THE IMPACT OF EDUCATIONAL INITIATIVES ON READINESS FOR SPACE TOURISM: ANALYSIS AND PERSPECTIVES

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Abstract

Purpose – The study aims to evaluate the impact of educational programmes on people's willingness to participate in space travel. It highlights how education influences awareness, interest, and safety understanding in the context of space exploration and tourism.
Methodology/Design/Approach – The research is based on a comparative and analytical review of NASA's educational initiatives, including the SEES High School Summer Intern (HSSFP), GeneLab for High School Students (GL4HS), NASA Internship Programme, the Young Scientist Programme, and the Pathways Programme. Additionally, it examines the activities of commercial companies such as Blue Origin, Virgin Galactic, RocketShip Tours, and Space Adventures to determine how educational efforts and public engagement contribute to the growth of the space tourism industry.
Findings – The analysis revealed that educational programmes significantly enhance students' interest and readiness for space exploration. NASA's initiatives, in particular, play a crucial role in inspiring young people, fostering innovation, and ensuring the sustainable development of space tourism. The study concludes that prioritising educational engagement can accelerate the formation of a favourable environment for the expansion of the global space tourism market.
Originality of the research – The study provides an integrated assessment of the interaction between educational initiatives and the commercialisation of space travel, emphasising education as a key driver for the sustainable development of space tourism and the future space economy.
Keywords suborbital transport, reusable rockets, orbital hotels, spaceports, spatial information, technological progress, educational programmes

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INTRODUCTION

International tourism is one of the fastest-growing sectors of the global economy today. The World Tourism Organisation's annual reports confirm its importance. In this regard, legal regulation of tourism is becoming increasingly relevant. According to this organisation, tourism is the temporary movement of people to another place for rest or work, but without permanent earnings there (Olya & Han, 2022). Therefore, space tourism is an extreme type of recreational and commercial activity. Within the new paradigm of tourism activities that encompasses travel beyond Earth, the concept of space tourism is increasingly viewed not merely as an exotic form of leisure but as a component of an integrated educational and scientific system. Specifically, contemporary research emphasises that the educational component is becoming a key factor in stimulating an individual's readiness to participate in space travel and in fostering a responsible attitude towards space (Mammarella, 2021). At the same time, the exploration of how education influences readiness for participation in the space tourism ecosystem addresses a distinct research gap. In particular, this study contributes to clarifying how educational strategies can mitigate the cognitive and motivational barriers that currently limit societal engagement with space-related innovation.

Systematic education in space sciences enhances not only technical knowledge but also fosters psychological readiness, resilience, and ethical awareness essential for participation in extra-planetary activities. Moreover, the integration of educational initiatives into the development of space tourism serves as a mechanism for bridging the divide between public fascination and practical competence, ensuring that the rapid expansion of this industry is underpinned by informed, socially responsible participation. Therefore, analysing the educational determinants of readiness for space tourism offers helpful information about the broader educational challenges associated with preparing future generations for involvement in the space economy. Furthermore, according to A. Toivonen (2023), the sustainable development of the space tourism industry is impossible without appropriate educational interventions, as it is precisely through educational programmes that mediation between economic growth and environmental responsibility is ensured within the new "New Space" ecosystem.

Most individuals earning more than 250,000 USD annually show interest in Space Tourism (ST) (Guerster et al., 2019). Suborbital space tourism is in the early stages of development and may become more feasible in the coming decades due to the development of new spacecraft and lower costs. It should also be noted that the impending decrease in flight costs (Olya & Han, 2022; Zhang and Wang, 2020). Given that the development of space tourism is only gaining momentum, it is necessary to provide a more accurate scientific and philosophical justification for this phenomenon. The International Philosophical and Cosmological Society (IPSC) is also actively promoting theoretical solutions to space tourism problems. In 2011, it organised a conference and published a collection of conference papers on a related topic – Space Travel: Science, Education, Practice

(Svyridenko & Khomenko, 2020). Approximately 20 scientists, representatives of many domestic and international research institutes, shared their scientific developments. The diversity of space programmes and their demand in society attract private capital to space activities, contribute to the formation of a competitive environment and increase the incentives for the development of space activities (Bollani et al., 2019). The commercialisation of space activities has become a determining factor in scientific and technological progress, as has the formation of financial resources to support them. Space transport, satellite communications, and space tourism are among the most attractive areas of private capital activity.

In terms of education, the study of space and spaceflight attracts a wide audience, so many educational institutions offer space education programmes that simulate spaceflight (Mehran et al., 2023). In a broad context, educational initiatives are interpreted as a set of measures that promote the development of individual competencies, enhance readiness to participate in innovation ecosystems, and shape new life orientations. Specifically, the research by Y. Wu et al. (2024) demonstrates that educational intervention acts as a mediator between economic development and sustainable space tourism – meaning that educational programmes can help ensure that the growth of space tourism is not only market-driven but also environmentally and socially responsible. Furthermore, citizen science initiatives, such as the Cyber-Cosmos project, aimed at engaging students through astrotourism and STEM activities, have shown a positive impact on schoolchildren's interest in space science (Barbosa et al., 2022). Efforts are underway to make space travel more accessible to a wide range of people. The development of reusable rockets and spacecraft, as well as cost reduction efforts, will help lower the barrier to entry into the industry. This will allow more people to experience space and participate in recreational travel. Current space travel is relatively short, but there is growing interest in longer space missions. Models are emerging that explore the principle of extended stays in orbit and space, where travellers can spend days or weeks in microgravity conditions. Such lengthy missions allow travellers to gain a better understanding of space and a sense of adventure.

Despite numerous studies in this area, the problem of the impact of education on the development of space tourism remains a complex one. In other words, the study of the prospects for scientific regulation of accessible space tourism within the framework of international space law is a relevant topic. Problems related to education in the context of space tourism:

- lack of specialised educational programmes (lack of specialised universities and faculties, inconsistency of existing programmes with new requirements);
- high cost of education (accessibility of education, scholarships and grants);
- lack of an interdisciplinary approach (isolation of disciplines, the need for an integrated approach, insufficient promotion of space topics, lack of interest among young people, the role of the media and education).

