Go Observing to take observations with the telescope
- LTImage to view and analyse images
- The Learn section of the website for reference material
- The classroom focussed activities
- Other short activities and quizzes
- The STEM club activities
- Other (please specify)

12. Thinking back to your most recent lesson/session or series of lessons/sessions, how much would you agree or disagree with the following statements?

	Agree very much	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree very much
My students generally enjoyed the lesson/session	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my students build their knowledge about STEM	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my students learn how to apply practical skills to problem solving	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my students change the way they see the value of STEM subjects outside of the classroom	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my students better understand the links between STEM subjects and other topics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It helped my pupil's understanding of potential of STEM subjects when thinking about choosing what to study at GCSE/ A level/ Degree level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13. What specific knowledge you do feel your students have gained from working with NSO resources?

14. What specific skills you do feel your students have gained from working with NSO resources? TICK ALL THAT APPLY

- Technical Skills
- Literacy Skills
- Communication Skills
- Spatial Skills
- Thinking Skills
- Social Skills
- Practical Skills
- Creative Skills
- Research Skills
- Numeric Skills
- Problem Solving Skills
- Observation Skills
- Any Other Skills (PLEASE SPECIFY)

15. What was the single most important benefit you feel the students gained from taking part?

16. Please can you complete any of the following sentences you feel apply to your students who used the NSO resources: My students were:

Surprised by...

Most interested in...

Inspired by...

Disappointed by...

Bored by...

Most enthusiastic about...

17. To what extent do you think using the NSO website and resource has enabled your students to feel more positive about any of the following?

	To a great extent	To some extent	No discernable difference	Don't know/ Too hard to say
Themselves and their abilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other people/ communities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
University	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The worth and value of studying STEM subjects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

18. Are there any other learning outcomes you feel the students gained from the sessions?

19. Was there any part of the website or resources you used that was particularly effective in helping you and your students achieve your/their objectives? If so, what was it and how/why did it help?

20. Was there anything specific about the NSO website and resources that provided learning opportunities for your students that the school is unable to provide?

21. Please indicate anything that is new or different that you are likely to do in the future because of your use of the NSO website and resources? TICK ALL THAT APPLY

- Teach an astronomy or STEM club
- Use other robotic telescopes
- Use computers more in the classroom
- Engage my students in off-curriculum discussions/activities
- Use astronomy to teach other subjects (e.g. maths)
- Keep up to date with the latest space news

Other (please specify)

22. What, if anything, do you think your students might do as a result of their interaction with the NSO resources?

23. How likely are you to use the NSO website and resources again?

0-Not at all likely	1	2	3	4	5	6	7	8	9	10 - Extremely likely
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

24. What made you decide to engage with the NSO? TICK ALL THAT APPLY

- I had heard good things about it
- The topics covered are part of my curriculum this academic year
- I was attracted by the STEM applications it could provide me
- The hands on, practical element of the website and its resources attracted me
- It was an opportunity for me to learn in a real-life environment
- It was an opportunity for me to use resources not available at school/college/ home or elsewhere
- It was free
- An opportunity to use a professional telescope
- The quality of resources
- A trusted resource
- Other reasons (please specify)

25. What NSO resources have you used? TICK ALL THAT APPLY

- Go Observing to take observations with the telescope
- LTImage to view and analyse images
- The Learn section of the website for reference material
- The classroom focussed activities
- Other short activities and quizzes
- The STEM club activities
- Other (please specify)

26. Have you done any of the following connected to the National Schools' Observatory? TICK ALL THAT APPLY

- A Lesson
- An out of class session such as a STEM, science club or science centre activity
- Use the NSO website for information
- Use the NSO website for an activity
- Use the NSO telescope

27. Which of these did you last do?

- A Lesson
- An out of class session such as a STEM, science club or science centre activity
- Use the NSO website for information
- Use the NSO website for an activity
- Use the NSO telescope

28. When did you last do any of these things?

- Less than a month ago
- Between 1 and 6 months ago
- Longer than 6 months ago
- Don't remember/ Not sure

29. How many times in the last year do you remember using the NSO for anything?

- Just one
- 2 or 3
- 4 or 5
- More than 5
- Don't remember

Thinking about the last lesson, session or use of the NSO website you had, please answer the following questions.

30. What was this lesson/session/use about?

31. How much did you enjoy the lesson/session/use?

- I enjoyed it very much
- I enjoyed it somewhat
- I didn't enjoy it that much
- I didn't enjoy it at all
- Don't know/ Not sure

32. How much do you feel you learnt during that lesson/session/use?

- I learnt a lot
- I learnt a little
- I didn't learn anything
- Don't know/ Not sure

33. What new knowledge, if any, do you think you learnt?

34. What new skills, if any, do you think you learnt? TICK ALL THAT APPLY

- Numeracy
- Literacy
- Computing
- Communication
- The scientific method
- Problem solving

Something else (Please specify)

35. What was the most surprising or interesting thing you learnt during any of the lessons, sessions or other uses connected to the National Schools' Observatory?

