The New Educational Review

DOI: 10.15804/tner.2022.69.3.15

Joanna Pyrkosz-Pacyna
AGH University of Science and Technology, Kraków, Poland

Katarzyna Cieślak
AGH University of Science and Technology, Kraków, Poland

Marcin K. Zwierżdżyński
AGH University of Science and Technology, Kraków, Poland

Space Exploration Perception and Engagement Intention Among STEM University Students – Results from a Mixed Method Study

Abstract

Space exploration is currently gaining momentum. This interest is crucial for attracting students to space sciences. We present the results of a qualitative and quantitative study on space exploration perception among university students. Our study showed that participants are interested in space sciences, but their intention to engage in space education is low. Female and male students did not differ in terms of general attitude and interest in space and were equally (not) likely to engage in space education and career. Our findings have practical value for designing interventions to enhance students' engagement in space education.

Keywords: *space exploration perception, engagement intentions, space education, STEM students, mixed methods*

Introduction

Space exploration develops rapidly, inspiring interest and mixed feelings (Launius, 2003). For some, it is a crucial area of research, and for others an unnecessary expenditure with no direct social benefits. Previous research on social attitudes towards space exploration focused mainly on social support for public funding of national space agencies and showed that it depends heavily on age, gender, and

scientific literacy (Montecalvo & Larkin, 2018). However, the general population supports national space programmes, as shown by research in countries like the US (Pew, 2019) and China (Hines, 2022).

Additionally, studies found that people vastly overestimate how much public spending there is on space exploration (ESA, 2018). The other important aspect refers to engagement intention among students. Studies show that students are generally positive about the possibility of learning about space (Bergstrom et al., 2016). Students refer to space subjects such as physics as interesting and useful in their future careers (Reid & Skryabina, 2002) and that space sciences should be more important in a person's overall general knowledge (Ottavianelli & Good, 2002).

Nonetheless, space exploration is also considered extravagant and unnecessary. Space studies are considered difficult and suited only for the best and brightest (Bergstrom et al., 2016). Another often mentioned misconception regarding space sciences is the discipline's narrow view. It is related mostly to astronomy, physics, or mechanical engineering, whereas many more disciplines are involved in this field, such as biology, geology, informatics, telecommunication, medicine, psychology, law, and others.

The space sector is perceived as male-dominated, occupied by individuals with very high intellectual capabilities, and not accessible to most people. This perception will likely create a homogenous environment where only specific types of people are represented. In order to make space more inclusive, accessible and socially relevant, further studies on this subject are necessary.

In this article, we wish to present results from the mixed method study we conducted among university students. The study aimed to determine the general attitude towards space exploration and engagement intention in space. The gender differences were also investigated.

Qualitative Study

Method

The qualitative method we chose was focus group interviews (FGI). We conducted a total of six online FGIs (MS Teams platform) with people studying at a large Polish technical university, including students of technical faculties (two FGIs), students of a social faculty (two FGIs) and students involved in a space science club (two FGIs). A total of 33 people participated in the study, including 16 men

and 17 women. Each FGI lasted about 1.5 hours, was recorded and then fully transcribed. Participants agreed to be recorded. They received remuneration for participating in the study (in the form of university gadgets or financial gratification). The research received a positive evaluation from the Ethical Research Committee at our University. The encoded text data (transcripts of recordings) were analysed using the MAXQDA software. In quotes, M is for male, F is for female students, S is for social, T is for technical faculty, and C is for space club members.

Results

The results of the qualitative research are divided into two parts. In the first part, we present the respondents' answers to four thematic threads: associations with space, features of space research, reasons for space exploration, and the perception of working in the space industry. We present the intersectional themes in the second part, synthesising statements from various study parts. These themes are the exclusivity and inaccessibility of space research, opinions on ethical dilemmas related to space exploration, and the dynamics of space education.

Associations with Space

Three analytical categories emerged: people and organisations (i.e., Elon Musk, SpaceX, NASA), objects and bodies (i.e., telescopes, satellites, rockets, Moon, planets), and concepts and ideas which turned out to be the most abstract, combining both philosophical (spirituality, infinity, mystery, beauty, emptiness) and political (race, conquest, colonisation) themes.

Particularly noteworthy is the concept of space itself: empty, infinite, beautiful, huge or inconceivable, as in the symptomatic fragment below:

> The first thing that comes to my mind about the cosmos is that it is incomprehensible. When I venture into such space in my mind, I turn back because I conclude that it is so incomprehensible. I don't think I have a psyche to deal with this (F/S).

Features of Space Research

Three categories of features emerged: positive, ambiguous and negative. The positive category was dominated by benefits relating to both cognitive (interesting, fascinating, exciting) and utilitarian (ground-breaking, useful, necessary). A group

of features related to the activity (engaging, inspiring, thrilling, uniting). The category of ambiguous features was dominated by those showing the interdisciplinary, team/group and international nature of space research and its complexity. In the group of negative features, the notion of space research costs has come to the fore, which is well reflected in the following fragment:

> It seems to me they cost a lot of money, they cost a lot of time, a lot of human resources, a lot of mineral resources that are quite rare on Earth, and we send it into space (M/T).