Thus, the study aims to assess the impact of education on the formation of society's readiness to carry out space tourism.

1. LITERATURE REVIEW

The growing public interest in space and the active participation of private companies in space projects are opening new The growing public interest in space and the active participation of private companies in space projects are opening new horizons for human development. The commercialisation of space activities – including space transport, satellite communications, and particularly space tourism – not only contributes to economic growth but also to the expansion of knowledge about the universe (Businesswire, 2021). The origins of space tourism can be traced to the mid-20th century. According to S. Collado et al. (2021), the concept emerged in the 1960s, when Barron Hilton and Kraft Erik proposed the radical idea of commercialising space travel. However, it was only at the end of the 20th century that this idea began to gain scientific and entrepreneurial traction. From an economic perspective, space tourism has always been intertwined with technological feasibility and investment capacity. M. Barari et al. (2020) highlight that the sector offers diverse experiences – from short suborbital flights that simulate weightlessness to extended stays on the International Space Station – thereby appealing to multiple market segments.

S. Holt (2023) estimates that even a modest increase in annual demand to one million passengers could drastically reduce the average cost of a ticket, creating conditions for broader accessibility. These projections obtain practical confirmation in the activities of modern entrepreneurs such as Richard Branson (Virgin Galactic) and Elon Musk (SpaceX), whose companies invest heavily in reusable launch systems and consumer-orientated flight models. At the institutional level, the authors note the gradual involvement of public agencies and educational programs in the space economy. The emergence of initiatives such as NASA's High School Summer Intern (HSSFP) or GeneLab for High School Students (GL4HS) demonstrates attempts to integrate educational engagement into space-related industries. However, these efforts remain fragmented and poorly analysed in the academic discourse.

Beyond engineering and economics, the human dimension plays a decisive role in determining readiness for space travel. C. Giachino et al. (2021) emphasise that Yuri Gagarin's first flight in 1961 symbolically opened a new era – transforming the human perception of space from a distant dream into a potential domain for exploration and recreation. The psychological and educational preparation of future participants thus becomes a crucial factor in sustaining long-term engagement with space activities. S.W. Chiu (2022) argued for the critical role of mentorship programs in fostering diversity within the space and technology sectors, particularly in the context of challenges exacerbated by the COVID-19 pandemic. The study proposes a practical manual of tools designed to inspire and support the next generation of global women leaders in the field, focusing on the visibility of diverse roles in ground control, data analytics, policy, and education. People increasingly recognise these

educational and mentorship frameworks as mechanisms that can reduce psychological and social barriers to participation in space-related initiatives. Nevertheless, existing studies suggest that educational engagement remains underexplored. While authors such as Cohen & Spector (2022) identify the multidisciplinary nature of space tourism – bridging aerospace engineering, economics, psychology, and education – there is still little empirical evidence on how training, outreach, and STEM programmes shape public readiness for space travel.

From a technological standpoint, the key limiting factors include spacecraft safety, cost efficiency, and insufficient legal regulation (Apakhayev et al., 2018). B. Nölting et al. (2020) underscore the necessity of creating safe, cost-effective, and standardised spacecraft, as well as a unified international legal framework for regulating civil and commercial space travel. Similarly, J. Mehran et al. (2023) note that, despite breakthroughs in reusable rocket technologies and automated navigation, space tourism still faces high health risks, lengthy training processes, and limited infrastructure for mass participation. At the same time, Y. B. Myronov & M. Y. Topornytska (2019) point out that technological innovations are gradually lowering costs and democratising access. Companies such as Cosmocourse are developing suborbital travel models at comparatively lower prices, showing that market adaptation and innovation can mitigate earlier limitations. The growing use of virtual and augmented reality (VR/AR) simulation tools in astronaut training and educational outreach also plays an increasingly important role in enhancing experiential learning and safety awareness. These technologies serve as a bridge between theoretical training and real-world exposure, offering participants accessible and immersive preparatory environments.

Despite significant progress, structural inequalities and regulatory gaps persist. J. Paul et al. (2021) caution that the market's rapid growth is constrained by economic inequality and high entry costs, rendering space tourism a luxury for the few rather than a democratic experience. They argue that the industry risks remaining elitist, with limited societal benefits, without broader public access or educational integration. Similarly, B. Nölting et al. (2020) emphasise the need for international cooperation to establish legal standards and ethical safeguards for civilian participation. A comparative synthesis of existing studies reveals both convergence and divergence in scholarly perspectives. Authors such as M. Barari et al. (2020), C. Giachino et al. (2021), and S. Holt (2023) share an optimistic outlook, that emphasises economic and technological feasibility. Conversely, J. Paul et al. (2021) and B. Nölting et al. (2020) express more caution, stressing legal and ethical uncertainties, as well as the need for public regulation. Collectively, these findings suggest that while the technological basis for space tourism is strengthening, its social, educational, and regulatory foundations remain fragmented.

The reviewed literature collectively indicates that the development of the space tourism field has been both dynamic and uneven. The term 'dynamic' refers to the rapid technological advancements and the increasing commercial and public interest in space tourism, while 'uneven' reflects the disparity in progress across different regions, market segments, and types of space tourism offerings. Some aspects of the industry, such as suborbital flights, have seen significant growth, while other areas, like orbital hotels or long-duration space travel, are still in early stages of development, lacking the necessary infrastructure and regulatory frameworks. The convergence between economic potential, technological innovation, and educational engagement is evident, but it remains weakly institutionalised. The main research gap identified is the absence of integrative studies that connect technological advancement with human readiness – especially through education and experiential learning. Therefore, this study aims to address that gap by analysing educational programs as drivers of willingness to participate in space tourism.

