AEB Escola Virtual: An Efficient Tool for Space Education

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Keywords: Space Education, E-learning in STEM, Aerospace Sciences, Remote Learning, Digital Education Platforms

Abstract: Space education improves the scientific and technological growth of a country. It needs tools that are easy to access and effective in training future professionals. In this context, the AEB Escola Virtual became a lively platform for sharing knowledge in the space area. It offers free and high-quality courses for students, teachers, and professionals. This paper evaluates the platform using data from 2024, focusing on its growth, educational impact, and role in science communication in Brazil and abroad. Launched in September 2021, AEB Escola Virtual is now the main online learning platform of the Brazilian Space Agency (AEB). It offers free courses on satellites, rockets, space law, geopolitics, and aerospace. In 2024, the number of participants grew by 70%, reaching over 20,000 registered users by March 2025. Most are university students and professionals in the aerospace area, showing the platform is reaching a qualified audience. Users come from 245 regions worldwide, with 95% living in Brazil. In 2024, 17 different courses were available. Thousands completed courses and got certificates, proving strong participation. Surveys demonstrate that over half of users show satisfaction with the course materials. This attests to the platform's value and beneficial effects. In conclusion, AEB Escola Virtual is a useful resource for science outreach and space education. It continues to grow, has wide reach, and helps prepare skilled people for the Brazilian Space Program. Future for 2025–2026 include improving the platform interface, creating new courses, and boosting user participation to make it stronger in Brazil and other countries.

ID number: IIICAB-054

1. INTRODUCTION

Space education plays a strategic role in building scientific and technological capacity. It connects physics, astronomy, engineering, and Earth sciences to real-world challenges and advanced technologies, promoting human, social, and economic development. As space technologies increasingly influence society, in communication, weather forecasting, geolocation, environmental monitoring, and defence, scientific literacy and critical thinking depend on structured space education from early schooling to teacher training.

In Brazil, astronomy and astronautics have had limited presence historically in school curricula. In 2004, the Brazilian Space Agency (AEB) created the AEB Escola Program to promote scientific outreach and develop educational materials from elementary to high school. The aim was to inspire future professionals and build a specialized workforce. Over time, AEB has expanded the program to include workshops and educational events across all regions of Brazil [1]. One initiative supported by the program is the Brazilian Astronomy and Astronautics Olympiad (OBA), which uses engaging and challenging methods to spark student interest (Bastos, 2020). In 2017, AEB launched Brazil's first space camp, the Vocational Space Technology Center (CVT-E), located in northeast Brazil. The Center hosts public school students for simulated space missions using practical projects [1].

The acceleration of digital education, especially during the COVID-19 pandemic, created new opportunities for distance learning through virtual learning environments (VLEs) and Massive Open Online Courses (MOOCs). The spread of the internet and digital technologies helped integrate VLEs into formal education systems worldwide [2], particularly in underserved regions. VLEs offer flexible schedules,

overcome geographic barriers, and provide access to digital resources [2]. MOOCs are designed to reach large online audiences [3]. Moraes and Silveira [4] studied astronomy MOOCs and found a strong presence of English-language content, video-based lessons, and forums, with a focus on cosmology and astrobiology. Challenges included a lack of cognitive learning strategies, insufficient diversity in astronomy content, and limited hands-on activities.

VLEs also support STEAM (Science, Technology, Engineering, Arts, and Mathematics) education, which fosters innovative thinking and problem-solving. These platforms offer simulations, collaborative projects, and access to specialized tools often unavailable in traditional classrooms. They also help reach underrepresented groups and diversify the talent pipeline [3].

The AEB Escola Virtual platform is a key example of this approach. It offers free, open online courses on satellites, space systems, and the history of space exploration, aimed at students and educators from basic to higher education [5]. Its structure includes open educational resources, videos, quizzes, and interactive elements [5]. The platform supports the open science goals of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and promotes equitable access to knowledge [6].

