Planet Hunters, Zooniverse Evaluation report

Authored by Dr Annaleise Depper
Evaluation Officer, Public Engagement with Research
Research Services, University of Oxford

UNIVERSITY OF OXFORD

Contents

1. Key findings and highlights

An evaluation of Planet Hunters was undertaken in 2019 to explore the outcomes and impacts of the project on citizen scientist volunteers; the benefits and challenges of Planet Hunters; and the ways in which Planet Hunters could be enhanced in the future. An online survey was used to explore people's experiences of taking part, which was completed by 577 volunteers.

Key outcomes and impacts on citizen scientists

- 74% learned about Astronomy and the process of searching for exoplanets.
- 66% reported that they enjoyed learning about Astronomy.
- 21% felt inspired to learn more about Astronomy beyond Planet Hunters.
- 19% experienced a feeling of pride in being a citizen scientist and personal satisfaction in being able to help the scientific community.
- 8% reported positive benefits to their individual wellbeing and sense of satisfaction in life as a result of taking part in Planet Hunters.

Learning from the evaluation

- 89% of volunteers participated in Planet Hunters because they wanted to contribute to scientific research.
- 49% indicated a reason that might limit or prevent them from taking part in Planet Hunters; including a lack of time and other personal commitments; limited understanding of the task; difficulties with the platform or interface; classification anxieties; lack of individual feedback and recognition; and tedious, fatigue and repetition.
- 50% provided a recommendation to enhance their experience of Planet Hunters; including improving accessibility and interface usability; providing additional information and support to volunteers; and providing more feedback and recognition of volunteers.

2. Introduction

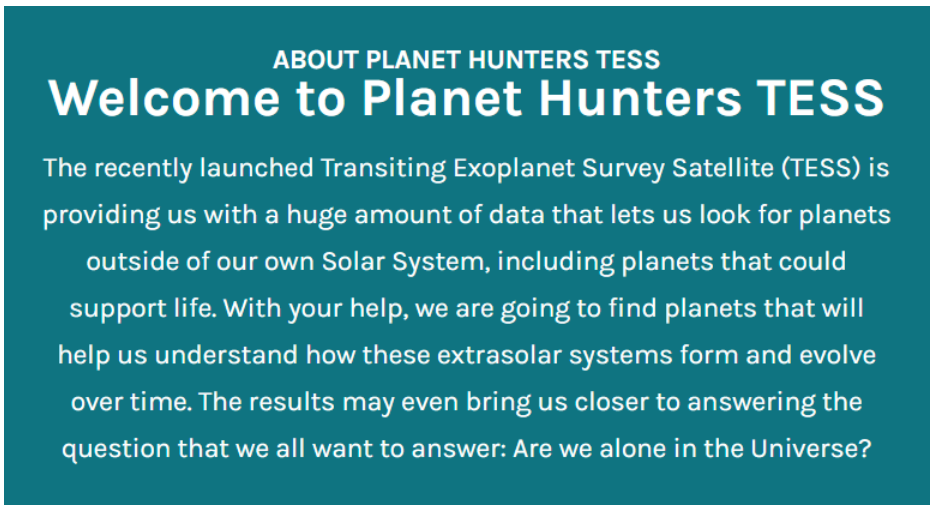
Planet Hunters is a project on the citizen science platform, Zooniverse, which brings together people from across the world in the search for planets outside of our Solar System. With the help of citizen scientists, researchers have been able to find out more about the diversity of planets and how extrasolar systems evolve over time.

Researchers from the Department of Physics at the University of Oxford originally launched Planet Hunters in 2010 with data provided by the NASA *Kepler* mission, and more recently re-launched the project with new data from NASA's Transiting Exoplanet Survey Satellite (TESS). Since December 2018, over 12,000 citizen scientist volunteers from over 98 different countries worldwide have contributed their time to classify millions of light curves through Planet Hunters TESS.

As citizen scientists, people from all walks of life are invited to examine light curves drawn from the data to identify transits from extrasolar planets. Research has shown that the collective effort of citizen scientists and their ability to review light curves and recognise glitches has proven to be more accurate than computer algorithms[2].

"The involvement of citizen scientists has shown to be a valuable and reliable tool in exoplanet detection." [1]

The aim of Planet Hunters is to make important discoveries of new planet candidates, and in the process increase people's understanding of science and planetary systems in our Galaxy; enable volunteers to gain new skills as citizen scientists to detect planets; and inspire volunteers to learn more about Astronomy beyond the project.



[1] Fischer. D., Schwamb, M., Schawinski, K., et al. 2012. Planet Hunters: The First Two Planet Candidates Identified by the Public using the Kepler Public Archive Data. *Monthly Notices of the Royal Astronomical Society,* 419, 2900–2911.
[2] Lintott, C., Schwamb, M., Barclay, T., et al. 2013. Planet Hunters: New Kepler Planet Candidates from Analysis of Quarter 2. *The Astronomical Journal,* 145 (151).

3. Evaluating Planet Hunters

Questions remain as to why do people engage in Planet Hunters; what, if anything, do people learn; what factors limit people's participation; and how can researchers at the University of Oxford learn from people's experiences to enhance the project?

An evaluation of Planet Hunters was carried out in 2019, to explore these questions by engaging with the views and experiences of volunteers. The evaluation was both summative (to explore the outcomes and impacts of Planet Hunters on volunteers) and formative (to gather learning and findings to enhance Planet Hunters in the future).

The purpose of this evaluation was to explore:

- the outcomes and impacts of Planet Hunters on citizen scientist volunteers;
- the benefits and challenges of Planet Hunters;
- and how Planet Hunters can become more inclusive of its growing, diverse community.

Evaluation methodology:
An online survey was used to explore volunteers' experiences of Planet Hunters:

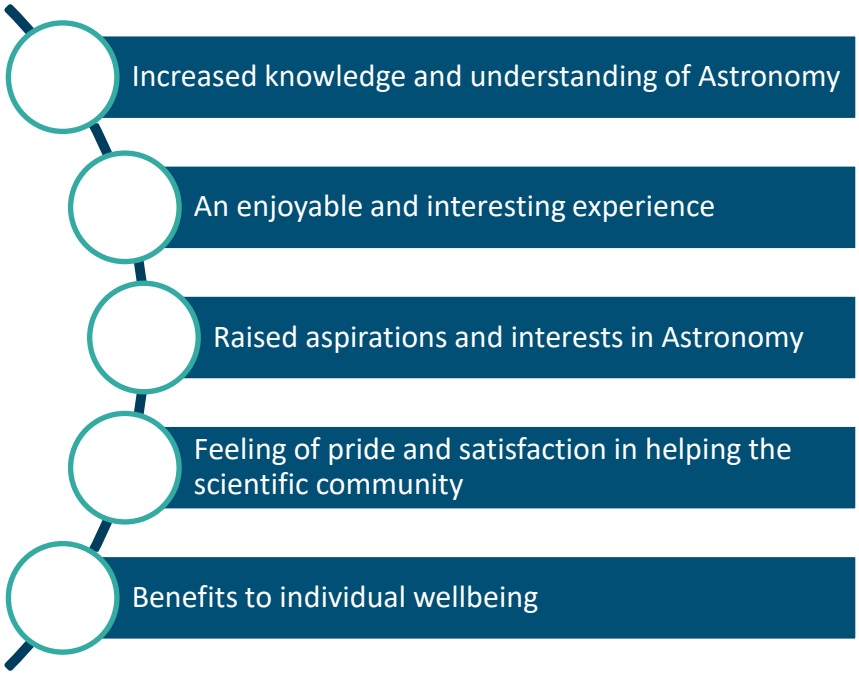
- The survey was circulated via the Planet Hunters email list; shared through a blog post; and a link to the survey was also added to the Planet Hunters project page (see Appendix 1 for survey questions).
- A total of 577 volunteers completed the survey (5-6% response rate).
- Please note, as this was a self-selected survey, the results are not necessarily representative of the Planet Hunters community as a whole. See Appendix 2 for a summary of the key demographic information about the volunteers who completed the survey.

Thank you to the volunteers and research team who contributed their time and support in the process of this evaluation.

4. Exploring impacts and outcomes on citizen scientists

This first section explores the different outcomes and impacts of Planet Hunters on citizen scientist volunteers. A summary of these key outcomes and impacts is provided below, which are then further expanded upon on pages 7-19.

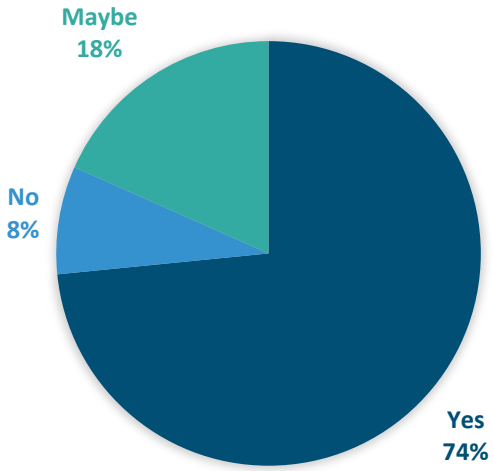
Key outcomes & impacts on citizen scientists



4.1 Increased knowledge and understanding of Astronomy

While some volunteers highlighted that they already have a good understanding and knowledge of Astronomy and the process of searching for exoplanets, 74% reported to have learned something through taking part in Planet Hunters.