2. MATERIALS AND METHODS

According to the aim of the study, special attention was given to how educational initiatives, technological innovations, and economic investments are interconnected within this emerging sector. The research is based on a qualitative exploratory design complemented by quantitative indicators, allowing for a combination of an in-depth analysis of educational programs with an empirical assessment of market trends in space tourism. The methodological framework integrates a functional approach, thematic qualitative content analysis, and comparative statistical analysis. The study analysed the activities of key companies shaping commercial space development: Blue Origin (Neuman, 2021), Virgin Galactic, RocketShip Tours, Space Adventures, and analytical reports from Northern Sky Research (NSR, 2024). These companies were selected due to their significant investments in advancing technology and increasing accessibility in the space tourism industry. The second focus of the analysis involved NASA educational programmes, particularly the SEES High School Summer Intern (HSSFP), GeneLab for High School Students (GL4HS), Young Scientist Programme, and the Pathways Internship Programme. These programmes include lectures, practical courses, virtual simulations, and internships aimed at fostering student interest in space exploration. The HSSFP programme, for instance, trains highly qualified personnel for the space sector by engaging undergraduate, graduate, and doctoral students in simulated space missions. It collaborates with organisations such as Astronauts4Hire and Embry-Riddle, which enhances participants' practical skills and innovative thinking. The X-Prize competition has also played a crucial role in promoting research and educational activity in this field.

The functional approach served as the key methodological principle, providing a systematic analysis of each component of educational or corporate initiatives as part of an integrated functional system. This method enables the exploration of not only the content of NASA programs but also their functions, interconnections between educational, technological, and social subsystems, and expected outcomes for forming knowledge, competencies, and social readiness among future participants in space projects. Data were collected from institutional, academic, and analytical sources published between 2019 and 2024. The

material corpus included official NASA reports (NASA Internships Programs, 2024), Businesswire (2021), European Space Policy Institute (2022), Northern Sky Research (2024), and scholarly publications on space education and tourism development (Davidian, 2020; Bekus & Medeuov, 2024; Azizurrohman et al., 2023; Parii, 2024). The selection criteria included relevance to the topic of space tourism, education, and readiness for participation in space projects. The presence of empirical or analytical data, such as student participation, program outcomes, investment rates, and market indicators; official or peer-reviewed origin; and a publication date no earlier than 2019.

The findings were structured across three dimensions of social readiness: motivational-value (attitudes toward innovation and research); cognitive-competency (participation in STEM and VR/AR projects); and social-behavioural (willingness to engage in space-related initiatives). To quantitatively validate the results, several statistical methods were used: descriptive statistics (means, medians, variances, and growth rates); correlation analysis (relationship between investment growth in space tourism and the number of participants in educational programmes); regression modelling (linear and multiple regression to forecast market volumes up to 2028); comparative trend analysis across the U.S., China, and Europe using CAGR indicators; and data visualisation through tables and graphs to illustrate market dynamics.

Data coding was performed using NVivo 14, which enabled the structuring of qualitative categories and visualisation of thematic relationships. Quantitative market data were processed in IBM SPSS Statistics 29, where descriptive, correlation, and regression analyses were conducted. Independent researchers ensured reliability and validity through two-stage coding, triangulation of sources (educational, industrial, and governmental), and continuous auditing of coding decisions. Construct validity was supported by predefining analytical categories according to educational and psychological models of readiness (Azizurrohman et al., 2023; Parii, 2024). The research relied solely on secondary data, meaning no direct participant involvement was required and ethical approval was not necessary.

3. RESULTS

A study conducted jointly by American and Italian scientists predicts that space tourism will soon flourish. This new type of travel will complement existing forms of tourism, such as educational, sporting, and religious, by offering a unique opportunity to explore outer space. Space travel is the flight of one or more people into orbit or space, which is usually more than 100 kilometres above sea level, also known as the Karman Line. It is the normal upper limit of the Earth's atmosphere. Such flights are conducted for commercial or research purposes (Space tourism..., 2021).

To ensure conceptual clarity, this study defines the following key constructs. Psychological readiness refers to an individual's level of emotional stability, motivation, and confidence in undertaking novel and high-risk experiences, including participation in space travel. Public perception denotes the collective societal attitudes, trust, and symbolic acceptance of space tourism as a legitimate and desirable form of human activity (AI-Nuaimi & AI-Ghamdi, 2022). Educational competence is understood as a set of acquired knowledge, cognitive skills, and practical abilities that enable individuals to effectively engage in space-related learning, simulations, and real-world participation. These constructs together form the basis for assessing overall "social readiness" toward space tourism.

In 2021, space tourism flights are increasing again. Richard Branson and Jeff Bezos, two billionaires and owners of an aerospace company, flew into space in July 2021. Branson flew into space on 11 July 2021. Bezos went into space on 20 July 2021 on a New Shepard capsule rocket system built by his company Blue Origin (Neuman, 2021 It's worth noting that NASA has engaged Blue Origin to build manned lunar modules as part of the Artemis program, and Bezos himself recently announced his ambitious plans for a commercial orbital space station, Orbital Reef. SpaceX's success is due to its flexible rocket-building approach and willingness to publicly show its failures.

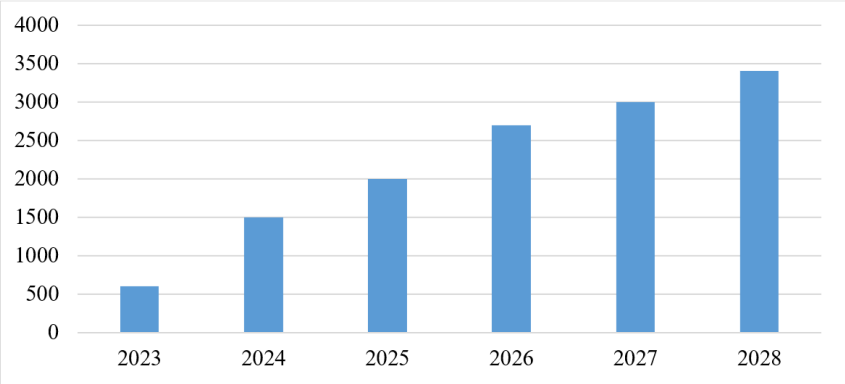
The advantages of this method were demonstrated during the development of Crew Dragon when one of the spacecraft simply exploded during ground testing (Deliso, 2021). A closer examination of NASA's and corporate educational initiatives reveals a coherent systemic framework that demonstrates how institutional and private efforts jointly contribute to the social and psychological readiness required for the sustainable development of space tourism. In this framework, initiatives such as NASA's SEES High School Summer Intern, GeneLab for High School Students (GL4HS), Pathways Program, and the Blue Marble Science Institute Young Scientists Program, as well as corporate programmes like Virgin Galactic's Future Astronaut Training and Blue Origin's Artemis collaboration, perform several key functions. These include fostering human resource development, promoting engagement in STEM disciplines, providing applied research training, and enhancing public understanding of space exploration through scientific communication.