Space agencies such as United States National Aeronautics and Space Administration (NASA), European Space Agency (ESA), and Indian Space Research Organisation (ISRO) invest heavily in space education through formal and informal programs, MOOCs, student competitions, and real-world research experiences. In Brazil, the AEB Escola Virtual platform plays a growing role in making space science more accessible. With digital tools, low-cost strategies, and institutional partnerships, Brazil's space education ecosystem has now a new opportunity to expand.

This article presents the AEB Escola Virtual as a successful case of a national virtual learning platform focused on space education. Launched in 2021, the platform has grown rapidly, supporting scientific outreach and training for Brazil's Space Program and beyond. Using innovative strategies such as gamification and modular learning, it improves engagement and learning outcomes. The following sections will describe its features, usage data, and educational impact in Brazil and abroad.

2. METHODOLOGY

This study uses a mixed-method approach, combining descriptive and analytical strategies to explore the development, participation, and results of the AEB Escola Virtual platform [7] from its launch in 2021 to early 2025. The research began with the collection of primary data from the platform and official institutional reports. These sources gave detailed information about registered users, offered courses, course enrolments and certifications, and user feedback from course evaluation surveys. The goal was to understand the platform's growth, educational impact, and participant engagement.

The quantitative analysis focused on key metrics such as number of users, nationality, age, profession, satisfaction with the courses and learning materials, and user suggestions. Descriptive statistics, including frequencies and proportions, were used to characterize participation patterns. Charts and georeferenced maps were created to visualize both user engagement trends and geographic distribution.

The qualitative analysis looked at the structural changes of the platform, improvements in access, and support from partner universities that helped produce the courses. User feedback from surveys was systematically reviewed and categorized to highlight recurring themes related to course quality, usability, and perceived educational value.

Finally, quantitative and qualitative results were integrated to provide a comprehensive understanding of the platform's role in space education in Brazil, demonstrating how usage patterns, user satisfaction, and institutional support interact to shape its educational impact.

3. RESULTS AND DISCUSSION

Since its launch in September 2021, the AEB Escola Virtual platform has demonstrated significant expansion in its user base, geographic reach, and course offerings. As of May 26, 2025, the platform registered 22,444 users, reflecting a continuous and consistent growth trend. Of these, 95% of users are from Brazil, while the remaining 5% represent international participants from 245 different regions, indicating the platform's capacity to reach global audience.

To understand who is using the platform, user demographic data was collected through post-course forms. This data is essential to guide future strategies and to evaluate the effectiveness of the platform in reaching its target audience.

Figure 1 presents the educational background of the participants. Most users are undergraduate students, indicating strong engagement from young learners pursuing training in science, engineering, and technology. A significant portion of users also holds graduate degrees, showing that the platform is not limited to basic learners but also serves professionals and advanced students seeking continuing education.