36. If different, what was the most enjoyable or inspirational thing about the lessons, sessions or uses connected to the National Schools' Observatory?

In the next few questions we are going to ask about STEM subjects or occupations. These are Science, Technology, Engineering and Maths subjects or occupations.

37. How much do you agree or disagree with the following statements about your lessons, sessions or uses connected to the National Schools' Observatory?

	Agree very much	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree completely
It helped me understand how to use scientific methods to find out how things work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It showed that STEM subjects are useful for understanding how things work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It showed me that studying STEM subjects might be useful even if I don't want to be a scientist or an engineer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
STEM subjects are more interesting than I thought	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

38. Which of the following statements best applies to you? As a result of the NSO lesson/ session/use...

- I now feel more interested in STEM
- I now feel less interested in STEM
- I don't feel any different about STEM
- Don't know/ Not sure

39. Do you feel you are now more able to...

	Yes	No	Don't know/ Not sure
Take or analyse astronomical images observations?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in informed STEM or science discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Share your skills and knowledge with others?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understand more about how to look/search for things you are interested in?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Listen to other people's ideas?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

40. What, if anything, have you done as a result of your lessons/sessions/use connected to the National Schools' Observatory? TICK ALL THAT APPLY, MORE THAN ONE POSSIBLE

- Shared what I did with members of my family
- Shared what I did with friends
- Shared what I did with colleagues or fellow students
- Shared what I did on social media
- Visited a museum or other place to find out more about science/space/astronomy
- Re-visited the National Schools' Observatory website
- Visited another website connected with space/astronomy
- Joined a group interested in space/astronomy
- Watched a video about to space/astronomy
- Watched a TV programme about space/astronomy
- Read a book or magazine about space/astronomy
- Looked at the Moon, stars or planets more than before

41. What did you do when you revisited the National Schools' Observatory website? TICK ALL THAT APPLY

- Read some information pages
- Did a quiz or activity
- Submitted an observation
- Watched a video
- Read the news
- Wrote or asked a question on the forum

Anything else? (please specify)

42. As a result of your activity connected to the National Schools' Observatory please tell us if you agree or disagree with the following statements

	Agree very much	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree completely
I would now consider studying or working in STEM or science related fields	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that I now look more positively at STEM or science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'd like to participate in more STEM or science activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can use the knowledge I learnt when doing similar activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It has made me want to find out more	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

43. If you were the director of the National Schools' Observatory website what would you do to make it more interesting or useful to people like you?

About you

Please tell us a few things about you so we understand who is using the website.

* 44. Do you identify as

- Female
- Male
- Neither
- Other
- Rather not say

* 45. What is your age?

- Under 18
- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 or older
- Rather not say

* 46. Are you registered disabled?

- Yes
- No
- Prefer not to say

47. Which of the following would you use to best describes your ethnic origin?

- White British
- White other
- Asian
- Black
- Chinese or East Asian
- Mixed
- Prefer not to say
- Don't know

Other (Please write what you feel best suits you)

48. How easy did you find the website to navigate and find what you wanted?

0-Not at all easy	1	2	3	4	5	6	7	8	9	10 - Extremely easy
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

49. Is there anything about the content of the website that you think should be changed or improved?

50. Is there anything about the format or usability of the website that should be changed or improved?

51. Finally, if you were to summarise the NSO website and resources in three words what would they be?

6.5 SCHOOL SESSION OBSERVATION GUIDE

Overall Objective: To assess the collective student level of engagement and learning during the session

What we are looking for during the session. Evidence of...

- Engagement (with tasks and teacher)
- Concentration
- Energy applied to task
- Persistence – do they attempt something fail and then try again?
- Satisfaction and enjoyment
- Collaboration
- Decision making
- Taking responsibility for own learning

1. General observation of the group

Name of school	
Name of teacher	
Session type	
Time of day	
How many students	
Year group	
Ratio of adults to children	
Type of School (location, mixed/single sex)	
Composition of group (gender, ethnicity)	

Things to look out for...

The environment

- Does the environment have any impact on the session (distractions / noise etc)?
- Does the set up allow for all students to see and hear comfortably?

The activities

- Do students show interest, willingness to participate, boredom, disruptive behaviour etc? Note examples, are the activities seemingly more suitable for particular groups of students e.g. boys, girls
- Which parts of the session appear to stimulate and interest? Why? Note examples. Which do not?
- How do they appear to be interested or stimulated? Examples

- Are there any points where students appear to tire or become bored or disruptive? Examples
- How do students react to the teacher? With interest, boredom, excitement etc? Examples.
- Are the activities conducted appropriate for the students? Examples of why they are or are not.
- Are students challenged and stretched? How?
- Are they encouraged to think in new ways/ any way? How?
- Is there any evidence of students having been briefed or introduced to the topic before the session?

