# ONLINE LITERACY ASSESSMENT ALSO AS A LEARNING STRATEGY: A PROPOSAL FOR ASTRONOMY

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## Abstract

Astronomy is one of the most interesting, accessible, and engaging sciences. Raising astronomy awareness is important for creating a more informed, scientifically literate, and creative society. It is an investment in the future of our planet. It also makes people appreciate the natural world. Therefore, it is important to assess how much the ordinary person knows about astronomy. In the literature we found several astronomy diagnostic tests. However, they are limited to the diagnose: they do not allow the participant to learn more about this field.

To address this issue, we created a literacy assessment tool that also allows, the participants to learn about astronomy. The so-called, Astronomy Literacy Test (ALT), is an assessment and education tool designed to improve astronomy literacy. ALT is a test based on the 'Big Ideas in Astronomy' (document endorsed by the IAU - International Astronomical Union), which proposes a definition for astronomy literacy. Our focus is to make ALT an interesting and engaging test to take. To build ALT we have selected some intriguing concepts under each Big Idea to frame the questions. The questions in ALT are designed in such a way that at least 2-3 questions are present for each Big Idea. We include some self-learning components in ALT, so that participants can learn more about the concepts included in the Big Ideas document.

ALT has multiple choice questions and is different from the other tests, as it allows anyone irrespective of age, country, and education qualification to answer it. It is interactive and user-friendly, with images to help illustrate the astronomical phenomena. Every question is made compulsory to answer. The participants also have a choice to select 'no idea' if they do not know the correct answers.

After completion of the test, the participants can have access to all the questions and their answers along with a short explanation. This helps the participants to get the correct answers and gain knowledge about the topics. It provides links to reliable websites for further learning. The websites chosen were mostly Government space agency websites along with educational websites. The questions are designed in different difficulty levels ranging from regular astronomical phenomena (like solar and lunar eclipse), to advanced topics (like gravitational waves and exoplanets). This will motivate them to test their knowledge and explore topics that they might not know before.

ALT is under development, and we are now in the process of collecting valuable inputs from the scientific community. After this process, we will validate it and perform the pilot study. With that work done ALT may be used as an entrance test for astronomical courses in universities and may be used to design various science popularization activities. It can also be used as a tool to raise astronomy awareness. ALT could become a powerful tool in creating an astronomically literate society.

Keywords: Astronomy, Literacy, Assessment tools.

## 1 INTRODUCTION

Although not all research is primarily aimed at communication to a public, classified by Burns et al [1] as a lay public, it is the social relevance of the research that should be constituted as one of the starting points to decide on the relevance of its dissemination to this type of audience.

For this audience, as we can see in the last Eurobarometer data, neither understanding the results nor understanding the processes that led to them are trivial tasks. However, this understanding has become much more relevant in the current context, where people need to make daily decisions associated with science and technology, but are flooded with fake news, false science and bad science [2]. Therefore, we refer to the concept of scientific literacy, in a broader sense [3] and for which only knowing the

research results is no longer sufficient: it is also necessary for ordinary people to have access to the process that leads to such results.

This is even more relevant when we know the positive effects of public engagement with science and technology – PEST [4], in the awareness and interest in science; in promoting their understanding; in generating affective responses towards it and, in essence, promoting reasoned opinions regarding scientific issues [1].

Astronomy is one of the sciences of choice for this purpose. Indeed, Astronomy is a connecting bridge between people of various cultures, countries and generations. It compels us to broaden our knowledge and think critically about why the universe is the way it is. It is a tool that allows us to achieve sustainable global development because of its influence on technology, science and cultures [5].

Regarding technological impact, astronomy is the driving force in developing new technology. It pushes scientists and engineers to answer basic questions and to create new innovations. Astronomy is the key reason behind development of sensitive light and radio wave detectors and fast computers. The modern-day telescopes like James Webb, ELT, are engineering marvels. The huge data collected from various astronomy projects have led to the creation of astronomers who are well versed in data analysis and coding. 21st-century skills that are transferable to many societally relevant applications (this is trained in e.g. the SKIES and DARA Big Data projects). There are a lot of examples in which technologies initially developed for astronomy research have become a part of our daily lives [6]. GPS (Global Positioning System), solar panels and Magnetic Resonance Imaging (MRI) scanners are a few of them. One of the most recent examples is the use of ventilators during covid 19 pandemic.