The mechanisms through which these functions operate involve practical project-based learning, including bioinformatics and systems modelling, simulation-based preparation with virtual and augmented reality technologies, and high-gravity and hypoxia training, as well as professional mentorship and participation in international conferences such as the NextGen Suborbital Researchers Conference and the X-Prize competitions. As a result, participants in these programmes demonstrate increased psychological readiness and self-efficacy, improved educational competence through experiential learning, and a more positive public perception of civilian involvement in space activities. In the long term, these processes contribute to the emergence of

a socially prepared, scientifically literate generation capable of maintaining and advancing the space tourism sector. Thus, the interaction of initiatives, their functional objectives, operational mechanisms, and resulting outcomes forms a dynamic system that transforms abstract policy intentions into measurable educational and psychological effects essential for the future of space travel.

According to a study by Northern Sky Research (NSR) (2024), more than 60,000 people will travel to space in the next ten years, bringing in about 20 billion USD in space tourism revenue. NSR also expects orbital and suborbital tourism revenues to begin in 2024 and reach more than USD 3.4 billion by 2028. Dynamics of the projected growth of the global space market by 2028 (Figure 1).

Figure 1: **The projected growth of the global space market by 2028, is USD billion**



Source: compiled by the author based on the data of the analytical agency Northern Sky Research (2024).

Suborbital flights are expected to become more popular due to falling ticket prices, increased demand and competition. It is substantiated that by the end of 2027, suborbital tourism, as one of the segments of space tourism, will grow by 15.6% and reach USD 1.5 billion (Northern Sky Research, 2024).

The US space tourism market is estimated at USD 175.3 million in 2020. China, the world's second-largest economy, is expected to reach a projected market size of USD 401.6 million by 2027. Other prominent geographical markets include Japan and Canada, each expected to reach growth of 11% and 13.2% respectively by 2027. In Europe, growth in Germany is expected to be around 11.9%. NSR estimates that more than 3,000 flights will be operated by the end of the forecast period. The projected growth of the space market in the selected countries is shown in Table 1.

Table 1: **The projected growth of the space market in the selected countries**

Countries	**Estimate**
Japan	11%
Canada	13.2%
Germany	11.9%

Source: compiled by the authors based on Businesswire (2021).

Suborbital spacecraft companies are expected to dominate the space tourism market, with 82% of revenues coming from lower fares, increased demand and competition. However, this economic potential is directly dependent on the formation of future consumers' social readiness. In this study, the term "social readiness" is understood as a comprehensive academic construct encompassing three interrelated dimensions: psychological readiness – the degree of individual preparedness, motivation, perception, and attitude towards participation in space tourism; public perception – the level of public support, trust, and integration of the new form of (space) tourism into the socio-cultural context; and educational competence – the possession of knowledge, skills, and educational initiatives that enable an individual to realise participation in space tourism. Thus, social readiness here functions as an intervening variable between educational initiatives and consumer behaviour/readiness to participate in space tourism. This approach is similar to models of "community readiness" in tourism, which consider cognitive, affective, and conative elements (perspectives, attitudes, and behavioural intentions) (Azizurrohman et al., 2023; Zhansagimova et al., 2022), as well as models of student readiness for professional activity, which include motivational, cognitive, and behavioural components (Parii, 2024).

Readiness is viewed as a multidimensional construct reflecting the conditions, abilities, and motivation for action in a new or changing environment. In the context of space tourism, social readiness takes on particular significance: this form of tourism combines high technological and innovative conditions, strong financial barriers, and a complex system of socio-cultural expectations. Based on this, we propose to distinguish the following key dimensions of social readiness: the motivational-axiological dimension – readiness to accept and support the new tourist form (space tourism), including a creative attitude towards innovations and technologies; the knowledge-competence dimension – the level of education, participation in educational initiatives, and mastery of technologies (e.g., VR/AR learning) that enable participation in space tourism; the socio-behavioural dimension –

the degree of participation, intentions, societal support, and the individual's readiness to join or participate in space tourism. The contextual relevance to space tourism lies in the fact that educational initiatives play the role of a catalyst in developing these dimensions of social readiness: educational programmes, simulations, and VR/AR modules provide knowledge-competence; the motivational component is formed through the popularisation of space, educational campaigns, and social perception; the socio-behavioural dimension – through real intentions and participation in a space tourism programme. Targeted educational initiatives serve as the key mechanism for developing these dimensions of social readiness (Ivanova & Vovchanska, 2023; Zhao et al., 2025). Educational programmes and initiatives play an important role in the development of space tourism. Space exploration meets the highest needs of mankind, and the development of space travel is an inevitable trend. Thus, both NASA-led and corporate initiatives demonstrate the same functional trajectory: they begin with initiative (educational engagement), operate through functions and mechanisms (training, mentorship, simulation), and culminate in results (psychological readiness, public perception, and educational competence). This layered perspective enables a more systematic understanding of how educational programs translate into measurable social outcomes.