Learning outcomes

- How appropriate do the activities/ session appear to be for the students overall in terms of the following learning objectives (GLOs):
- Where possible, give observed examples.
 - Developing knowledge and understanding of the topic
 - Improving skills e.g.
 - Investigative skills
 - To improve social and co-operation skills
 - To learn to increase communication skills
 - To improve decision-making skills

- Delivering enjoyment, inspiration & creativity
- Stimulating activity, leading to changes in behaviour and progression
- Changing attitudes and values e.g.
 - towards science/ physics/ astronomy
 - towards science/ physics/ astronomy being used in practical scenarios

Session element observations:

Name of element:

Associated observations:

6.6 SCHOOL SESSION STUDENT FOCUS GROUP DISCUSSION GUIDE

INTERVIEWER: This is a guide only, if you can follow up anything you noted during observation of the lesson/session [IF APPLICABLE] – for example use of resources, reactions to the activities by students etc. Estimated time required: 30-40 minutes. Audio record each discussion in a quiet room but with teacher or TA in attendance if discipline or child protection is a concern. Aim for 6-10 attending, ideally 8 if it can be arranged.

Why take part in NSO [ASK IF PART OF AN OBSERVED ACTIVITY AND ADAPT DEPENDING ON STUDENT ACTIVITY I.E. IF THEY ARE IN A CLUB OR DOING GCSE]

- Why did you decide to take the GCSE in Astronomy? OR
- Why did you decide to join the after school club?
- What did you or do you hope to get out of the GCSE/Club

Overall recall [ASK IF NOT PART OF AN OBSERVED ACTIVITY]

- Do you know what the National Schools Observatory (NSO) is? ASK THEM TO GIVE A BRIEF DESCRIPTION
- When did you last do something connected to the NSO? What did you do on that occasion?
- What about previous occasions – what have you done connected to the NSO?

Most recent interaction

Okay, I want to first talk about the most recent NSO (or name teacher has given it) lesson, session or club activity.

- Did you enjoy the lesson/session? Why/ Why not?
- What were the good things about it?
- What was your favourite thing that you did or found out? Why do you say this?

- Do you think you learnt anything new during this lesson/session?
- IF YES: What did you learn? SPONTANEOUS RESPONSES FIRST THEN PROBE ON:
 - What new knowledge do you think you have picked up?
 - Did you develop any new skills?
- IF NO: Why don't you think you learnt anything new?
- Is there anything in particular about this lesson/session that you will tell other people about? If so, what?

All NSO activity

Okay, now let's think about all the NSO sessions or lessons you've taken part in over the last year or so.

- What new knowledge or facts have you learnt as a result of these lessons/ sessions?
- What new skills or abilities have you picked up or developed as a result of these lessons/ sessions?

- Has it made you feel more confident in any way? IF SO: How?
- Has it changed the way you think or feel about astronomy? [OR OTHER SUBJECT DEPENDING ON HOW THE TEACHER HAS USED IT]
- IF SO: What has changed? Why do you think this change has come about?
- Has it changed the way you see astronomy/other topic as a potential subject to study in the future? IF SO: How?
- Has it changed the way you see STEM/science as a way into different types of work in the future? IF SO: How?

- As a result of taking part in these NSO lessons/ sessions has it inspired you to do something different? SPONTANEOUS THEN PROMPT WHERE NECESSARY FOR:
 - Shared what I did – with whom, how?
 - Visited a museum or other place to find out more about science/space/astronomy – where, what did you do there?
 - Re-visited the National Schools’ Observatory website – to do what?
 - Visited another website connected with space/astronomy – to do what?
 - Joined a group interested in space/astronomy
 - Watch a video or TV programme about space/astronomy – what was it?
 - Read a book or magazine about space/astronomy – what was it?
 - Looked at the Moon, stars or planets more than before
 - Applied for a course related to NSO – what, where?
 - Anything else?

Access and usability

- Have you used the website yourself? IF YES:
- How user friendly have you found the website to be? Examples
- What elements could be changed to make it easier or better to use?

LJMU awareness and branding [SECONDARY STUDENTS ONLY – ASKED IN PHASE 2]

IF NOT SPECIFICALLY MENTIONED:

- Do you know who is behind the NSO programme? IF CORRECT ANSWER ASK:
- How do you know this?
- How evident it is from the website?
- Should the LJMU branding be more obvious? IF YES: Why, how?
- What do you feel about LJMU running this kind of programme? What value do you think it brings to the university?