On the other hand, the universe is an open lab. With it we can study environmental conditions that are inaccessible on Earth. During the last hundred years astronomy has led to development of new interdisciplinary fields like astrochemistry, astrobiology, and data driven astronomy (for example). It also brings astronomers together, from all over the world, due to the collaborative work required to understand the astronomical phenomena. It is an open science with raw data, libraries, and programming tools available for all. Many open-source software (like *Stellarium*, *Celestia*) allow open access to maps of the night sky. arXiv is a site which has open access to scientific articles ensuring the science is inclusive.

As stated by several authors - for example, Salimpour [7] and Costa [8] - astronomy is a gateway science (Fig. 1): a science that motivates and gives context for the learning of other sciences. Astronomy and space sciences have always been fascinating topics amongst young minds. It is a very easy mode of introducing science and technology to young kids. This has led many people to choose a career in STEM and contribute to their country's scientific advancement.

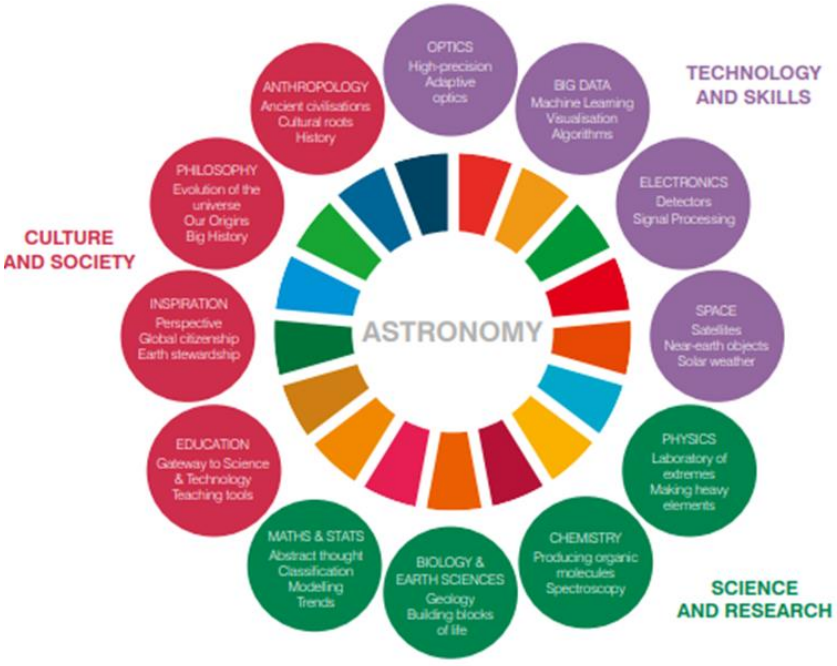


*Figure 1. Connections of astronomy with other disciplines and subjects, from the International Astronomical Union strategic plan [5]*

Astronomy is also a bridge between science and global citizenship. Indeed, it is one of the most engaging sciences with the potential to make people appreciate our planet - raising awareness on sustainability and global citizenship. It has led to the promotion of science methodologies [9] and a huge number of citizen science projects: a powerful tool for every citizen to be able to learn and contribute to astronomy research [10]. Furthermore, astronomy also increases the scientific literacy [11] which, in turn, raises awareness of sustainability, global citizenship and motivates people to take initiative in preservation of life on Earth.

Therefore, to motivate people to study astronomy and raise astronomy awareness, we are creating an online assessment and learning tool under the name ALT "Astronomy Literacy Test". The online assessment tool ALT aims at increasing astronomy literacy among individuals from various backgrounds irrespective of their education or age. It provides them with accurate bibliographic references. ALT stands out, at the same time, as an assessment and learning tool; it motivates the participants to explore more about the astronomy field.

# 2 METHODOLOGY

## 2.1 The Commencement

We first started by looking for a reference source based on which we could create ALT. We concluded that "The Big Ideas In Astronomy - A Proposed Definition of Astronomy Literacy" [12], a global document endorsed by IAU, is the best possible reference for our test. The project started by analysing the Big Ideas thoroughly and discussing the concepts for creating a survey. The Big Ideas document consists of 11 big ideas in astronomy that should be known by every citizen. It expands these ideas as sub-ideas. It involves very simple topics such as our Solar System, Sun/Moon, etc, and expands up to complex ideas like cosmology, exoplanets, and climate change. We then studied similar assessment literacy surveys and tests conducted in the past. The question arises about the target participants that would take the survey. Through a lot of reflexions, we concluded that the survey should be made available to each and every citizen. We believe in the concept of "One Earth, One Family" due to which we believe that every citizen should have the knowledge of astronomical phenomenon and contribute to the development of astronomical research in any possible way they could.