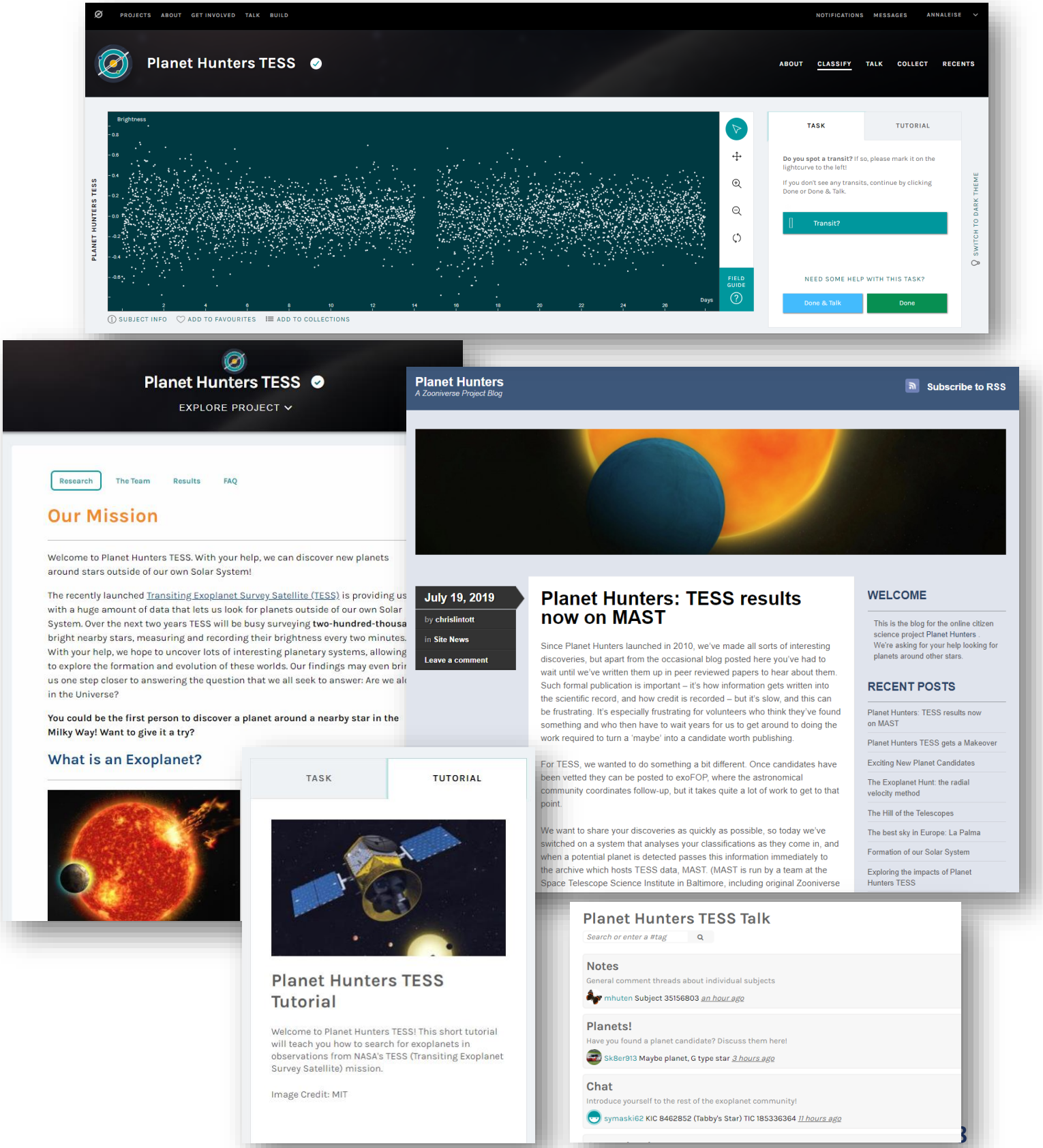
Did you learn anything through taking part in planet hunters?



Where did this learning take place?

For many volunteers, this learning took place through the main project site and the process of examining light curves drawn from the data to classify transits from extrasolar planets. The results also show that volunteers learned about Astronomy more broadly and the process of searching for exoplanets through the project information pages, tutorial, blog pages, and Talk (an online discussion forum for citizen scientists to observe, collect, share and discuss data from the project):

Where did this learning take place?



What did volunteers learn?

Through the process of taking part in Planet Hunters, citizen scientist volunteers developed their knowledge and understanding of Astronomy; information about stars and light; the importance of citizen scientists in the search for exoplanets; and the complexities and difficulties of this work.

The diagram below highlights the different subjects that volunteers learned, with exoplanets and planets being the most commonly referenced topic. In the diagram, the size of each box represents the relative frequency of the particular theme. These themes are then further unpacked on pages 10-11.

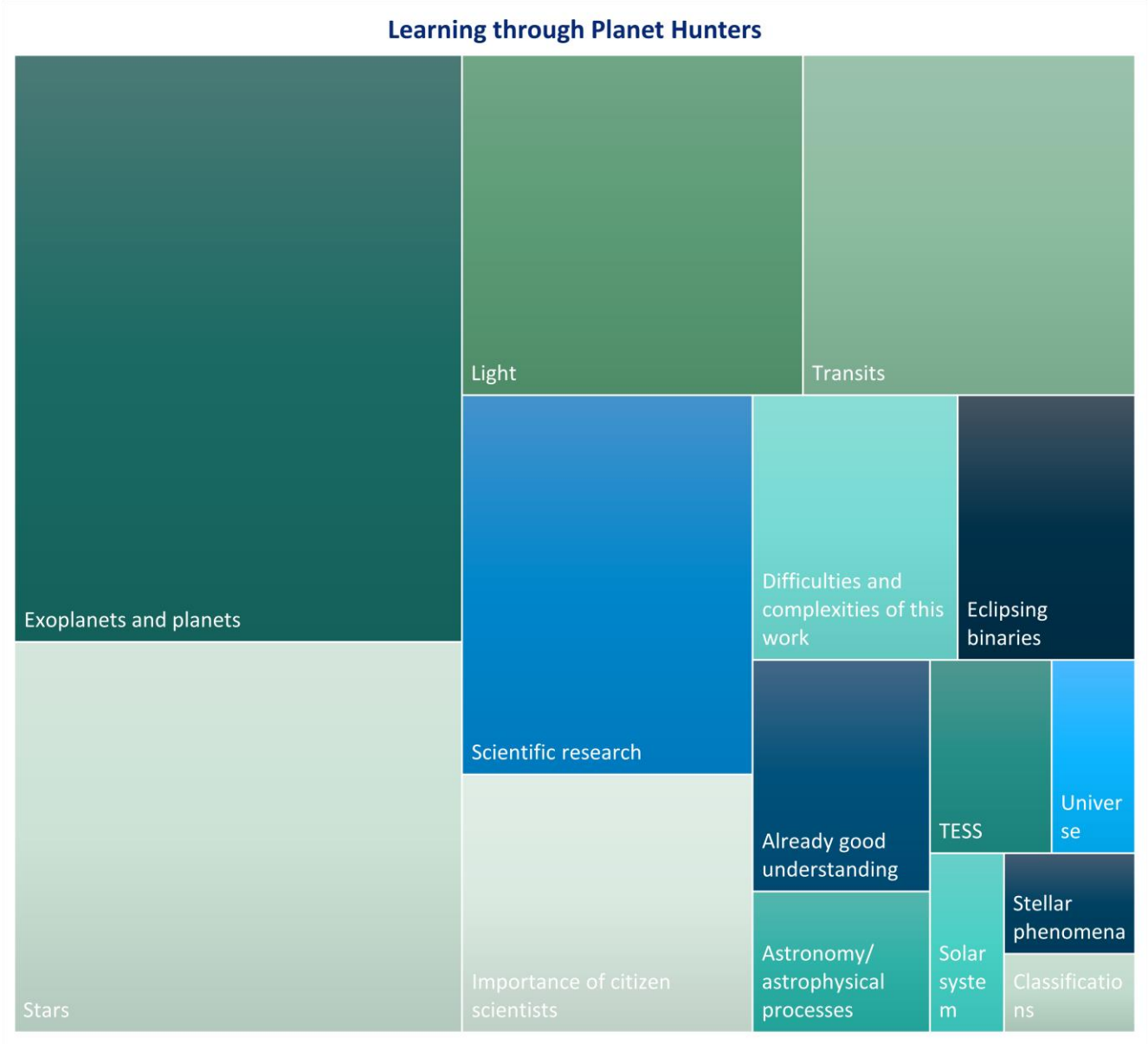


Figure 1: Themed responses to the survey question: 'What did you learn?'. Total no. of responses to this question: 396.