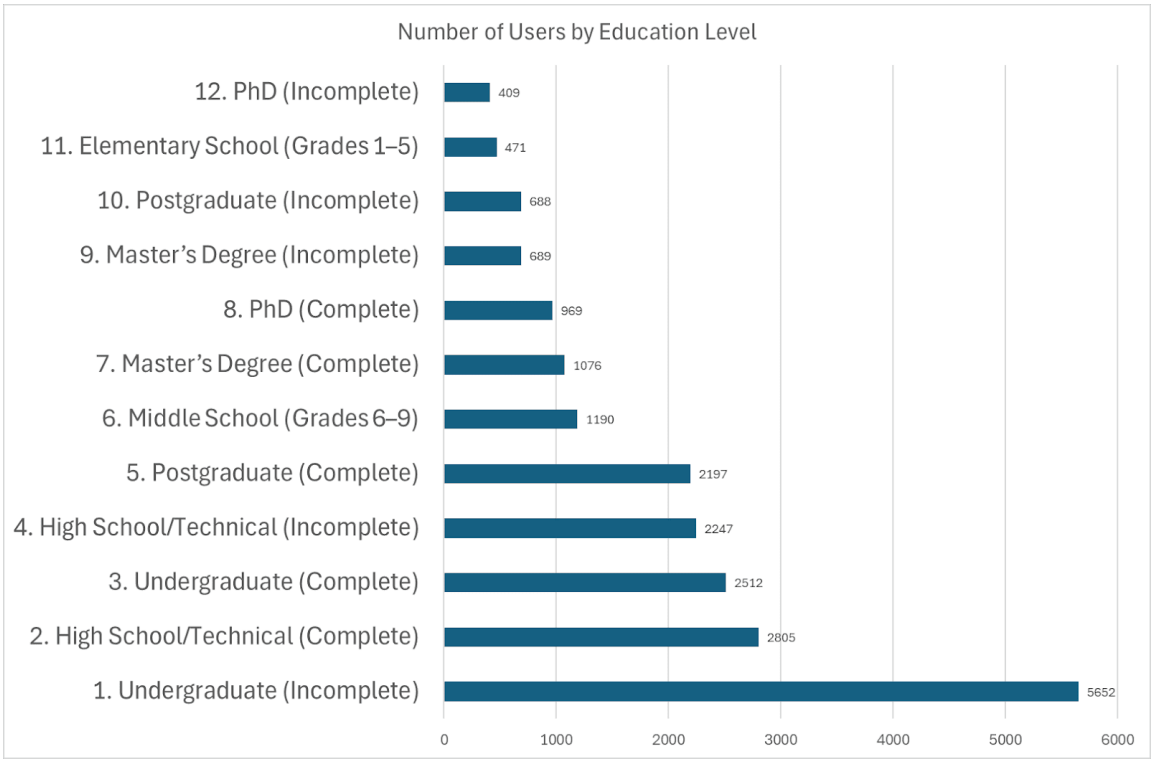


Figure 1. Number of users by education level. Created by the authors with the platform access data.

Figure 2 shows that students are the dominant user group, followed by teachers, researchers, and professionals in related fields. This aligns with the platform's dual mission of supporting both formal education and professional development. The presence of educators reinforces the platform's potential impact on multiplying knowledge, as these individuals are likely to integrate the material into their own teaching practices, in line with Seixas et al. (2017) [8].

