



Running a hybrid astronomy program for school students and adults: insights from Petrozavodsk State University

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Abstract. With astronomy removed from the school curriculum, students have limited opportunities to pursue their interest in this field: they can either study for specialized Olympiads or independently watch documentaries and read popular science books. As a natural science, astronomy not only broadens students' worldview but can also influence their career choices and academic trajectories. In order to popularize astronomy both as a science and as a hobby, it is essential to provide educational opportunities in astronomy to adults as well. Yet only a few cities offer specialized clubs where non-students can deepen their knowledge of astronomy and pursue their interest in space. The advances in information technologies expand the potential of both educational and popular science projects. The introduction of online classes not only increases participant numbers but also allows for the involvement of a broader pool of instructors and creates more flexible learning conditions. This report discusses the experience of transitioning the Asterion Astronomy Program at Petrozavodsk State University from in-person classes to an online format. It examines the advantages and disadvantages of this model, the challenges of engaging young people and sustaining their motivation, and analyzes the results achieved over several years. The authors emphasize the importance of implementing various astronomy-related projects for both school students and adults within the framework of continuous natural science education, contributing to the development of a well-prepared cohort of future university students and professionals pursuing careers in astronomy.

Keywords: astronomy education; supplementary education; astronomy club

1. Introduction

After astronomy was removed from the school curriculum, students have had limited opportunities to engage with this field of interest. Within the existing curriculum, astronomy is addressed only incidentally in subjects such as physics and geography, which hinders the development of a coherent scientific worldview. In addition to its role in shaping a broader scientific outlook, studying astronomy during school years may influence students' future career choices and academic pathways (Parko et al. 2016; Skorikova & Kuznetsova 2020).

A number of studies report a decline in scientific literacy among Russian school students (Kersha & Obukhov 2023; Shiling 2023; Belikova & Novolodskaya 2022). Shiling (2023) argues that the cultivation of scientific literacy can be effectively supported through various extracurricular activities, special interest classes, and project-based learning. Consequently, expanding supplementary education in this area remains a relevant objective.

Krupa et al. (2021) examine a number of studies on the implementation of digital technologies and online formats in supplementary education.

In its traditional form, astronomy education in Russia is maintained primarily through school Olympiads, in-person clubs, and interest groups at schools and universities. Planetariums also play a notable role, with outreach activities targeting both students and adults (Novichonok & Skorikova 2015).

Previous studies have highlighted several benefits of incorporating digital technologies into education, noting in particular the flexibility of online formats and the opportunities they provide for independent study. Research also suggests that student engagement in online classes increases when learners can interact with one another, receive feedback from teachers, and participate in smaller groups. Students' evaluations of online courses are reported to depend on such factors as the teacher's involvement and enthusiasm, the appeal of the course content, the inclusion of assessment, and the cost of participation. Moreover, online education is considered to have a positive impact on reducing social and economic inequality by expanding access to supplementary education and offering a degree of anonymity in the digital environment (Krupa et al. 2021; Harvey et al. 2014).

Despite these findings, the specific issue of online clubs as a form of supplementary education for school students has received little scholarly attention. Most existing studies focus primarily on the use of digital tools within traditional in-person classes. Addressing this gap, the present paper explores the potential of distance learning for supplementary education, using the astronomy program for school students organized at Petrozavodsk State University as a case study.

2. Program structure and delivery

The Asterion Astronomy Program dates back to 2008, when it was established at Petrozavodsk State University as a club for university students. Since then, it has expanded to include astronomy enthusiasts of all ages who appreciate the subject in its broadest sense – not only as a science but also as a hobby.

In response to the participants' request, a general astronomy program for school students was launched in 2012 as part of Asterion. Its members attended in-person lectures covering various astronomy topics, delivered in a popular science format.

The primary goal of the Asterion Astronomy Program is to popularize astronomy and science in general. At the same time, it aims to address the following objectives:

- educational – to provide all interested individuals with a general understanding of basic concepts in astronomy;
- career guidance – to encourage high school students to pursue astronomy as well as other science-related fields;

- popularization – to attract a broader audience to amateur astronomy.

For a detailed account of the program’s experience with in-person activities, see Novichonok & Skorikova (2015).

In 2020, due to the COVID-19 pandemic and restrictions on in-person events, Asterion launched online classes, which have continued ever since. These classes are held once a week throughout the academic year for two age groups: the younger group (school students in grades 1–6) and the older group (school students in grades 7–11 and adults). The program structure allows the same topic to be studied in both groups but with different approaches: the younger group receives adapted, condensed information through the use of game-based methods, while the older group follows a more in-depth curriculum aligned with the school physics syllabus.

Each academic year focuses on one specific branch of astronomy, such as *General Astronomy and Space Exploration*, *The Solar System*, or *The World of Stars and Galaxies*. Students can join the program at any time and attend it for several years, continuously exploring new topics. Moving from the younger group to the older one also marks an important milestone for participants. The course curriculum is compiled by a team of instructors before the start of each academic year, and it includes 26 one-hour classes per age group, conducted from October to May, with special emphasis placed on ongoing astronomical events and recent discoveries.

Unlike the more common model of distance learning which relies on students independently viewing pre-recorded lessons, classes are conducted in real time via online conferencing platforms and take the form of lectures with opportunities for discussion. This format enables continuous interaction between participants and instructors, allowing students to seek clarification at any point via microphone or chat. Additionally, at the end of each class there is designated time for discussion, questions, and feedback.