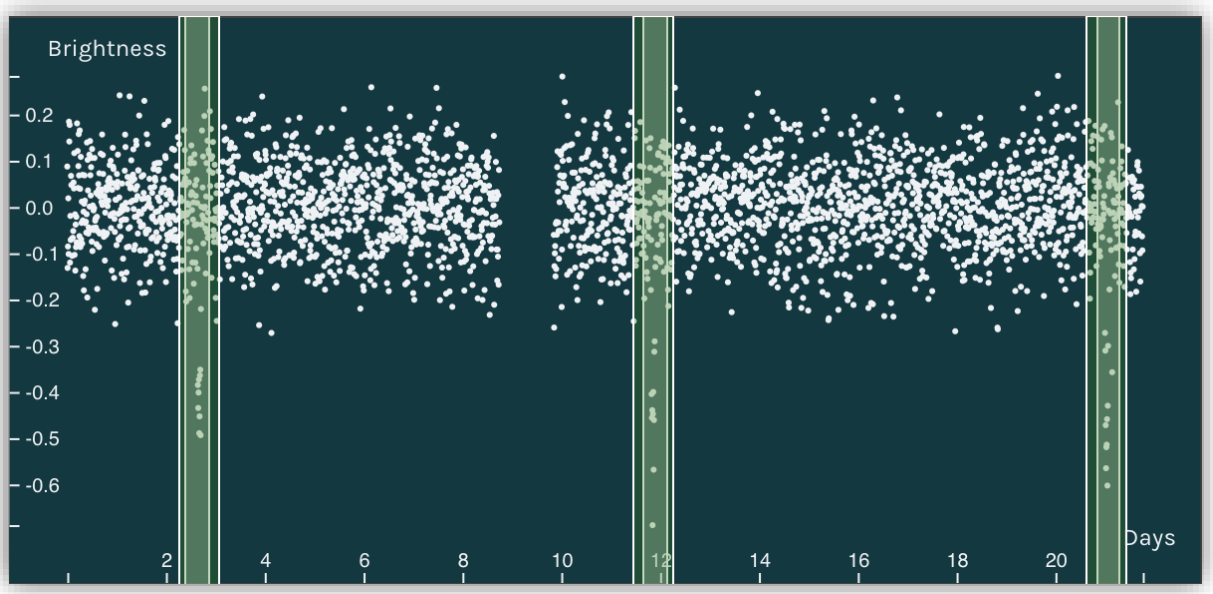
Learning about: Astronomy and astrophysical processes

53% of citizen scientists learned about Astronomy and astrophysical processes; for example, the detection of exoplanets, planetary systems and planetary information. Many volunteers gained new skills as citizen scientists to detect planets, and in the process volunteers learned information about stars, such as the different variable stars, the brightness of stars and eclipsing binary star systems. Volunteers also learned about the correlation between stars, their light curves and transits; the process of analysing light curves and patterns when a planet transits a star. Some felt that their previously held knowledge and assumptions about the Universe had been challenged, and highlighted how they have now come to appreciate the Universe and the possibilities of exoplanets. Through being able to take part directly as citizen scientists, Planet Hunters has significantly increased people's understanding of planetary systems and informed volunteers about the diversity of exoplanets.

"I learnt a lot about transits, not just planets, but binaries too. I did not know how the light curves looked like before this, and now I know a lot more than that."

"I learned about transit curves and how and that it is possible to detect multiple planets around a star"

"I learned how to identify not only possible transits, but also how to identify other light curves such as eclipsing binary stars. This has encouraged me to further research the subject"



Simulated data on Planet Hunters

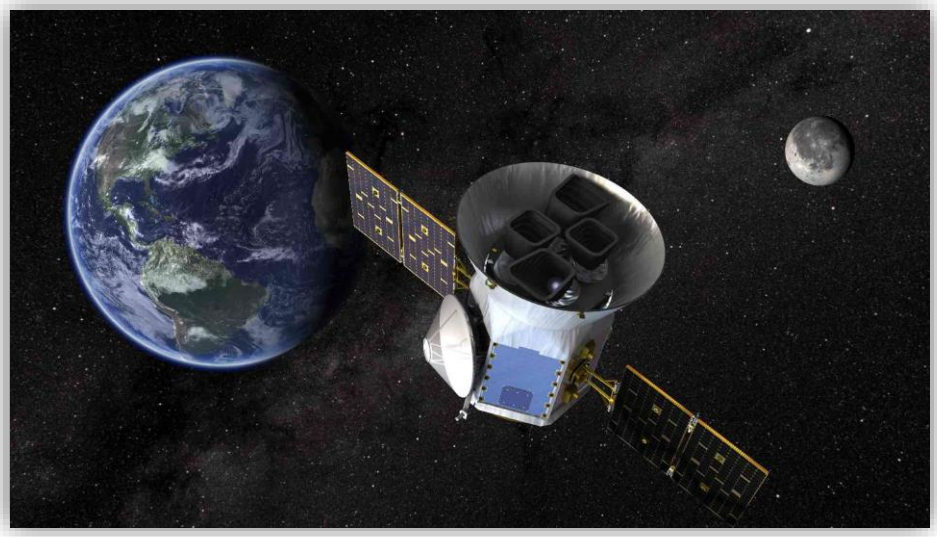
Learning about: Data, scientific research and the role of citizen scientists

18% of volunteers learned about research methodologies and the ways in which scientists gather and analyse data through working with citizen scientists; and how this data is then used to increase scientific understanding of exoplanets. People's knowledge and awareness of the TESS satellite programme and the data collected through satellites has also increased, with some referencing that they are now more aware of exoplanet hunting and the missions behind this (e.g. from TESS; Kepler). Moreover, some volunteers now have an increased appreciation of both the complexities and difficulties of detecting new planets and the importance of citizen scientists; and the ways in which people without a background in science can contribute to research and making scientific discoveries.

"Planet Hunters has made me aware of Astronomy Data research. For a common person it is almost impossible to have access to such data, also there is an in-depth explanation of the tasks that are expected to be performed. There are tutorials and a Fieldguide which helps in knowing what to do and it helps with the precision in choosing the data properly. The Chat window is a useful feature to learn from the other participants and for encouragement."

"I learned about the actual research medium taking place and how it really works instead of viewing a graphic or reading an article."

"A better understanding of the research on exoplanets and TESS."



TESS launch (Photo credits: Nasa's Goddard Space Flight Center)

4.2 An enjoyable and interesting experience

Overall, 87% of volunteers rated their experience of Planet Hunters as good or excellent. When asked for what reasons do you engage in Planet Hunters, 66% of volunteers highlighted that they took part because they enjoyed learning about Astronomy.

While individual responses varied between each participant, the word cloud below highlights the various words that volunteers used to describe their experience of Planet Hunters that relate to enjoyment (with the size of each word representing the relative frequency).

"I enjoyed learning about the various types of exoplanet and their relationship with their parent star. I also enjoyed learning about binary star systems."

"I really enjoy it and it has connected me to the topics I help with"

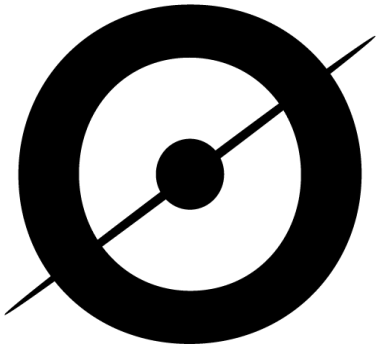
"I think it's an interesting activity and I enjoy participating."

4.3 Raised aspirations and interests in Astronomy

Planet Hunters has inspired many of its volunteers to learn more about Astronomy beyond the project; and this next theme explores the different ways in which Planet Hunters has raised people's aspirations and interests in Astronomy.

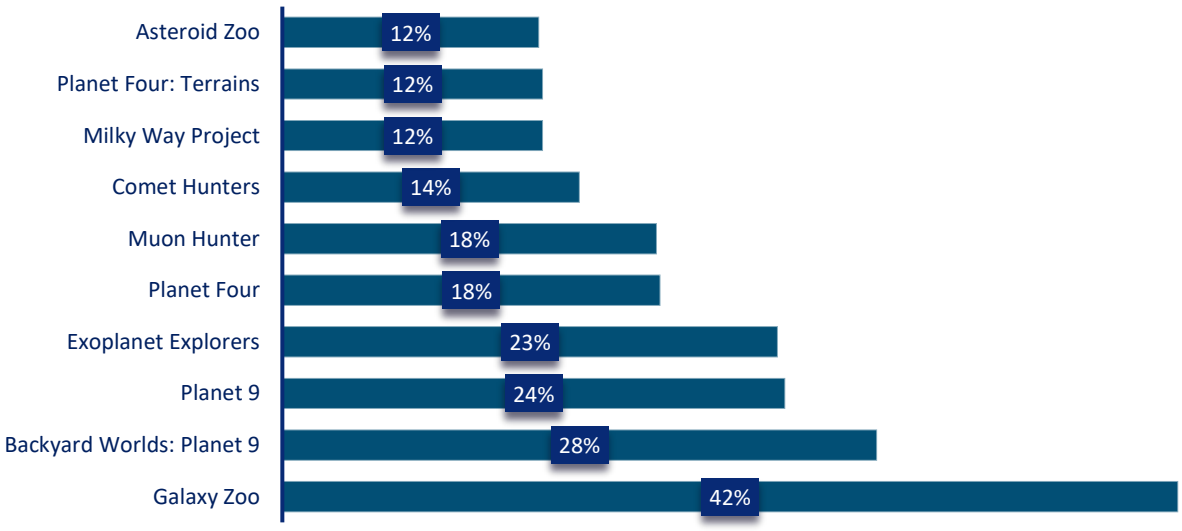
Participation in other Zooniverse projects

Planet Hunters has inspired many volunteers to take part in other projects on Zooniverse. Since taking part in Planet Hunters TESS, 74% of people have engaged in other Zooniverse projects. The majority of these were related to Astronomy, such as Galaxy Zoo (42%); Backyard Worlds: Planet 9 (28%); Planet 9 (24%); and Exoplanet Explorers (23%). The bar chart below illustrates the top 10 most common projects on Zooniverse that volunteers have taken part in since engaging in Planet Hunters TESS.



74%

of volunteers have taken part in other Zooniverse projects, since Planet Hunters TESS



Inspiring others to take part in Planet Hunters

54% of volunteers have promoted Planet Hunters to others, or have shared information and knowledge about the Universe and search for extrasolar planets. For example, informally talking about the Universe with friends and family; initiating a new Astronomy club; or writing a blog post about the project. Planet Hunters has also been used as an educational tool in schools and Universities to engage pupils/ students. Of those that responded to the survey, 7 school teachers and 4 University/ College lecturers highlighted how beneficial the project has been in educating students about the Universe and the process through which scientists make discoveries. At the same time, students enjoyed being able to deal with real data, and the project increased their interest and engagement in Astronomy.