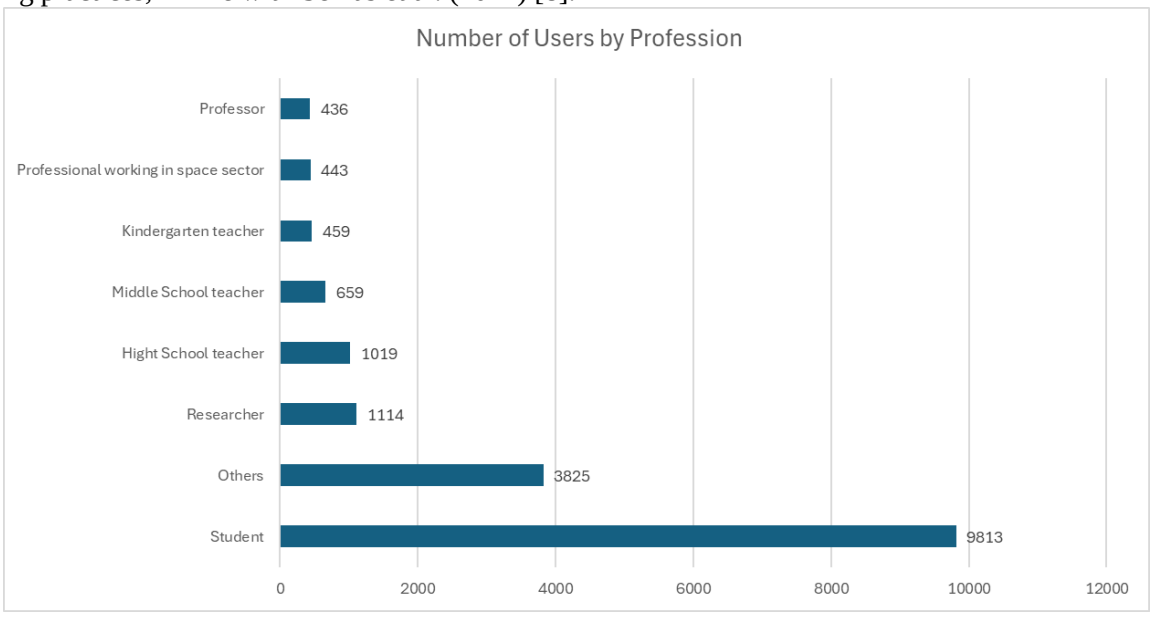


Figure 2. Number of users by profession. Created by the authors with the platform access data.

The gender distribution, shown in Figure 3(a), reveals a predominance of male users, which is consistent with the gender disparities still found in STEM and aerospace fields. With this aim, programs such

as Girls in Space (‘Meninas no Espaço’ in Portuguese) a partnership between AEB and Federal University of Rio Grande do Norte (UFRN) [9], has sought to promote female access to the space field.

Within Brazil, Figure 3(b) highlights a strong concentration of users in the Southeast and Northeast regions. This geographic pattern may be linked to the presence of major universities and research institutions, as well as ongoing partnerships and outreach projects in these areas. It also reflects broader regional inequalities in digital infrastructure and educational access, which platforms like AEB Escola Virtual can help mitigate.

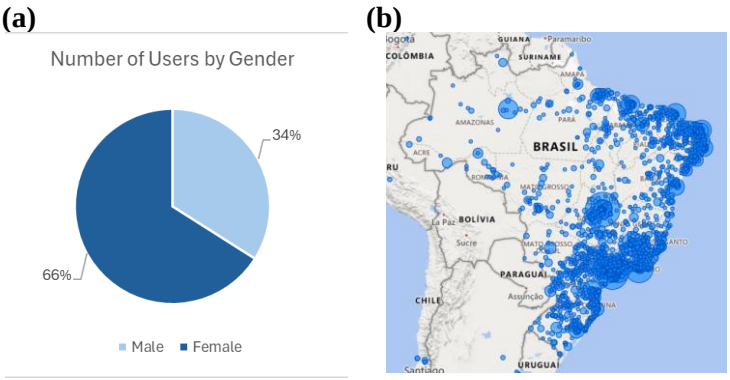


Figure 3. (a) Number of users by gender; **(b)** Distribution of users in Brazil. Created by the authors with platform access data.

3.1 Courses offered and completion rates

In the year 2024, the platform organized 26 classes from 16 different courses, grouped into four thematic categories: Human and Social Sciences; Exact and Earth Sciences; Aerospace Sciences; and GLOBE Program (Environmental Science and Citizen Science) [10]. A total of 11,675 students enrolled in these courses, and 2,617 certificates were issued, resulting in an average completion rate of 22.41%. This rate is considered satisfactory for open-access, self-paced courses, where user engagement and retention are natural challenges, as noted by Moraes & Silveira (2020) [4]. Due to the high number of users who access courses only a few times without completing them, a common feature in open and free educational platforms, a new policy was implemented in 2025: anyone who does not access the course for more than 30 days will have their enrolment automatically cancelled. This measure aims to increase the accuracy of course efficiency metrics, differentiating users who dropped out early from those who actively tried but were unable to complete the activities required for certification.