The cooperation was ambiguously assessed because interdisciplinary teams require many skills in politics and communication. It is reflected in the quote:

> What separates us on Earth, whether we are talking about nationality, skin colour, sexual orientation or income, in terms of the conquest of space, we all go as one human race. The question is, is it reflected in reality? Most likely not, as with all myths (M/S).

Reasons for Space Exploration

The answers fell into three groups: cognitive reasons (satisfaction of curiosity, understanding the world, creating knowledge), practical reasons (problem-solving, technology development, profit generation, hypothesis verification) and those relating to the "dark side" of human nature (mainly about the lust for power and money). The topic of colonisation appeared. The respondents indicated both elements related to ecology ("colonisation as a response to a climate catastrophe), industry (colonisation as a supply of necessary raw materials), but also to politics and social issues, an example of which is the following excerpt:

> Even if you manage to colonise it, you won't be able to transport all the people. If there is a climate catastrophe or some other catastrophe on Earth, and some people will be able to move to another planet, then the rest will stay here. It will probably be those who cannot afford to relocate (F/C).

Perception of Working in the Space Industry

Work in the space industry has a dimension directly related to space itself and its exploration (missions, machines, people), a dimension related to skills and

activities of a technical nature (data analysis, engineers' work, mathematics and IT). However, it also has a social dimension (PR, media, management or business).

The respondents were also asked to link their fields of study with a potential job in the space industry. In the first round of answers, many people did not see a place for themselves in this industry. However, during the discussion, they began to see a broad spectrum of potential professions in the space area.

> Basically, IT and computers, too, were once viewed as complex, inaccessible machines that only people who had some supernatural knowledge could operate. The breakthrough was a computer for home use […] It seems to me that a similar type of revolution applies to the field related to space (F/S).

Unsurprisingly, members of the space science club most often saw themselves in the space industry. However, most of the respondents from this group have a very realistic approach to work, seeing in it a lot of elements common to any other industry (paperwork, routine, everyday activities). The respondents know that many ordinary employees are behind the great successes of NASA or SpaceX.

> The space industry is so wide that it is difficult to describe a typical working day for a person working in the space industry because it can be anything. From tests for future astronauts to engineering, or more business work (M/C).

Exclusivity of Space Research

One of the most interesting intersectional threads was the exclusivity and inaccessibility of space research. It was also one of the negative features of space research most often reported by the respondents. The exclusivity indicated by the respondents had several meanings:

- no local space research centre (*it just doesn't happen in my country*, F/S),
- high cognitive qualifications (*you must be terribly smart to deal with this*, F/S),
- high financial expenditure (*there is a lot of money, resources and not every country is able to create something like this*, F/S),
- life opportunities (*mainly women who are more burdened at home simply lack the time to explore this cosmic topic*, F/C).

The topic of exclusivity was mainly raised by women. Comparing students of technical faculties participating in FGI in terms of gender, it can be concluded that

men are much more willing to get involved in the space industry than women. Women suppress their own interests, despite the awareness of their qualifications and willingness to engage:

> When I was little, I was very interested, in fact I'm still interested in it, and I would like to work in this industry, but I don't think I would get there (F/T).

> I imagine that such things are associated with NASA, some high level, for such research they take the best. And frankly speaking, I don't think I'm good at it. I am quite ambitious, but I think that is too high level (F/T).

In turn, men are more proactive despite being aware of the industry's difficulties and the lack of local space centres.

> I want to target the space sector, so I'm getting increasingly involved. I am aiming to get myself somewhere in this space industry (M/T).

> Although I think that developing such a company in Poland may be difficult in terms of some aspects, I think that in other parts of the world it is possible, and at the same time I would not exclude that in the future; some people also had to at some point to start from scratch (M/T).

Ethical Dilemmas of Space Exploration

In addition to the exclusivity of space research, the ethical dilemmas of space exploration were the topics covered in various parts of the FGI. Students associated these dilemmas with four areas:

- ecology (the issue of space debris, the destruction of Earth's resources in order to explore space, *space can be reduced to such gadgets that Elon Musk does now, these are gadgets created at a high ecological cost*, F/S),
- politics (international competition, new cold war, *A society struggling with some problems, for me this is a bit distracting from what you have to do in the first place*, M/S),
- intentions (space research as PR in terms of „greenwashing," *despite the enormous contribution to space engineering, space exploration, I do not like it very much, that it is used by* [Elon Musk] *to cover, let's say, slightly less ethical aspects*, F/T),
- safety (health of space crews, making decisions about someone's life, *they*

> [China] *could go to Mars because it seems to me that it is just ethical for them to send man on one-way missions*, M/T).