"I am making 3 beginners telescopes and planning to start a small Astronomy club to inspire more people in Astronomy. Planet Hunters opened my mind in many ways"

"I share information with family, friends, colleagues and try to get them to join in a project"

"My student really got into the project. They thought it was really neat that they would get an acknowledgement if they helped find a planet, and were excited by the fact it was really data. I asked them to do a minimum of 20 classifications and no student did less than twice that (and some completed as many as 150 classifications)"

"I teach a college astrobiology course, and I use appropriate citizen science activities as part of the students' graded coursework. This project ties in perfectly with the exoplanet module. The course has about 400 students throughout the year."

"I am pleased that it exists…I have passed it to several teachers of other subjects and that it is a project that has tremendous potential ... Zoouniverse and its projects teach us to be supportive, to collaborate, democratize knowledge and make us be closer to the reality of scientists"

54%

of volunteers have promoted or shared Planet Hunters with others

Increasing interest and engagement in science

Since taking part in Planet Hunters, 9% of volunteers felt inspired to learn more about Astronomy and the physical sciences more broadly. For example, volunteers have sought opportunities to learn more about galaxies, planetary systems, planet formations and the Universe through other forums and means, such as reading articles, following news about space or joining Astronomy groups in online social networks. Some volunteers emphasised that although they were already actively engaged in Astronomy as a hobby, their experience in being part of the Planet Hunters community has made them feel more connected to these topics.

Some volunteers shared their own personal experiences of previously aspiring to study or pursue a career in Astronomy, but have not been able to, and that their experience in Planet Hunters has provided them with an opportunity to fulfil their passion for Astronomy.

Other citizen scientists have experienced a renewed passion, appreciation or curiosity about space. For example, they may now spend more time looking up at the sky, have brought a telescope or started using a telescope more frequently, or have joined an Astronomy club. Some volunteers now feel more motivated to take part in other Astronomy related projects on Zooniverse, or contribute in different ways to Zooniverse projects, for example, through being a moderator.

"I dreamed of becoming an astronomer in my youth, did not work. Participation in the Planet Hunters made my life more interesting and meaning made its appearance. It brought me closer to my dream."

"I have just become more engaged in my astronomical hobby"

"…[I decided] to start learning all about stars. I think I am hooked - stars are the most fascinating thing! I bought a telescope - a real one - first time in my life. I have gotten involved in my local astronomy club. I have put up all my old star maps from childhood. I feel a sense of wonder of the universe again, and have gotten interested in many other kinds of missions, like GAIA or Hayabusa, for example. I have also decided I have to step up when I see 'science denial' around me. I have tried, also, to teach what I'm learning, so others who have no science background can see what I see - how cool all of this is. Also... I was going through, first time, a pretty intense, difficult, painful crisis of the existential variety when I got involved in Planet Hunters. It gave me a place to put some energy and catch my breath... Planet Hunters has been good for me!"

Increasing aspirations to study

4% of citizen scientists highlighted that taking part in Planet Hunters has raised their aspirations to pursue educational opportunities in science or dedicate more time to study, for example to study an Astronomy related course or University degree, or attend a conference. For some, their experience in Planet Hunters has developed their interest in Astronomy and provided them with a clearer vision for a future career in science, or provided renewed motivation in their present career.

"I feel I've become more engaged in astronomy, which I've always loved. I read more, use my telescope more, and keep more up to date on new developments. I've also pursued some educational opportunities."

"I was able to get clearer vision of my future; I want to be an astronomer and physicist, so this was a great chance to develop my interest."

"I accelerated my thought processing in astronomy. I've started studying higher engineering mathematics again."

Informing research and research outputs

Engagement in Planet Hunters has also influenced the direction of 3% volunteers' research and has resulted in other outputs, such as publications, talks, blogs and articles. Citizen scientists have shared their experiences of taking part in the project through blogs and articles, or have been invited to be a co-author on a publication. For volunteers who are currently involved in Astronomy-related research, the work of Planet Hunters and Zooniverse more broadly, has inspired new directions or influenced their approach to research and analysing information.

"[Planet Hunters] has influenced the way in which I analyze situations about space."

"I have been asked to write an article on my journey at planet hunters"

4.4 Feeling of pride and satisfaction in helping the scientific community

19% of volunteers experienced a feeling of pride and personal satisfaction of being a citizen scientist and being able to help the scientific community. These individuals were happy to help and volunteer their time to give back and contribute to something they feel is important and could make a difference in advancing scientific knowledge. The opportunity to help discover new planet candidates, and indeed be the one who could potentially be the first to make that discovery, was both highly appealing and exciting.

"I am primarily motivated by how I can help others… I love feeling like I am part of something important and contributing to the world."

"It's rewarding to think that our efforts are helping to reveal more information about space in our particular area of the galaxy."

"I love what I've done and knowing that I am participating in a project that search for new planets makes me feel excited"

A sense of community

With over 12,000 volunteers to date, Planet Hunters has a large global community, and some citizen scientists experienced a feeling of belonging and a shared connectedness of being part of this community who were all striving for a shared objective. For example, 4% of volunteers emphasised that a key motivation to take part was to feel part of something important and they felt accepted by others within the community of volunteers.

"I love the project and feeling like a small part of a big team… Thank you for giving me the opportunity to take part."

"I get a good ego boost (in a good way) makes me feel part of a global community"

"I have learnt so much and enjoy feeling part of the community helping the researche[r]s."

Opportunities to take part in Planet Hunters, without a background in science

Out of the volunteers who completed this survey; 31% did not have a background in science, and there were many volunteers that appreciated the opportunity contribute to Planet Hunters, despite not having a background in science, or this was not their area of expertise. Many of the volunteers shared an appreciation and interest in Astronomy and science, but prior to their involvement in Planet Hunters, have not had the opportunities to take part in scientific research, study, or pursue a career in science; and volunteers expressed significant gratitude that they were able to contribute through this project.

"It's a very easy to use interface, can dive in and out at ease and I really enjoy A- that I am contributing to a field of interest even though it's not my area of expertise and B- learning as I do it!"

"I want to thank[s] the opportunity to collaborate in science to someone that doesn't have studied in university. It makes me feel helpful."

4.5 Benefits to individual wellbeing

As a result of taking part in Planet Hunters, 8% of citizen scientists highlighted positive benefits to their lives; individual wellbeing; and sense of satisfaction in life. Planet Hunters has created a positive environment and the conditions for these individuals to experience positive benefits, including:

- Increased sense of confidence, happiness and inspiration.
- Sense of belonging to a community; opportunity to meet and interact with other volunteers with similar interests.
- Creating new meaning and purpose to life.
- Procrastination and distraction from the stress of everyday life; a way to fill time in the day or take a break from work.
- Helping people to unwind and relax; reduce levels of anxiety.
- An opportunity to enjoy and fulfil an existing passion for science.
- Feeling excited by taking part in Planet Hunters.
- Fostering closer relationships with family members by sharing a common interest and activity.

"It's fun and helps me stay involved in the love of science that I don't get from work."

"…it is so different from my day job it gives me a break from what can be an all[-]consuming profession."

"On this short time I can say this is really exciting, the universe is really wonderful and meanwhile I can do something to make me feel close to it I'll be really happy with myself."

"This is a very positive project to be involved with, especially the interactions on the 'Talk' & other social platforms."

"I actually find looking at the plots a really nice relaxing way of finishing the day at my desk."

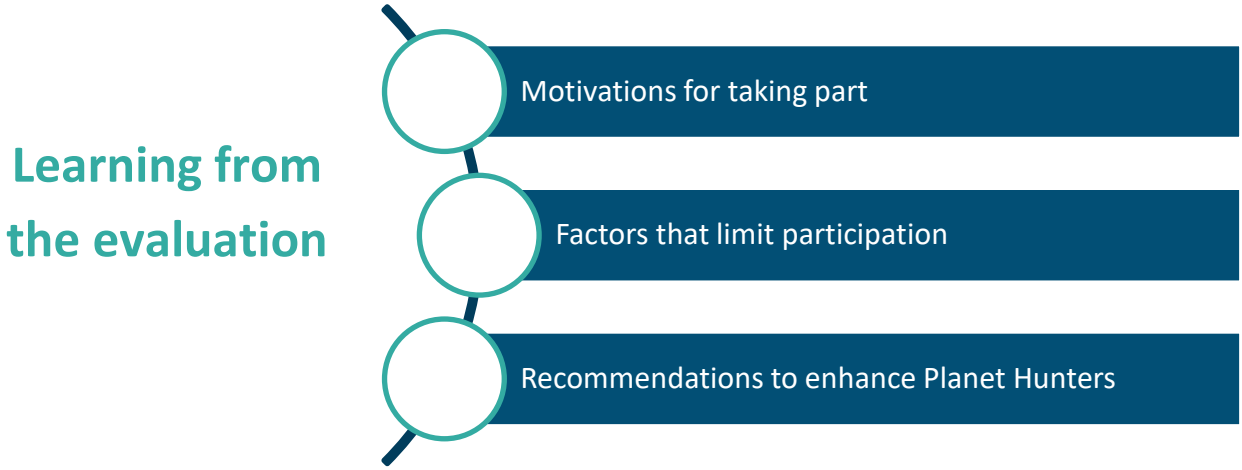
"Closer to son and grandson who are also interested"

"I really have enjoyed this project, and Zooniverse in general. I've always loved science, but never thought I'd have an opportunity to make a real contribution. Zooniverse has been a big factor in making my retirement fun and meaningful."