Figure 4 shows the variation in completion rates across courses offered from 2021 to 2024. For example, the course “Introduction to Rocket Physics – Initial Concepts,” launched in 2024, had 1,029 registrations and 180 certificates, while “Solar Cells and Electrical Circuits” achieved a high certification rate with 213 certified students out of 699 registered users. GLOBE courses, offered in asynchronous and hybrid formats in partnership with universities such as Federal University of Maranhao (UFMA) and Federal University of Rio Grande do Norte (UFRN) also performed well, highlighting the success of institutional collaborations. Courses with hands-on content, such as rockets or electronics, provide greater engagement and certificates. This pattern corroborates user feedback that highlighted the need for more video content and interactive activities, reinforcing the importance of diverse instructional formats.

Since its launch, the AEB Escola Virtual platform has progressively expanded its course offerings. Each year, new courses were added, reflecting both the platform’s development and the increasing diversity of topics available to users. Notably, in 2024, 11 courses were launched, a number considerably higher than in previous years. This growth demonstrates the platform’s continuous effort to broaden educational opportunities in space science and to respond to the learning needs of its audience over time.

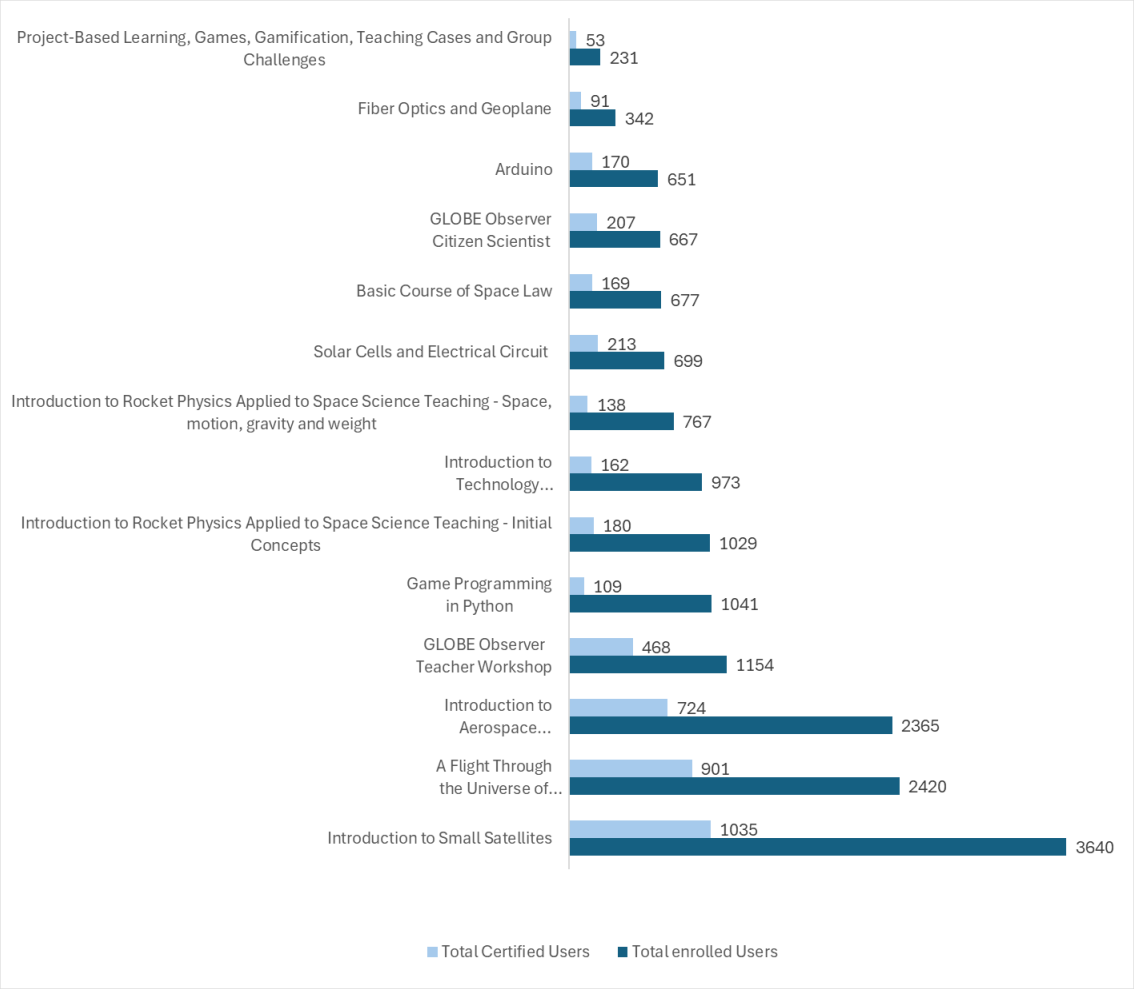


Figure 4. Enrolment and completion of courses. Created by the authors with platform access data.

3.2 Evaluation of learning experience

To evaluate the educational impact of the platform, a feedback survey was applied to all users who completed courses. The survey included questions about prior knowledge, satisfaction with materials, perceived learning, evaluation methods, and language clarity. Responses used a 1–5 scale, where 5 indicated the highest level of agreement.

The results indicate consistently high user satisfaction, as illustrated in Figure 5. In particular, the responses show strong agreement regarding the usefulness of the courses (Question A), the clarity of the language used in the materials (Question E), and the overall quality of the learning resources (Question B). Figure 5 also highlights subtle variations among other survey items, providing a nuanced view of user perceptions across different aspects of the platform. These results underscore that the AEB Escola Virtual effectively delivers a meaningful learning experience and supports inclusive education, aligning with the UNESCO (2022) [6] recommendations for open and accessible science education.

Several students also offered open comments. One participant from the IMATEC course (a training dedicated to the application of technology readiness level concepts) reported that understanding the stages of technological readiness helped connect theoretical knowledge to real-world applications and inspired them to reflect on the social impacts of innovation. Another user appreciated the content but expressed difficulty with the text-heavy format, suggesting that future courses include more video-based learning.

The data presented in this section support the idea that AEB Escola Virtual It is fostering scientific literacy, reaching thousands of students in Brazil and abroad, and assisting in the preparation of future space-related professions. The combination of quantitative and qualitative data provides strong evidence of the platform's success in creating an inclusive, scalable, and high-quality learning environment — as envisioned in the original AEB Escola program and in alignment with the theoretical foundations discussed throughout the article.