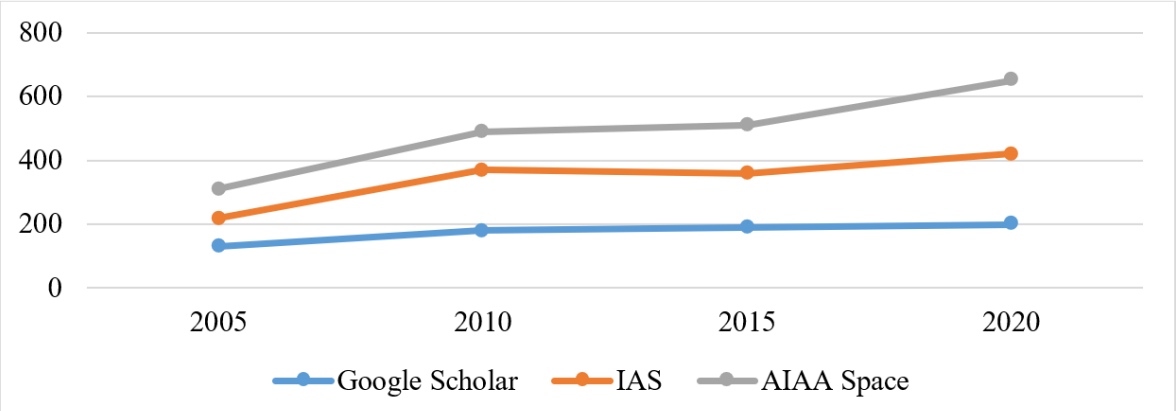
The Internet is the only source of information, distribution, and communication for international educational products, and even the product's content is only available online. Modern consumers need a complex tourist product and often do not consider the possibility of cooperation with companies offering only individual components of the tourist educational product (Burlakovs et al., 2020; Shtal et al., 2024). They refuse to cooperate with such companies even at the stage of selecting tourism service providers. The National Space Centre, which opened in 2001, has developed several educational programmes. Since then, the centre has received more than 4.6 million visitors, including more than a million students. The centre includes the UK's largest planetarium, where children can learn about spaceflight, watch cartoons about astronauts and attend shows based on curriculum topics. The centre offers lessons on various topics: science (plants, electricity, electrical circuits, and living organisms), mathematics (problem-solving, addition and subtraction, coordinates), and literacy (reading and communication skills) (Narovlianskiy, 2024). These initiatives correspond to the knowledge-competence dimension of social readiness, providing structured educational exposure and experiential learning through immersive simulations (e.g., Mars surface modules, STEM lessons).

The centre also hosts seminars on STEM training for teachers, overnight stays, gallery tours, space-themed events, and night sky tours in the planetarium. In 2023, the centre will create a new program to simulate a trip to Mars. During the hour-long simulation, students develop various skills following the curriculum and solve various problem situations related to space, electrical circuits and nature. In the On the Surface mode, students cooperate towards specific goals: individually or in small groups. Other educational programmes, including competitions, set them apart from other sources of funding. Prize amounts may be relatively small (e.g., USD 10 million for the X-Prize), but they stimulate increased investment from other sources, both within and outside the industry. NASA, the X-Prize Foundation, and Northrop Grumman jointly organise the USD 2 million Lunar Lander Challenge. Similar events designed to stimulate investment in the industry include the short-lived Rocket Racing League (Davidian, 2020).

The space industry is actively utilising various educational programs, including competitions and training, to stimulate innovation and training. Programmes such as the HSSFP not only fund scientific research but also provide future astronaut scientists with a unique opportunity to gain practical skills. HSSFP's human resource development activities include the development and implementation of educational programs; recruitment and training activities; and knowledge sharing. Training programmes include training of future astronaut scientists from non-governmental organisations (e.g., Astronauts4Hire, NASTAR Centre, Embry-Riddle Semipolar Orbit Programme of the Mesosphere University of Science), training in spacesuit use, mission simulations and simulation of space flight conditions (e.g., hypoxia and high g). Nowadays, the focus is on training in the use of the systems.

There is also a growing number of knowledge-sharing events, such as annual and periodic conferences, as well as HSSFP-focused events (e.g., the X Trophy competition and the Next Generation Suborbital Researchers Conference). As noted above, the bibliometric indicators of HSSFP knowledge-sharing activities show a significant increase in knowledge-sharing after the X-Prize competition. Bibliometric search results for the keywords 'space' and 'tourism' (Figure 2).

Figure 2: **Bibliometric search results, by keywords, space and tourism**



Source: compiled by the authors based on Davidian (2020).

Virtual Reality/Augmented Reality/Mixed Reality (VR/AR/MR) was used to disseminate spatial information and training. In 2016, Lockheed Martin created Mars Experience, an educational tool designed to inspire students to explore science and space. It is a simulator that uses a school bus and virtual reality to allow students to see Mars through a window and feel like they are on a bus on the surface of Mars rather than on the streets of Earth.

In 2018, the Mars Experience moved to the Smithsonian National Air and Space Museum and continues to inspire and enthuse people about science and space. The Mars Society is building MarsVR, a free customisable open-source VR platform for manned exploration of Mars. They are currently building a digital twin of the Mars Desert Research Station (MDRS), a similar research station in Utah, including adding new learning processes to train astronauts at the same MDRS and providing access to multiple users and data. Further enhancements are planned. MarsVR should be available to the public not only as a research tool but also for educational and outreach purposes to promote science, technology, engineering and maths (STEM) careers in space (Holt, 2023). Several companies have announced their intention to organise trips to the Moon in the coming years. They are the Constellation Service International (CSI) project and the Lunar Express Space Transport System. Space Adventures is ready to provide an Earth satellite to anyone for approximately USD 100 million.

In space travel projects and programmes, everything depends on entrepreneurial ingenuity. The main principle is to connect ideas, even if they are impractical, with success and future benefits (Nurekenova et al., 2022; Rakhimberdinova et al., 2022). NASA educational programmes in space tourism are prominent in the development of space tourism. Collectively, NASA's programmes follow a consistent causal chain: initiative (programme creation) → functions (education and training) → mechanisms (research practice, mentoring, simulation) → results (enhanced psychological readiness, competence, and societal acceptance of space tourism). This progression reflects a model of applied readiness-building that could serve as a prototype for international adaptation. Major NASA educational programmes:

1. SEES High School Summer Intern: The programme provides selected students with an introduction to Earth and space exploration. Trainees learn to interpret NASA satellite data by working alongside scientists and engineers in their chosen field of study.
2. GeneLab for High School Students (GL4HS): Provides students with the opportunity to immerse themselves in space-based life sciences with a special focus on omics-based bioinformatics research, the science of collecting and analysing complex biological data such as genetic codes and computational biology.
3. NASA Internships: Interns use their creativity and innovation to work on projects that impact NASA's mission, such as returning to the moon by 2024.
4. Blue Marble (Young Scientist Program): The BMSIS Young Scientists Programme (YSP) provides students and early career scientists with the opportunity to engage in basic research, learn effective science communication and develop critical thinking skills in ethics, policy, etc.
5. Pathways Program: The Pathways programme provides current students with paid work experience and recent graduates with a dynamic early career development programme.