---

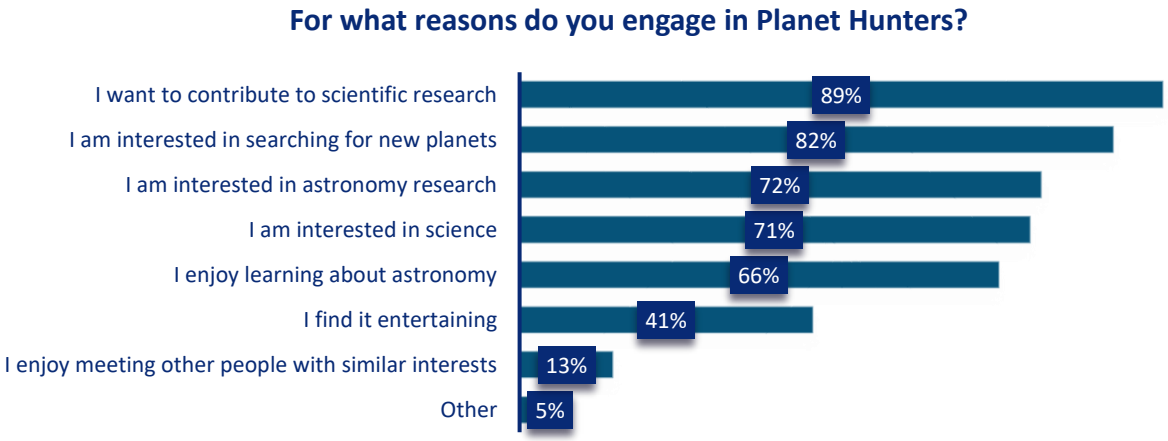
5. Learning from the evaluation

The survey responses have also highlighted a range of ways in which the Planet Hunters research team can learn from the experiences of volunteers and enhance the project in the future. This next section explores people's motivations for taking part; the barriers to participation; and recommendations to further develop and improve Planet Hunters.



5.1 Motivations for taking part in Planet Hunters

The most frequent motivation for volunteers to take part was to contribute to scientific research and assist in the search for new planets outside of our Solar System:



Moreover, some volunteers commented that they experienced a sense of satisfaction that the human brain and collective effort of citizen scientists was more superior to machine learning, or more accurate than a small number of individual scientists reviewing large amounts of data. One participant thought that Planet Hunters has made important steps to democratizing knowledge; and bringing people closer to the work of scientists:

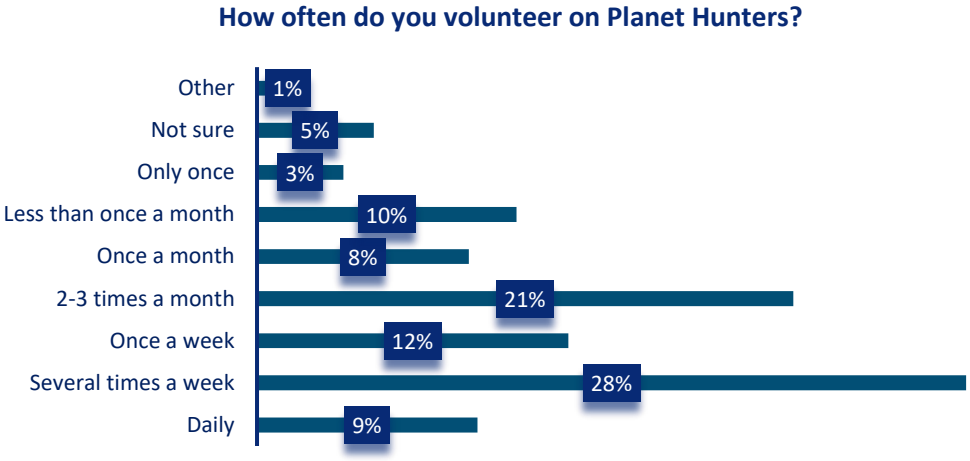
"I have passed it to several teachers of other subjects and that it is a project that has tremendous potential ... Zooniverse and its projects teach us to be supportive, to collaborate, democratize knowledge and make us be closer to the reality of scientists"

"I like the opportunity of working with real astronomical data. I learn interesting things beyond just how transit curves and features in the field guide look. (I am a scientist myself but working in a completely different field)"

"For one, I'm still impressed at human learning being superior at pattern recognition than ML!"

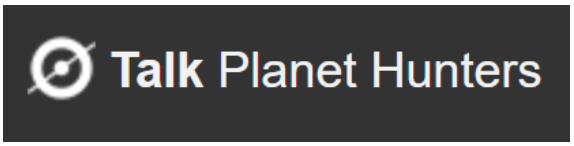
Frequency of participation

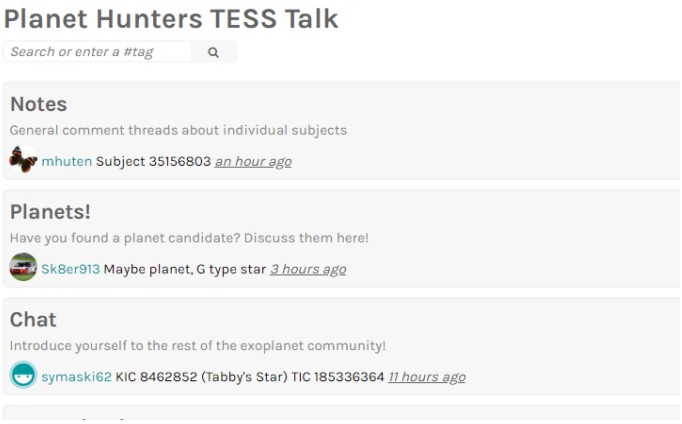
When asked how often do you volunteer on Planet Hunters, 28% of citizen scientists highlighted that they volunteered several times a week:

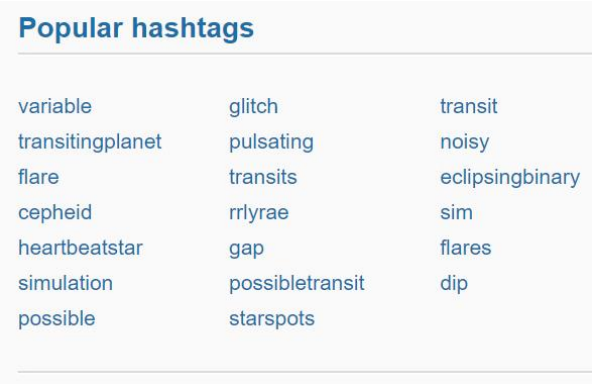


Planet Hunters Talk: Motivations for engaging in Talk

Planet Hunters Talk is an online discussion forum for citizen scientists to observe, collect, share and discuss data from the project. The forum includes a range of different discussion boards, whereby people can ask questions and contribute to discussions around the general interface or science-specific topics related to Planet Hunters. It also offers an online area for general discussion, chat and introductions for welcoming new volunteers to the project. Below are a list of the popular hashtags on Talk:

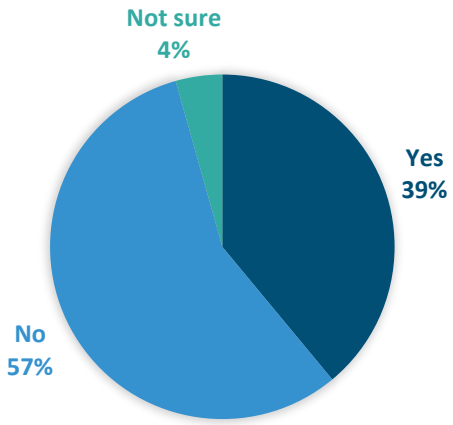






Out of 577 volunteers who completed the survey, 39% of volunteers use Talk:

Do you use Planet Hunters Talk?

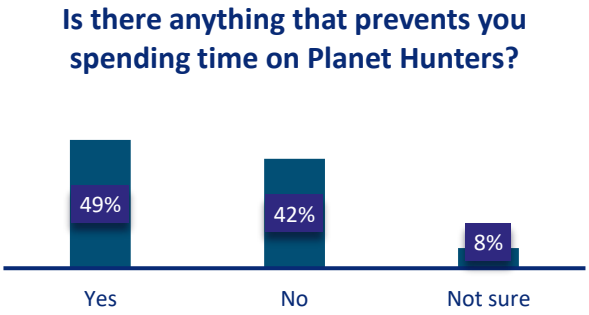


People predominantly use Talk to post something interesting that they have found or to have a question answered, while volunteers also use Talk to engage with researchers or other volunteers, and to observe other's people's questions and answers. For example, some volunteers learned things they may not have expected by scrolling through and reading the different discussions.

For what reasons do you use Planet Hunters Talk?

5.2 Factors that limit participation in Planet Hunters

Although citizen scientists reported a range of positive impacts and outcomes from taking part in Planet Hunters, many respondents also shared different reasons that might their participation.



Of the 49% that responded 'yes' to the above, the most frequent barrier to spending time on Planet Hunters was personal circumstances, a lack of time and 'everyday' commitments (work, studies, school, socializing and other interests). Other volunteers reported that a limited understanding of the task; difficulties with the platform or interface; and classification anxieties was a barrier to their participation.

The diagram below highlights the different barriers to participation; the size of each box represents the relative frequency of the particular theme, which are further explained on pages 25-27.