3. Online delivery: effectiveness and limitations

The transition to an online format has had a considerable impact on membership numbers. In the 2012–2019 academic years, the number of registered attendees fluctuated from 36 to 84 per year, with the majority (55–60%) belonging to the older age group. On average, each class was attended by approximately 7 to 10 participants. Following the shift to the online model, attendance increased due to the inclusion of participants from various districts of Karelia and even other Russian regions. In the 2024–2025 academic year, 182 participants registered for the program, representing 10 districts within Karelia and 16 other regions across Russia. Among these, 47% enrolled in the younger group and 53% in the older group; notably, 25% of all applicants were returning participants. On average, about 20 individuals attended each class, and approximately 60 participants attended more than half of all classes throughout the year.

The experience gained from the online model has helped determine the optimal group size: no more than 25 participants per class. This number enables instructors to sustain engagement, address all questions, and ensure proper classroom management – the latter being particularly important for younger students. The curriculum is designed in a way that allows participants to join the course at any point during the academic year.

That said, there is a notable discrepancy between the number of applications submitted and actual attendance. Attrition occurs due to various reasons, including a demanding academic or professional workload, changing priorities, a mismatch between participants’ expectations and the course format, or the difficulty of the material. Attracting and retaining students is a challenge faced by many supplementary education providers, and in order to address this, the Asterion Astronomy Program conducts annual surveys to evaluate its strengths and areas for improvement.

It should also be noted that the program’s activities extend beyond the online format, since observations – an essential component of astronomy education – are highly challenging to conduct remotely. Therefore, members from Petrozavodsk and its surroundings are regularly invited to

in-person observations as well as training sessions on working with astronomical instruments. Provided that they have the appropriate personal equipment, participants from other regions have the opportunity to conduct observations independently with remote guidance of the program’s instructors via online or telephone communication. Asterion also regularly shares links to live broadcasts of major astronomical events on its VKontakte page. In addition, the program’s instructors have organized a number of lectures and practical sessions in schools across various districts in Karelia; with stable funding, such outreach efforts could be sustained on a consistent basis.

In conclusion, it is worth outlining the key advantages and challenges of the hybrid format employed by the Asterion Astronomy Program.

Advantages

- *Wider reach among students and educators.* The online format brings in participants from remote areas of Karelia, which is particularly important given the limited availability of similar opportunities in smaller towns. Moreover, highly qualified experts, such as observatory staff, planetarium employees, and other specialists, can also be invited to participate.
- *More reliable class scheduling and attendance.* The transition to online classes minimizes the impact of illnesses, quarantines, and other unanticipated disruptions.
- *Faster and more effective feedback.* Modern school students are accustomed to online communication and, in many cases, find it easier to ask questions from the comfort of their own homes than in a classroom setting. Moreover, many online conferencing platforms allow attendees to send questions directly to the instructor or to the group chat while the class is in progress.
- *Opportunity for people with limited mobility to participate.*

Challenges

- *High level of engagement and self-discipline required.* It can be difficult for school students to remain focused throughout an entire class session, and the home environment provides numerous distractions, such as gaming, snacking, or simply moving around.
- *Technical issues.* Unstable Internet connection, microphone malfunctions, and sound problems – for both teachers and students. In most cases, such issues are resolved promptly or mitigated through compromise solutions.
- *Difficulty in monitoring comprehension.* Although some students may remain silent in in-person classes as well, they are easier to notice in a face-to-face setting, where instructors can engage them directly by asking questions or eliciting opinions. In online classes, it is more difficult to identify such “silent participants.”
- *Limited opportunities for group work.* The online setting poses challenges for organizing group work. While some platforms offer breakout room functionality, it can be difficult for a single instructor to switch between rooms in order to effectively monitor progress in each group.

The lack of face-to-face interaction between all participants is also often cited as a disadvantage of online classes; however, given the program’s hybrid format, this disadvantage is mitigated by in-person events.

In summary, the program currently serves a relatively small region, so the online lecture format described in this paper has proven to be both sufficiently effective and convenient. However, an increase in the number of students could lead to organizational difficulties and a decrease in instructional quality. In this case, launching similar initiatives in other regions could be a viable solution. The experience of the Asterion Astronomy Program demonstrates that such projects in supplementary astronomical education are in demand and can serve not only as a meaningful stepping stone in the training of future experts in the natural sciences but also as a valuable tool for improving public literacy in astronomy.

4. Conclusion

The experience of the Asterion Astronomy Program at Petrozavodsk State University operating in a hybrid format demonstrates the high demand for supplementary education in astronomy among both school students and adults. The shift to online classes has significantly expanded the audience, bringing in participants from remote areas of Karelia and other regions of Russia, which is particularly important given the absence of astronomy in the compulsory school curriculum.

The flexible format of online lectures with opportunities for discussion, adapted to different age groups, has proven effective. Key advantages of distance learning include accessibility for remote participants, the opportunity to involve highly qualified experts, and resilience to external factors such as illnesses and quarantines. At the same time, several significant limitations have been identified: decreased engagement due to distractions at home, technical issues, and challenges in organizing group work and monitoring comprehension.

End-of-year surveys indicate that students respond positively to the program's format, emphasizing its welcoming atmosphere, clarity of instruction, and motivation to explore the sciences.

In-person observations and practical training remain vital components of the program alongside online classes, helping to overcome one of the major shortcomings of distance learning – the lack of hands-on interaction with astronomical instruments.

The analysis demonstrates that the hybrid format of the program not only contributes to science outreach efforts, but also plays an important role in career guidance and in fostering public literacy in the natural sciences. To ensure successful development of such initiatives, it is essential to maintain a balance between the scalability of the online format and a personal approach to students. The experience of Asterion can serve as a model for establishing similar programs in other regions, advancing scientific literacy and helping to train the next generation of specialists in the natural sciences.

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