Looking ahead [IF TIME]

- What could be changed or added to make the NSO website and resources of greater value to you?
- Do you see yourself continuing to use NSO for the foreseeable future? IF YES: How?

6.7 SCHOOL SESSION TEACHER INTERVIEW GUIDE

Conduct this interview with the organising teacher, and preferably one who attended at least one of the sessions. It should take around 40-50 minutes and ideally be conducted on the same day, either during a spare period or at the end of the day. If this is not possible arrange to conduct a follow up interview by phone. Audio record the face-to-face interview, but if by phone, taking notes is sufficient if recording isn't possible.

Objectives

- Are you responsible for using NSO resources at your school? IF NO: What role did you play, if any, in making arrangements to use these resources?
- IF YES: What made you decide to use the NSO?
- How did you think your students would benefit from it?
- What about the school more widely, did you think there would be a more general benefit? IF SO: What?

Use at school

- How do you use the NSO resources at school?
- What have you found the most useful elements and/or resources to be?
- Conversely, what have you tried using and found to be less useful?

- What would be a typical set of lessons or sessions?
- What resources would you use to run these?
- How often, or how many lessons or sessions would you use the NSO for with a particular class or group?
- Do you set any pre NSO session tasks or activities for your students? IF YES: What did you ask them to do? How useful was this for the subsequent lesson or session?
- Do you use the NSO for homework? IF SO: How do you do this? [POSSIBLY MAP OUT ON PAPER]
- Why do you use the resources in this way?
- Do you combine NSO resources with others? IF SO: What else do you use and why?
- Have you linked your NSO activity with field trips or fieldwork of any kind? IF YES: Please tell me more
- Is there anything NSO could do to further support such fieldwork?

ASKED IN PHASE 2: IF NOT MENTIONED ASK SPECIFICALLY ABOUT THE STEM CLUB RESOURCES

- Have you used them? IF NOT: Any particular reasons why not?
- How have you used them?
- How helpful have they been for your teaching?
- How appropriate have they been for your students?
- How do they work in combination with the rest of the website?

- What would you change about them if anything?

Curriculum [IF NOT ALREADY COVERED IN THE PREVIOUS SECTION]

- How well do the resources align with your curriculum requirements?
- Is there anything that NSO could do to better align these requirements?

Learning outcomes: Students

- How do you think, if at all, the NSO resources have helped student develop in any of the following areas:
 - Making STEM enjoyable
 - Their awareness of and attitudes towards STEM
 - Their knowledge and understanding of STEM
 - Improving student skills in collaboration, decision making, speaking, listening and oral presentation skills
 - Improving student skills in working in a scientific way
 - Inspiring/facilitating creativity, independence and engagement
- IF NOT DONE ALREADY: Can you give any examples of these outcomes?
- Which of these were the strongest – i.e. the resources most helped in achieving?
- How well did these outcomes align with your original objectives?
- Do you have any examples where engagement with NSO by a student or students had led to them doing something significantly different?

CPD

- Did you take part in any NSO run CPD?
- IF YES: What did you do? How useful did you find this? What, if anything would you have done differently to have made it more effective?
- IF NO: Was there any particular reason for not taking part in the CPD?

Learning outcomes: Teacher

- Do you use the NSO website as a tool to learn more about the topics you teach?
- IF YES: What have you used and what have you learnt or how have you personally benefited?

Access and usability [IF NOT ALREADY COVERED]

- How user friendly have you found the website to be? Examples
- What elements could be changed to make it more accessible for you or for your students?

Context [IF TIME]

- Do you use any other similar resources for teaching STEM subjects?
- IF SO: What do you use? What, if anything do these offer that NSO does not?

- OR Put another way, is there anything NSO could learn from these resources to improve its own offer?

NSO promotion

- Have you ever recommended NSO to others; teachers or anyone else? Who have you recommended it to and why? What was their response, do you know if they went on to use it?
- If NSO was seeking to promote it further among UK and Ireland schools where and how do you think they should be putting their effort? Where are the best places to catch the eye of busy teachers? Which teachers should they be targeting?

ASKED IN PHASE 2: LJMU awareness and branding

IF NOT SPECIFICALLY MENTIONED:

- Do you know who is behind the NSO programme? IF CORRECT ANSWER ASK:
- How do you know this?
- How evident it is from the website?
- Should the LJMU branding be more obvious? IF YES: Why, how?
- What do you feel about LJMU running this kind of programme? What value do you think it brings to the university?

Looking ahead

- What could be changed or added to make the NSO website and resources of greater value to you and your students?
- Do you see yourself continuing to use NSO for the foreseeable future? IF NO: Please explain.
- What challenges do you think NSO faces in achieving growth in use of its resources?
- If NSO were to introduced charging for some or all of its resources what impact would this have your use and your student's use?

Thank and close