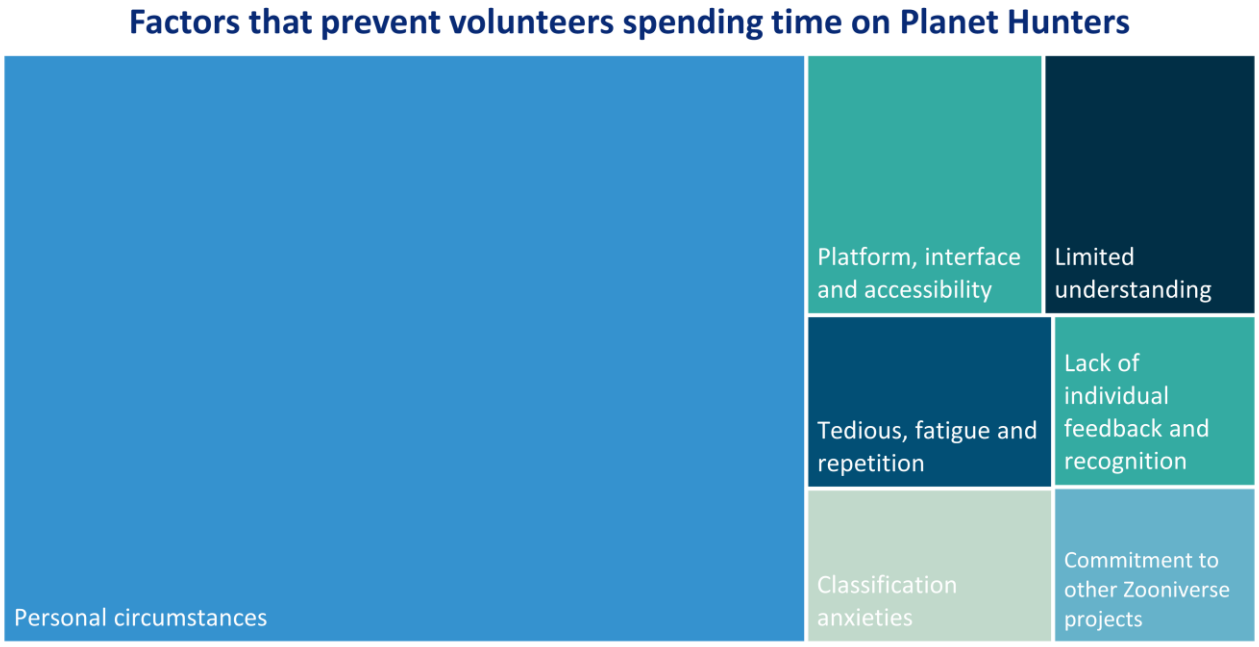


Figure 2: Themed responses to the survey question: 'If yes, please explain what prevents you spending time on Planet Hunters?'. Total no. of responses to this question: 282.

Platform, interface and accessibility

7% of volunteers highlighted difficulties in accessing the platform and problems with the interface. These included: difficulties in using Planet Hunters on a phone or other device; limited access to the internet; difficulties in understanding the task due to a language barrier; and a lack of a user-friendly interface. Others also felt frustrated that there were too many test examples and simulated planets to review. These simulated lightcurves enable the Planet Hunters team to test the system and ensure that they correctly interpret volunteers' classifications. However, some volunteers felt frustrated by spending time analysing a light curve, or thought that there were too many simulated planets to review.

> *"spending my time analysing an image and then being told it is synthetic is frustrating. I know the reason this is done, but still..."*

Limited understanding

6% of volunteers felt confused or did not fully understand what they were specifically looking for. For these individuals, there was often an assumption that a more in-depth understanding of Astronomy was needed to be able to engage in the project, and they had a limited confidence in their ability. While many emphasised that the tutorials and field guides were useful, others did not find these helpful and felt that the information was unclear, and that this limited their learning experience. Some also found it difficult to determine what a transit is, or were uncertain as to whether they were being exposed to actual data or another calibration example.

Tedious, fatigue and repetition

The task of continually examining and classifying light curves felt repetitive and tedious for 5% of volunteers, and the presentation of data felt visually mundane or there was a lack of interactivity compared to other projects on Zooniverse. Some felt that the project requires relatively high amounts of concentration, and experienced fatigue when looking through the series of images and data over long periods of time.

Lack of individual feedback and recognition

4% of volunteers felt that there was a lack of individual feedback on whether they had marked transit candidates correctly or incorrectly. Moreover, the limited feedback from the research team and recognition of volunteers resulted in some volunteers feeling demotivated. Volunteers received limited feedback about potential discovered planets and at times felt unsure of the impact of their contribution. Some emphasised that the provision of feedback would help them to learn; enhance their level of motivation; and increase their confidence in their ability to classify light curves.

"there is so little feedback or positive reinforcement, that the process becomes highly repetitive and boring."

Classification anxieties

The process of classifying light curves made 4% of volunteers feel anxious, as they feared that they might be interpreting these incorrectly. For certain cases, some volunteers felt that it was difficult to determine whether they were doing this correctly, and were uncertain of their abilities, and so feared that they would have a negative impact on the project.

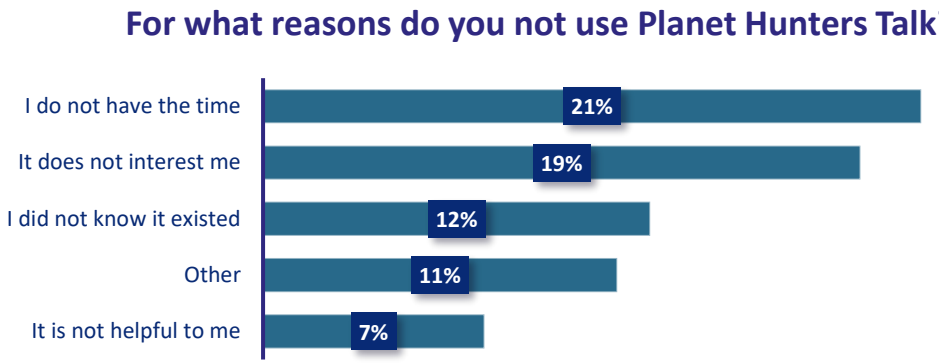
"Sometimes I feel I'm not accomplishing anything. Psychology of "looking and looking and finding something and... oh, that was a simulation" can be disheartening. Not sure how good I am at finding transits."

Commitment to other Zooniverse projects

With the large and growing number of Zooniverse projects, 3% of volunteers preferred to spend time on other projects on Zooniverse, and as a result had less free time to spend on Planet Hunters.

Barriers to engaging in Talk

The main reasons that prevented citizen scientists from using Planet Hunters Talk (the online discussion forum) were a lack of time; limited interest; a lack of awareness of Talk; and lack of value.



Volunteers that responded 'other' to this question highlighted that Planet Hunters Talk is not a relevant, supportive or accessible forum for them for a range of reasons, including:

- Language barrier.
- Lack of understanding of how forum works.
- Lack of certainty that other people are providing accurate information and advice.
- Assumptions that you need to have a scientific understanding to engage in discussions, or that the forum is for people more experienced in Planet Hunters.
- Fears of sounding stupid or ill-informed.
- Experiences of anxiety and fear when interacting with others.
- Lack of confidence when communicating with others.
- Uncertain what to say or ask.
- Limited interest in socialising with others.
- Preference to search for information and answers to questions elsewhere.
- Poor interface and not user-friendly.

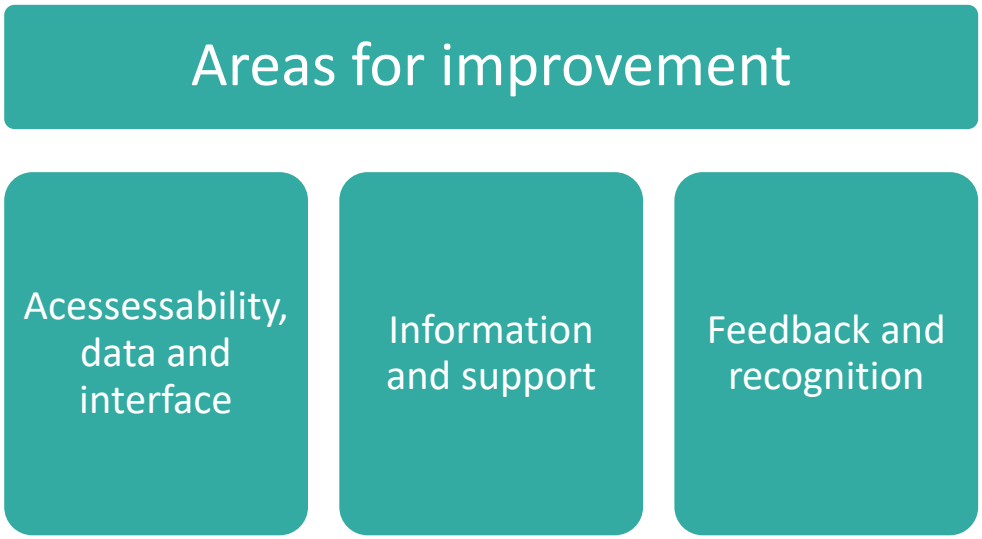
> *"I feel that I may not be knowledgeable enough to engage in conversation with other members who are more experienced in the field."*

5.3 Recommendations

While there have been significant benefits and positive outcomes arising from Planet Hunters, there are a number of areas in which the project could be further enhanced and improved, which could help make Planet Hunters even more engaging, rewarding and inclusive of its volunteer community.

Out of 577 volunteers who completed the survey, 50% provided a recommendation that could enhance their experience of Planet Hunters and make the project more engaging.

What follows is a summary of the range of ideas and key recommendations raised by volunteers, including, improving accessibility and interface usability; providing additional information and support to volunteers; and providing more feedback and recognition of volunteers.