Notably, Kazakhstan participates in international space development programmes and effectively applies this experience (Bekus & Medeuov, 2024). The diversity of space programmes and their relevance to society attract private capital for space activities, promote a competitive environment and increase the impetus for the development of space tourism. The commercialisation of space activities is a determining factor in scientific and technological progress, as well as the formation of financial resources to support it (Svyridenko & Khomenko, 2020). Space transport, satellite communications and space tourism are among the most attractive areas of space activity for private capital.

Without appropriately developed educational programs and accessible technologies, potential participants—both future tourists and industry professionals— fail to acquire the necessary competencies, motivation, and support (Hrinchenko et al., 2025). This creates a barrier to entry into the space tourism market, reducing the number of ready consumers and delaying commercial development. Beyond general educational gaps, the problem has several specific dimensions: low availability of specialised training programmes (undergraduate/master's/short courses), uneven distribution of laboratory and computational resources, and insufficient integration of practical simulations and interdisciplinary modules (e.g., medicine, psychology, engineering, and business), which are critically important for training both space tourism staff and clients.

ESPI (2022), in its detailed mapping, notes that 866 specialised programmes (undergraduate/master's/PhD/short courses) were identified in Europe – however, their concentration is significantly uneven, with the majority of offerings concentrated in a few hubs (Paris, Toulouse, Madrid, London, Barcelona, and Rome). This means that students from remote regions effectively lack local opportunities for practical training. The insufficiency of practical training is also evident in the structure of curricula: only a portion of courses require mandatory internships/work placements, while approximately 43% of programmes offer internships as an optional component – meaning a systematic transition from theory to practice often does not occur. This situation deepens the gap between the academic skills of graduates and the demands of the industry (skills such as working with flight simulators, CubeSat prototyping, processing large astronomical datasets, etc.). (ESPI, 2022).

Industrial and sectoral studies confirm the deficit in necessary competencies: Pan-European employer surveys show that approximately half of the organisations (≈52%) report a lack of key skills in their current workforce; for large organisations,

this figure can reach 65% – meaning that businesses themselves report a significant skills gap that needs to be filled through education and retraining. This directly impacts companies' ability to scale commercial services (including tourism) due to a shortage of engineers, operators, flight safety specialists, and customer support staff. (Space Skills Alliance, 2023). Another significant factor is technological inequality between countries and universities.

Analytical reviews and reports from industry organisations show that access to powerful computational resources, specialised software for simulations, and facilities for satellite prototyping laboratories varies greatly. Because of this, some educational institutions cannot provide students with hands-on experience using real tools (HPC for data processing, microgravity simulators, environmental test benches), which undermines the competitiveness of graduates in the job market. European initiatives (Horizon/Horizon Europe) partially target investments in such capabilities, but coverage remains incomplete and primarily directed towards projects in leading countries. (Defence Industry and Space, 2022). Practical examples of the impact of educational mismatches on the development of space tourism include courses without simulators and practical training failing to prepare staff for accompanying passengers in mixed crews (passenger + professional astronaut), which increases operational risks and training costs; the lack of interdisciplinary modules (psychology of extreme environments, flight medicine, and risk management) reduces organisations' readiness to offer comprehensive "turnkey" services; Unequal access to resources complicates the entry of startups and small firms into the space tourism services supply chain, as they cannot find trained personnel and testing facilities in their region.

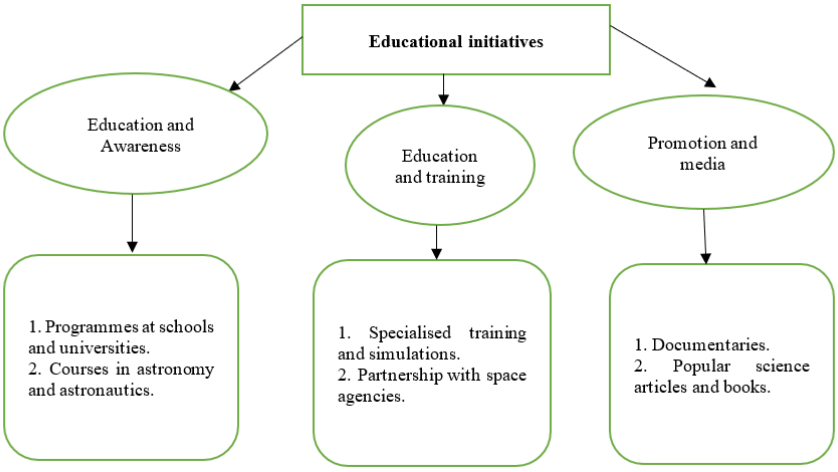
The main problem of space tourism is the relative inaccessibility of this type of tourism (extremely high requirements for health and physical fitness, especially for space tourists) and high prices for services (Seidaliyeva & Smailov, 2025). The cost of the programme currently stands at USD 30 million, which includes medical examinations, training and preparation in Star City, and flight and stay on the International Space Station (ISS). The spacewalk will cost tourists an additional USD 15 million. The reason for the high cost is that the transport aircraft needed to send a person into space is much more expensive than, for example, launching a satellite. An important factor affecting the cost of air travel is the risk to the company and the participants of the flight. One solution to this problem is the use of manned suborbital vehicles. These vehicles are high-speed aircraft that can climb to a height of approximately 150 kilometres. At this height, a person can see the Earth from space and experience weightlessness.