## 2.2 Literature survey

We studied each Big Idea and created at least one question for each of them. As stated earlier each big idea has been expanded to many sub-ideas. After this, we considered the most important sub-ideas under each Big Idea and started building questions on those concepts. The Sub-ideas to question were chosen keeping things like fundamental concepts, everyday phenomena and new discoveries in astronomy (for example) in mind.

All the questions were framed and revised till the best possible questions were formulated after a series of discussions and analysing different surveys. After that we realized that the surveys were focused on a particular group of people. Indeed, they did not stimulate participants and they did not provide the resources to gain more knowledge. In most cases the test solutions were not available for participants.

So, in ALT we will want participants to take the test but, also, learn more about the concepts. We are building the survey in such a way that once it is submitted, the participant will have access to the correct answers with brief explanations and links for further learning. For this, several websites were analysed for their content and the decision to keep them as references was made. We mostly kept government websites for the references as they prove to be the best authentic sources available. Some of the examples of reference sites are ESA, NASA, Britannica and Space.com.

ALT is being developed in an online platform called Lime Survey. It is made in a way that is easy for the participants to navigate through the questions. The conceptual questions in the survey are multiple choice-based questions that have 5 options. The first 4 options are based on the question asked, and the last option is kept as "No Idea". To each question we add an image to give the participants visualization of the concepts. The images motivate the participants to explore more about the astronomical phenomena.

## 2.3 Detailed structure of the survey

The Survey is divided into 3 sections: introduction section, the survey section and the solution section.

### *2.3.1 Introduction page*

This part is developed to introduce the participants to the survey that they are going to complete. The page contains all the important instructions for the participants regarding the survey. It is made in such a way that it encourages the participants to take the survey.

### *2.3.2 Survey section*

The survey consists of a total of 32 questions, the questions are divided into different sections. The questions are arranged in an increasing order of difficulty. The first few questions are easy and give the participant confidence to attempt the next level of questions.

Out of 32 questions, 25 are conceptual questions based on Big Ideas in Astronomy. The conceptual questions are divided into 5 pages with 5 questions on each page to ease the participants and increase their focus on the set of questions. From each Big Idea 2-3 questions have been developed, the sub ideas in each Big Idea were chosen due to basic knowledge and their importance in the present timeline of astronomy. Some examples:

1.1. Big Idea -1: “Astronomy is the oldest Science in Human History”.

This Big Idea contains information about the basic concepts that everyone should be aware of like the ancient cultures and civilizations that used astronomy for their benefits. It introduces the most basic theories about our Solar System.

1.2. Big Idea - 5: “Astronomy Benefits from and simulates technology development”.

This Big Idea contains information about the technologies developed due to astronomy which everyone should be aware of and how these technologies are benefiting them in their daily lives. The Big Idea 5 also contains information regarding telescopes and observatories.

1.3. Big Idea - 11: “We Should preserve Earth our only home in the Universe”.

This Big Idea contains information about how human-led activities are destroying Earth and space. It emphasizes that until now Earth is the only planet known to sustain life and we must preserve it at all costs.

After the conceptual questions pages are over, comes the general survey page which contains another 5 questions. This page is for the collection of general information about the participant for research purposes. It includes information on age group, gender, profession, educational background, and reason for attending the survey. The data collected through this will help us to analyse astronomy literacy in a particular group of people.

After the general survey page comes the last page which contains the last two questions of the survey. The first question is on the Citizen Science Projects and the second question is related to visually impaired people. This question informs the participants about the websites which help visually impaired people to learn astronomy, as well as motivate the participants to take action in producing more inclusive resources.

### *2.3.3 Solution section*

Once the survey is submitted, answers to all the questions, with short explanations, will be made available. Two authentic reference links will be provided after each explanation. This will help the participants explore each concept on their own and learn facts from reliable sources.

## 2.4 Future Steps

The questionnaire will be finalized and will be shared with the experts in science communication and astronomy education research. This will stabilize the internal structure of the survey and the new version of the survey will be shared with the specialist in social and educational psychology with whom the wording of the questions will be established. After this an astronomy specialist will be consulted along with one of the authors of Big Ideas and then the final survey will be finalized. The survey will then move to pilot study.

# 3 RESULTS/CONCLUSION

The survey under development - ALT - is still in the process of receiving inputs from the scientific community. However, from this same process we already know that ALT could be a new model of

literacy assessment survey. With it we also want to motivate people to learn more about citizen science projects and raise awareness about the needs of visually impaired people.

The ALT data could be beneficial for the development of Astronomy courses, for diverse groups of individuals based on their astronomy literacy, and various outreach activities (targeting the weak and strong areas of knowledge of the participants). ALT may also be used as an assessment tool for the Big Ideas and introductory-level astronomy courses.

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