Information and support

21% of volunteers recommended the provision of more information and support on Planet Hunters, for example, more in-depth and visually interactive information and guidance about how to complete a classification. Volunteers provided a range of ideas for how information could be communicated to volunteers to foster ongoing learning, while further suggestions were also made to facilitate engagement between researchers and volunteers:

1. Provide guidance and information in more accessible and visually engaging formats e.g. through the use of videos, an interactive guide, or infographics that could guide new users through the classification process.
2. Include more detailed examples of correct and incorrect classifications, to highlight to volunteers exactly what they should be looking for.
3. Promote the FAQs page alongside the tutorial, with answers to commonly received questions from volunteers, and encourage new volunteers to read through the FAQs before they start to classify light curves.
4. Provide more information about TESS and a more in-depth explanation of where the data comes from.
5. Continue to provide regular updates from the research team, including the communication of known data glitches.
6. Provide monthly updates (e.g. via the blog pages) from the research team with the latest news and information about possible new planet candidates and provide summaries of academic papers published as a result of Planet Hunters. If no news is available on the project, then share general Astronomy news and discoveries or provide suggestions and links to external sources with further information about exoplanets.
7. Update the Planet Hunters social media (Twitter, Facebook) pages more regularly, with more posts and updates about Planet Hunters from the research team.
8. Provide opportunities for volunteers to meet and interact with the Planet Hunters research team and other volunteers on Planet Hunters.
9. Increase awareness that people without a background in science can take part in Planet Hunters.
10. Provide information or a resource specifically for teachers/ lecturers who are interested in using Planet Hunters in the school curriculum/ University courses. Further information would be helpful that clarifies data protection requirements that teachers should be aware of (i.e. one teacher was unable to sign young people up to any public forum due to child protection laws).

Accessibility, data and interface

17% of volunteers highlighted that they would like to see improvements made to the interface, data, and accessibility of Planet Hunters. Many of these volunteers wanted to see an update to the Planet Hunters interface, while others emphasised other specific features or changes they would like to be made to Planet Hunters:

1. Launch a mobile app version of Planet Hunters to enhance use and engagement through mobile and tablet devices (3% of volunteers recommended a mobile friendly app version of Planet Hunters).
2. Include a zooming feature for light curves to enable volunteers to expand sections of the data fields and make more efficient evaluations of the data.
3. Provide guidance and tutorials in different languages to increase the accessibility of Planet Hunters to its international community of volunteers.
4. Allow the viewing of an entire light curve for each star and include a longer observation period.
5. Provide more information about the stars that volunteers are looking at (e.g. name, location, spectral type) along with information about the light curve (e.g. estimated radius, classification).
6. Allow the tagging of interesting objects.
7. Reduce the number of simulated light curves.
8. Enable volunteers to set their own preference for the speed at which the images change.
9. Provide more accurate and updated statistics regarding the completion of data.

Feedback and recognition

15% of citizen scientists highlighted that they would like to see more positive reinforcement and personal feedback for individual classifications. Providing personal feedback and recognising the contribution of volunteers was important to the Planet Hunters community. Volunteers appreciated that this personalised feedback would take significant time, however, they highlighted that more frequent recognition of the volunteer community and notification of possible planet candidates, would help to increase their enjoyment and motivation to contribute their time to the project:

1. Provide personalised feedback to individual volunteers once they have completed a classification. For example, notifying volunteers if they have made a correct or incorrect classification, and provide reasoning as to why this was correct and incorrect. Provide personal feedback and statistical information about how many classifications they have made and the degree of accuracy.

2. Provide regular updates on the research team's progress in the search for exoplanets, and notify volunteers if their contributions have made a difference. For example, notifying volunteers by email, through the blog pages or Talk if their classification has led to the identification of a possible planet candidate or an object of interest, and discoveries that have been made. On the project page, include a regularly updated catalogue of discoveries/ list of possible planets candidates and a list of volunteers who have identified these.
3. Utilise other forms of incentive to recognise people's contribution to Planet Hunters, such as merchandising (e.g. a personalised "I helped to discover an exoplanet" mug or t-shirt); personalised certificates (i.e. that could be downloaded, with how much time and classifications an individual has completed); or a record of their individual accomplishments/ contributions placed on their account.
4. Share the achievements of specific volunteers on the project page who have reached certain goals (e.g. spent over a certain amount of time on Planet Hunters or have completed a high number of classifications).
5. Provide credit and shared authorship to citizen scientists on academic publications and other research outputs.

Additional recommendations

Based on the barriers that have been identified by volunteers, and discussions with the Planet Hunters research team, below are some additional suggestions to further improve the project and promote Planet Hunters to new and diverse audiences.

1. Include a 'meet the researcher' and 'meet the volunteer' article or video on the project information pages or blog page. For example, researchers might share the purpose of Planet Hunters; what the data is being used for; and personal stories about their own background and how they came to be involved in Planet Hunters. While volunteers could share their experiences and stories about why they engage in Planet Hunters; what this involves; and also emphasising how people without a science background can contribute to the project.
2. In the project information pages, add a specific section about the volunteer community. This could include various stories and quotes from the volunteers (e.g. quotes that have been provided in this evaluation) as taglines/ headlines to the information pages. This would provide other volunteers with an idea about what they might learn through taking part; highlight the positive impacts arising from Planet Hunters on citizen scientists; emphasise the diversity of the Planet Hunters community; and highlight to volunteers that a background in science is not required to take part.

3. Facilitate a live Q&A session at a specific time/day, where volunteers can pose questions and interact with researchers or moderators (e.g. through Facebook Live, Twitter, Planet Hunters Talk).
4. On Planet Hunters Talk, include a discussion board specifically for volunteers who are new to the project to introduce themselves and actively encourage volunteers to ask any question they may have about Planet Hunters.
5. When making improvements and updates to the interface, continue to seek regular feedback from volunteers regarding their comments and recommendations.
6. Provide positive reinforcement to new volunteers, e.g. sending an automated email once they have completed a certain number of classifications. This would also be a helpful opportunity to highlight where they can find additional information about Planet Hunters and promote Planet Hunters Talk, where they can ask any question they may have on the discussion board specifically for new volunteers.
7. Encourage social interactions amongst the volunteer community and researchers outside of Talk, for example asking open-ended questions to volunteers on social media or initiating Twitter/ Facebook polls.
8. Share the stories of researchers through the blog pages; for example, how they came to be involved in Planet Hunters and what their role involves, to emphasise the diversity of the research team.
9. Share the stories of volunteers through the blog pages; for example, why they chose to volunteer, what is their own background and how they came to be involved in Planet Hunters, to emphasise the diversity of the volunteer community.
10. Promote Planet Hunters at science fairs and festivals; talk to visitors about volunteer opportunities.

6. Conclusion

This evaluation report has provided a summary of the key outcomes and impacts of Planet Hunters on its volunteer community. This report has illustrated significant findings and lessons learned that can be used to understand the potential value of and barriers to taking part in Planet Hunters, and the ways in which the project could be improved.

In returning to the key purposes of this evaluation, the following conclusions can be made:

1. Outcomes and impacts of Planet Hunters on citizen scientist volunteers

Planet Hunters has resulted the following outcomes and impacts on volunteers:

- 74% learned about Astronomy
- 66% enjoyed learning about Astronomy through Planet Hunters
- 21% felt inspired to learn more about Astronomy beyond the project
- 19% experienced a feeling of pride and satisfaction in being a citizen scientist
- 8% experienced positive benefits to their individual wellbeing

2. Benefits and challenges of Planet Hunters

A key strength of Planet Hunters is its ability to bring together groups of people, including those without a background in science, to become citizen scientists and actively engaged in the exoplanet search. At the same time, 49% of Planet Hunters volunteers highlighted a reason that limited their participation in the project, including:

- personal circumstances
- issues with the platform, interface and accessibility
- limited understanding
- tedious, fatigue and repetition
- lack of individual feedback and recognition
- classification anxieties
- commitments to other Zooniverse projects

3. How Planet Hunters can become more inclusive of its growing, diverse community

Indeed, there is still work to be done to ensure that Planet Hunters remains rewarding, motivating and inclusive of all volunteers. 50% of volunteers provided a recommendation that could support the development of Planet Hunters; including:

- providing additional information and support to volunteers
- improving accessibility and interface usability
- providing more feedback and recognition of volunteers

7. About this evaluation

This evaluation is part of a much wider building capacity programme at the University of Oxford that aims to equip researchers with the skills, knowledge, experience and support to plan, deliver and evaluate Public Engagement with Research activities.

This evaluation will also be written up as a case study, as one of four best practice case studies (one from each of the University's Academic Divisions), to provide inspiration, guidance and ideas for researchers and professional services staff on the evaluation of Public Engagement with Research activities.

For more information about evaluating Public Engagement with Research at the University of Oxford;

- See the current training opportunities; http://www.ox.ac.uk/research/public-engagement/support-researchers
- Contact **Annaleise Depper** (Evaluation Officer, Public Engagement with Research): annaleise.depper@admin.ox.ac.uk

8. Acknowledgements

Thank you to the citizen scientist volunteers who took the time to complete this survey, and shared their open and honest reflections, thoughts and recommendations for Planet Hunters. Your time in contributing to this evaluation is very much appreciated.

This evaluation was supported by the Planet Hunters research team in the Department of Physics at the University of Oxford. Thank you to Dr Grant Miller, Nora Eisner, Professor Chris Lintott and Professor Suzanne Aigrain, for helping to shape the evaluation questions and promoting the survey; and for your willingness to learn about both the successes and challenges that Planet Hunters faces, and to think about alternative ways to enhance the project.

This evaluation was conducted by Dr Annaleise Depper (Evaluation Officer, Public Engagement with Research, Research Services), with support from Dr Lesley Paterson (Head, Public Engagement with Research, Research Services) and Dr Michaela Livingstone-Banks (Public Engagement Facilitator, Mathematical, Physical, Engineering and Life Sciences Division) at the University of Oxford.

The programme to build capacity in evaluating Public Engagement with Research, which these evaluation case studies form a part of, was developed by the Public Engagement with Research Team in Research Services, and supported by the Public Engagement with Research Advisory Group (with representatives from across the Academic Divisions and the Gardens, Libraries & Museums).