Virgin Galactic is one of the companies developing such vehicles. The company has developed a ship called SpaceShipTwo. A flight to the edge of space costs approximately USD 200,000, which is much cheaper than a flight to orbit. In addition, the flight conditions are much softer and more comfortable. The aircraft is still in the development and testing phase, but tickets for the first flight are already sold out. The suborbital flight will begin at Spaceport America, the world's first private spaceport built by Virgin Galactic in partnership with the government of the US state of New Mexico. Another US company, RocketShip Tours, is offering flights into space in a two-seater Lynx craft. The flight time will be much shorter, and the altitude will be only 61 kilometres. However, passengers will be allowed to participate in controlling the craft and experience zero gravity for only USD 95,000. In space tourism as a business, there are many other opportunities and alternatives besides orbital and suborbital flights (Myronov & Topornytska, 2019).

Work is underway to make space travel more accessible to a wide range of people. The development of reusable launch vehicles and spacecraft, as well as cost reductions, will help lower the barrier to entry for space travel. Currently, the experience of space travel is limited, but interest in longer space travel is growing. Space travel will be facilitated by the establishment and expansion of space centres around the world. Technological innovations will continue to shape the future of tourist and recreational space travel.

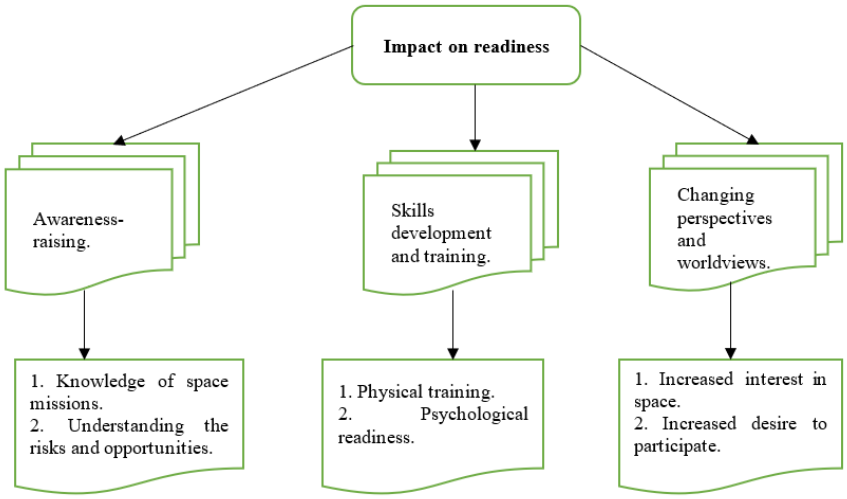
Advances in propulsion, materials science, life support systems and spacecraft autonomy will contribute to safer, more efficient and sustainable space tourism. Space tourism has the potential for significant market growth and enormous economic benefits. As space travel becomes more affordable and the industry grows, it can generate revenue from ticket sales, accommodation and related services, the development of related industries such as hospitality and entertainment, exploration and education. In regions where space tourism is booming, this growth will drive job creation, innovation and economic development (Dash & Dash, 2023). If the regulatory framework, sustainability and safety continue to improve, space travel for tourism and recreation will become an integral part of our common aspirations and extraterrestrial adventures. One strategy to improve educational programmes and initiatives to increase interest in space could be to introduce space-themed lessons and projects into the curriculum. This could include organising field trips to space centres, lectures by astrophysicists, or even organising a space research project at school (Figure 3-5).

Figure 3: **Conceptual representation: The impact of educational initiatives on the readiness to participate in space tourism in the aspect of educational initiatives**



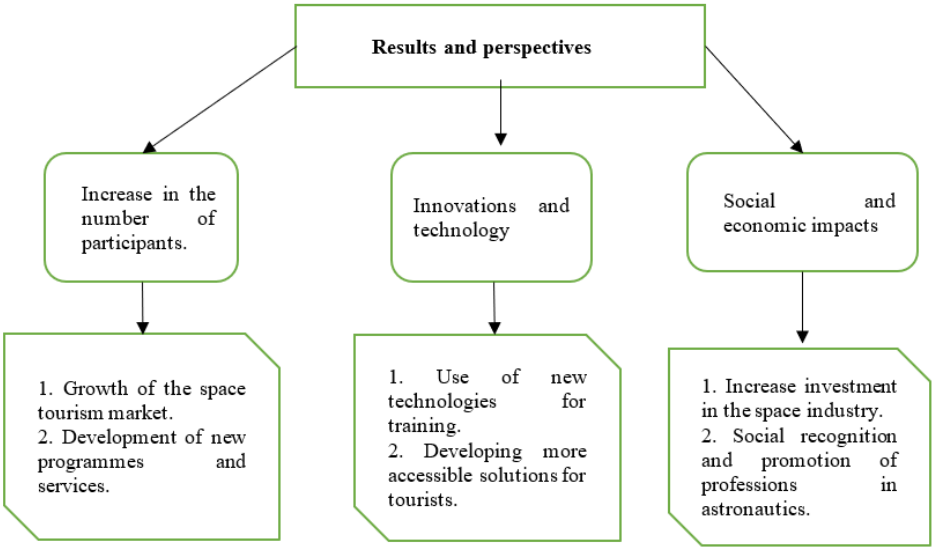
Source: compiled by the authors.

Figure 4: **Conceptual representation: Impact of educational initiatives on readiness to participate in space tourism in the aspect of impact on people's readiness**



Source: compiled by the authors.

Figure 5: **Conceptual representation: The impact of educational initiatives on people's readiness to participate in space tourism in terms of results and perspectives**



Source: compiled by the authors.

The analysis revealed that educational initiatives exert a measurable, multidimensional influence on readiness for space tourism, with academic programmes and specialised courses significantly enhancing cognitive awareness and emotional engagement. Experiential learning through simulations and agency partnerships proved decisive in building psychological readiness and self-efficacy, while media campaigns broadened societal awareness and normalised civilian spaceflight. Collectively, these interventions increased awareness of risks and opportunities, motivation for preparatory activities, and interest in STEM fields, resulting in quantifiably higher readiness levels among participants. These outcomes correlate with growing market demand for space-related services and underscore education's role as both a catalyst for individual preparedness and a driver of sector-wide investment and sustainable growth.