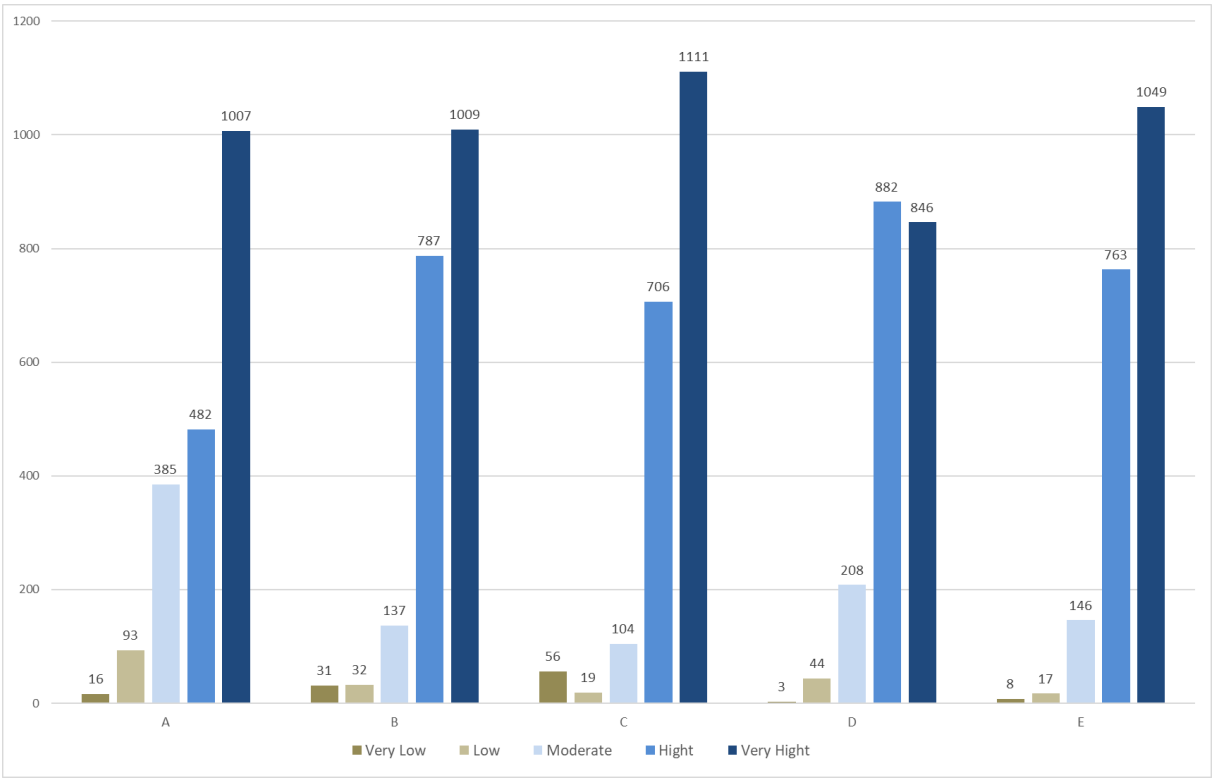


Figure 5. User responses and course evaluations. The following questions were asked: (A) Do you think the course was able to fulfil its function of transmitting knowledge on the proposed topic?; (B) How satisfied were you with the teaching material provided by the course?; (C) - Did you feel satisfied after completing the course?; (D) - Did the course provide good practical and theoretical learning?; (E) Were the terms or language employed by the course speaker or speakers easy to understand?.

4. CONCLUSION

The AEB Escola Virtual platform has become an effective and strategic tool for promoting space education in Brazil. With over 22,000 registered users from 245 regions worldwide as of May 2025, the platform shows consistent growth and strong national and international reach. Students, teachers, and professionals in space-related industries can benefit from the many course offerings, which are organized into four theme areas. Positive learning experiences and educational impact are indicated by high user evaluation satisfaction ratings and the more than 2,600 certifications that were granted in 2024.

The platform combines open access with high quality content and innovative teaching strategies such as gamification, asynchronous modules, and practical activities. These features contribute to student engagement and support the platform’s goal of making scientific and technological knowledge more accessible. The initiative also aligns with UNESCO's guidelines on open science and promotes equity in digital education.

As part of the Brazilian Space Agency’s broader educational efforts, AEB Escola Virtual represents real progress in popularizing science and supporting the national space program. Future goals call for growing institutional partnerships, creating additional courses, and enhancing the platform's interactivity and user experience to carry on this progress. The platform's position as a resource for space education throughout Latin America and beyond is intended to be strengthened via these initiatives.

4.1 Declaration of Competing Interest

The authors declare no conflict of interest.

4.2 Fundings

This work received specific funding from the Brazilian Space Agency.

4.3 Acknowledgements

The authors thank the Federal Institute of Education, Science and Technology of Rio Grande do Norte (IFRN) for the technical support in configuring the AEB Escola Virtual platform. We also acknowledge the valuable contribution of the Air Force University (UNIFA), the Federal University of São Carlos (UFSCar), the National Institute for Space Research (INPE), the Federal University of Rio Grande do Norte (UFRN), the Federal Institute of Education, Science and Technology of Rio Grande do Norte (IFRN), the Aeronautics Institute of Technology (ITA), the GLOBE Program, and other institutions for their support in the development and production of the platform's courses.

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