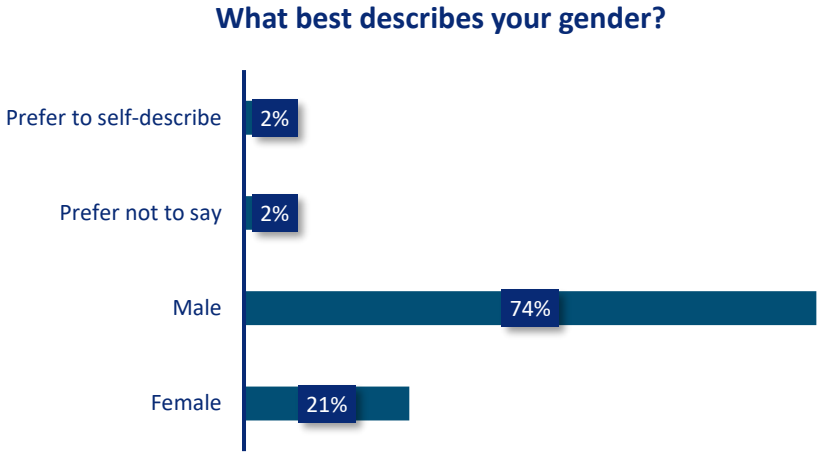
9. Appendices

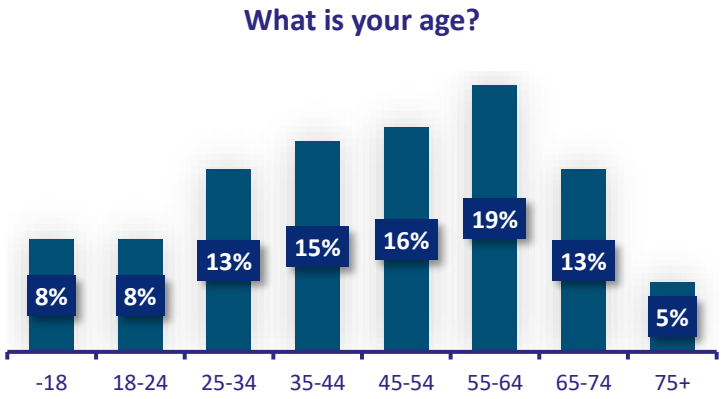
Appendix 1: Survey questions

Please see here for the survey questions.

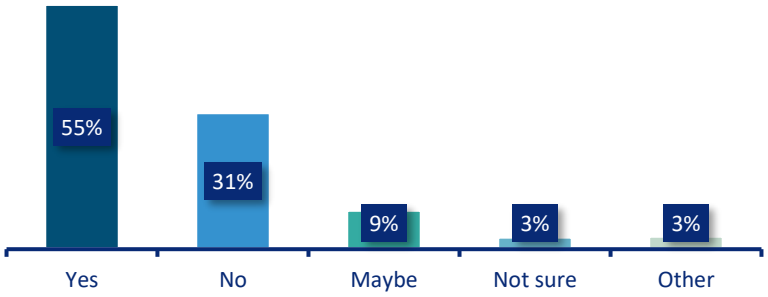
Appendix 2: About the survey respondents

Below is a summary of some of the key demographic information about the 577 volunteers who completed the survey:

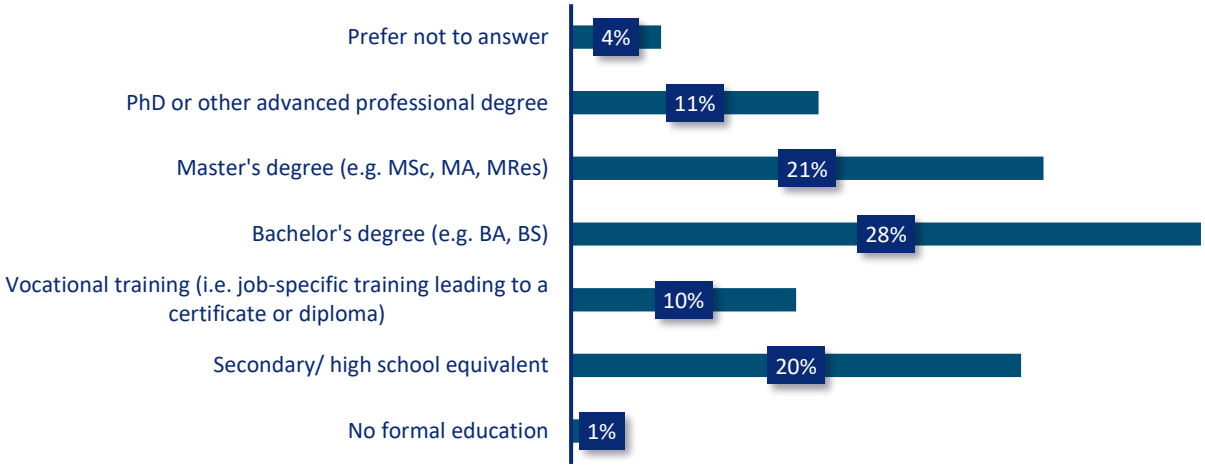




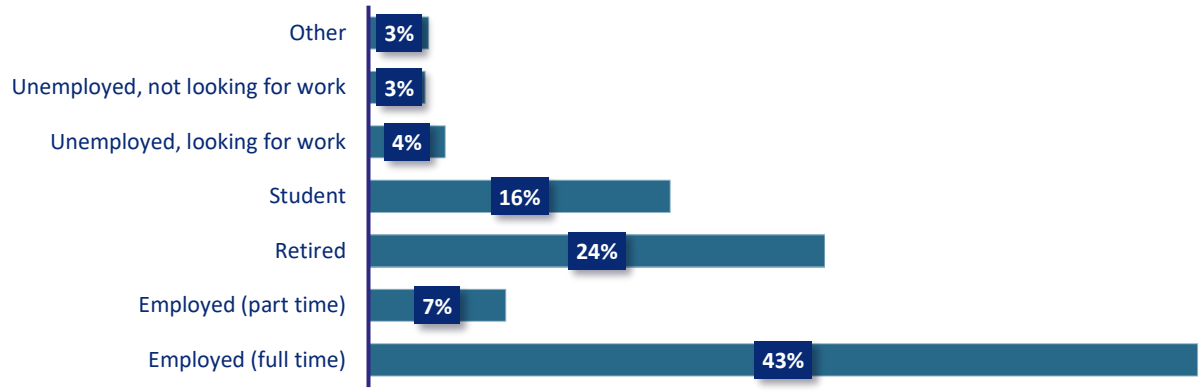
Do you have a background in science?



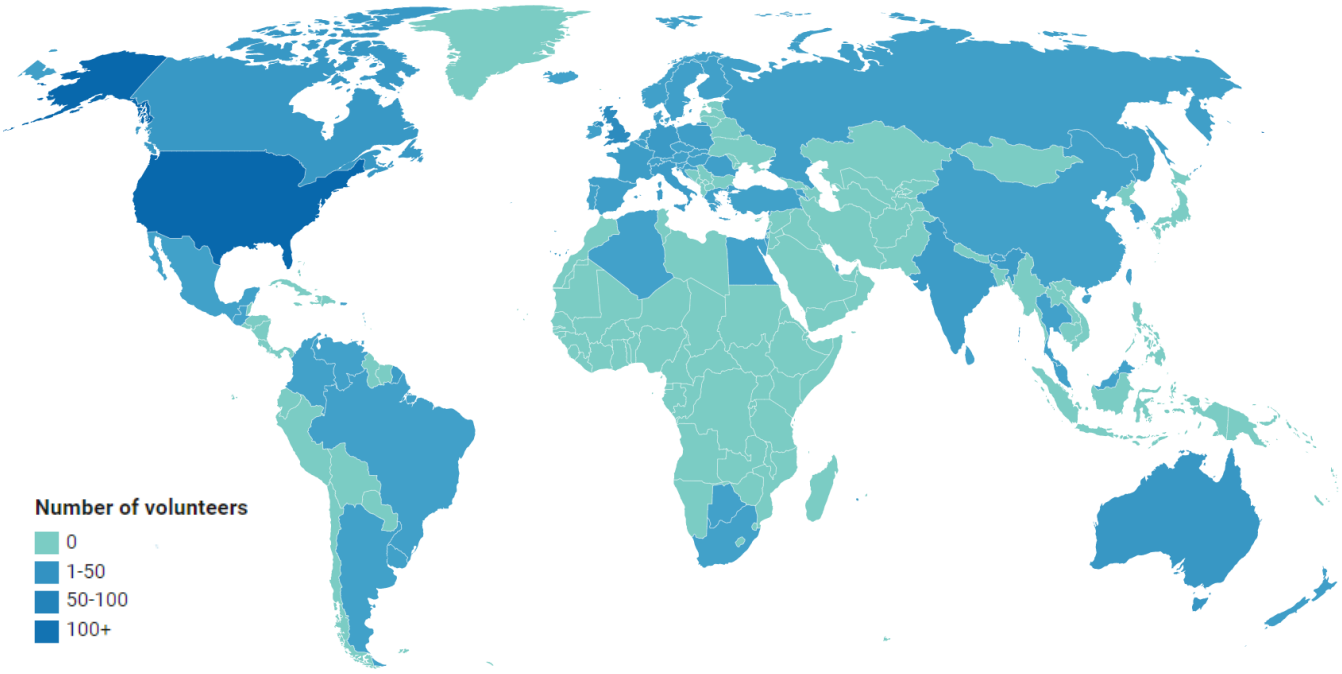
What is your highest level of education?



What is your current employment status?



Volunteers from 56 different countries completed the survey. The majority of volunteers who completed the survey live in English-speaking countries; most commonly the USA (32%):



See here for interactive map: https://datawrapper.dwcdn.net/GNGv4/4/

Notes

UNIVERSITY OF
OXFORD