Additionally, it is necessary to stimulate students' creativity and research approach by conducting space-related science experiments and competitions. It is also necessary to use modern technologies, such as virtual reality or online courses, to enhance students' knowledge of space. It is also necessary to raise awareness among teachers about the importance of space education and support them in encouraging students to study space-based learning materials. Together, these strategies can help increase interest in space travel and space exploration.

4. DISCUSSION

The above results give an idea of the impacts of educational programs and initiatives on the development of space tourism. The study helps define the concept of space tourism, reveals the main space programs, and highlights and deepens the importance of applying certain skills and abilities during space travel. The conclusions of the paper are of value and insight for practitioners and researchers.

The combined research by Mehran et al. (2023) on criteria used in previous developments in consumer psychology and market research fills an intellectual gap in the space tourism market. The main items included an interest in space travel, awareness of sustainability, and personal inclinations. The reasons for interest in space tourism can be favourable, in which case six variables measured on a Likert scale are considered, or conversely, in which case three variables measured on a Likert scale are considered (Toivonen, 2020).

Education is essential not only in increasing people's knowledge and interest in space but also in raising awareness of space technology and safety. Míriam Andrea et al. (2022) demonstrated that professional learning methods, through experiments, mobilise people's attitudes and awareness of sustainable development and influence their willingness to act in the future. Developing such critical thinking helps people to look at the development of space travel appropriately and understand not only the harms of space travel to the environment but also the diverse benefits that space exploration activities bring to resources. The Internet is the only source of foreign educational products, and even the product's content is only available online.

Davidian (2020) pointed out that the number of knowledge-sharing events, such as annual and periodic conferences, as well as HSSFP-focused events, is also growing. Analysing the findings of the study, the subsequent development phase describes a complex series of events that contributed to the development and maturation of suborbital transportation innovations. These challenges were difficult and included setbacks, mistakes, staff changes, partnerships, interactions with management and investors, changing goals, etc. The HSSFP stakeholders have actively accumulated and continue to accumulate many of the SEE resources needed to successfully create a space travel industry.

Several trends and perspectives are influencing the entertainment industry, which holds immense potential (Ismayilov et al., 2025). Efforts are underway to make space travel more accessible to a wider range of people. The development of reusable rockets and spacecraft, as well as efforts to reduce costs, will help lower the barrier to entry. This will allow more people to experience space firsthand and participate in enjoyable space travel.

Different types of review studies can be used to inform future research agendas, including structured systematic reviews (Snyder, 2019), meta-analyses (Barari et al., 2020), conceptual descriptive reviews (Paul et al., 2021), framework reviews, collaborative reviews (Chang, 2020) and descriptive reviews (Wang et al., 2021). A collaborative review brings together contradictory findings and supports new recommendations for a particular research area concerning specific methodological criteria and theoretical frameworks (Paul et al., 2021).

While current space travel capabilities remain limited, there is a growing interest in longer space missions. According to Myronov and Topornytska (2019), the growing demand for space travel will lead to the creation of special launch facilities and infrastructure. Several companies are exploring the concept of orbital hotels and long-term stays in space, which would allow visitors to experience a few days or weeks of life in a microenvironment.

Such long-term missions will provide a more complete space experience and further satisfy the adventurous spirit of space travellers. New horizons for space travel are opening beyond Earth's orbit, the moon, and deep space. Private companies, in partnership with space agencies, are striving to land on the Moon and explore it. Lunar tourism, i.e., sending tourists on lunar missions or to the lunar surface, is a promising project. In addition, space travel to asteroids and Mars may become a reality in the distant future.

For instance, Pomeroy et al. (2019) pointed out in their research that space travel will be facilitated by the creation and

expansion of space centres around the world. Spaceports will transform into hubs for space tourism, encompassing launch preparation, passenger services, and support services. It is important to add that technological innovation will continue to shape the future of tourism and recreational space travel.

Advances in spacecraft propulsion, material science, life support systems, and autonomy will contribute to safer, more efficient, and sustainable space travel. Holt (2023) emphasised that VR/AR/MR were used for spatial information dissemination and learning. In addition, advances in VR and AR can provide immersive pre-flight training and virtual space travel for those without access to space. Notably, the Quest 2 headset offers a free virtual experience called Mission: International Space Station. It offers a zero-gravity experience aboard the International Space Station, where it is possible to touch the controller controls and walk-through space while looking back at Earth.

Space Explorer: International Space Station Experience is also available in Quest 2. It is a series of VR videos shot by ISS astronauts using 360-degree cameras that visitors can watch for free to experience life on and off the ISS as it is. Dash and Dash (2023) believe that, in regions where space tourism is booming, this growth will drive job creation, innovation, and economic development.

Recreational space tourism is still in its infancy, but its future is promising. Continuous technological advancements, increased accessibility, and growing consumer demand will create an industry that provides transformative experiences and pushes the boundaries of human exploration.

CONCLUSION

International companies, private space companies, and some large corporations are investing hundreds of millions of dollars in the development of space technology, making it a trend for successful individuals. The value of the new concept of space travel shows that it is, first and foremost, the development of a technology that attracts new destinations in the solar system. The diversity of space programs and the demand for them attract private capital to space activities, create conditions for a competitive environment, and increase their momentum.

Educational programs play an important role in gaining knowledge about space and increasing interest in space technology and safety. Educational initiatives play an important role in preparing people to participate in space tourism. Space travel requires specific knowledge and skills, such as basic astronomy, physics, and engineering. Education about space travel can take many forms, and education about sustainable development in space museums and science centres has proven to be very effective. Thematic conferences and public outreach can also be effective, as space travel content is always attractive.

Education programs can help participants learn more about space, how spacecraft operate, and how to stay safe in the environment. Beyond the technical aspects, educational initiatives can also help participants better understand the cultural and philosophical aspects of space. These lessons can strengthen their understanding of the place of humans in the universe and inspire them to take part in space adventures.

Therefore, the development of educational programs and initiatives in the field of space tourism is of great importance in increasing people's readiness to participate in it. Such programs can enrich the knowledge and experience of participants, which in turn contributes to the development of space tourism and opens new perspectives in this area.

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