Dynamics of Space Education

During the FGI, the topic of institutional space education also emerged. All respondents agreed that in educational institutions, space issues are not treated as seriously as they deserve.

> I have the impression that my knowledge of the space was the greatest when I was a child. I often got space-related books for birthdays or other occasions. When I went to elementary school, middle school or high school, space was not discussed in any classes other than physics (F/S).

Several students emphasised that the school did not encourage space exploration and that their knowledge of space subjects was mainly derived from popular science content, media and pop culture.

Discussion of the Results

Qualitative research has shown that students are interested in space and want to develop this interest, confirming previous research in this area. Students see the connection between their fields of study and the possibility of working in the space sector, especially going beyond the fields traditionally associated with space. Respondents pointed out that the development of the space industry sometimes comes at the expense of problems occurring on Earth. Some, especially women, emphasised that the space industry is not for everyone and requires high qualifications.

However, we found that men and women had similar associations with space, space research, reasons for space exploration, and ideas about working in this industry. On the other hand, gender differences regarding self-esteem associated with the possibility of engaging in the space sector turned out to be significant. Despite the awareness of their own qualifications and interests in this subject, women were more likely to see difficulties and potential obstacles, while men were more determined and proactively oriented.

An important issue in developing space interests turned out to be education. Students agreed that educational institutions should ensure higher quality and attractiveness of the knowledge provided on space subjects. Students expressed

their willingness to engage in space-related courses, similarly to previous studies (Marušić & Hadžibegović, 2018).

Quantitative Study

Methods

In the quantitative part of the study, we distributed an anonymous online survey among technical university Students. The study participants were offered a chance to win a financial reward by participating in a draw. Among participants who declared the wish to take part in the draw, we randomly chose 10 people and awarded them 120 PLN (25 euro). We included one attention check question in the survey and excluded all participants who failed the attention check from further data analysis. The total sample consisted of 152 participants, 77 males and 75 females. The research received a positive evaluation from the Ethical Research Committee at the Faculty of Humanities at our University.

In the study, we used the following materials to investigate the subsequent variables:

1. *General attitude* – we have adopted Ajzen's (2002) scale and asked participants to rate the extent to which space exploration is valuable, interesting, and beneficial, in their opinion. Four items, Cronbach's alpha = .89.
2. *Sense of social belonging* – we have adopted the scale by Good, Rattan, and Dweck (2012) and asked participants to provide answers to the question: *If I were to join an interdisciplinary space science club I would feel* with sample items: accepted, like I do not belong, respected, anxious. Eleven items, Cronbach's alpha = .91.
3. *Self-efficacy* – we have adopted the scale by Bandura (2006) and asked participants to evaluate to what extent they feel comfortable they would be able to: *Expand knowledge of space using popular science materials* or *Participate in a research project related to space exploration*. Eight items, Cronbach's alpha = .91.
4. *Goal affordance* – we used the goal affordance scale by Diekman et al. (2010) and asked participants to rate to which extent, in their opinion, work in space exploration domain enables achieving the following goals: power, recognition, achievement, status (agentic goals); helping others, serving humanity, serving the community, working with people (communal goals). The reliability of both scales was satisfactory (Cronbach's alpha = .78 and Cronbach's alpha = .76, respectively). The scale consisted of fifteen items.

5. *Importance of space exploration* – sample questions: *Space exploration is very important*, *Space exploration should be a priority for society*. Six items, Cronbach's alpha = .9.
6. *Relative importance* – we asked participants to rate if space exploration is more, less or equally important as various societal issues, for example, medical advancement, preventing climate change, decreasing air pollution, etc. Thirteen items, Cronbach's alpha = .83.
7. *Familiarity* – we asked participants if they were aware what several space-related organisations or recent events are, for example, NASA, ESA, Space Systems (students club at the University where the study was conducted), recent landing on Mars, recent landing on Saturn (which did not take place – two dummy questions were included in order to evaluate the trustworthiness of this self-reported scale). Seven items, Cronbach's alpha = .81.
8. *Facilitation/conflict* – sample questions in this variable were based on the evaluation of how much participants agree that: *Space exploration contributes to discovering solutions to many important problems of people on Earth* or *Space exploration leads to the neglect of important problems of people on Earth*. Six items, Cronbach's alpha = .82.
9. *Engagement intention* – we asked participants to rate how likely it is that they will get involved in the following possible ways, for example, by *following the development of knowledge about the space* or *taking part in interdisciplinary students conference on space subjects*. Nine items, Cronbach's alpha = .92.
10. *Difficulty* – we asked participants to rate the perceived difficulty of studying and working in space domain on a scale where 1 equals difficult, and 7 equals easy (Cronbach's alpha = .71).

We used a 1–7 scale in all measures, with 1 being the lowest and 7 the highest rating.

Results

The results were analysed using the R statistical software environment. In the first step, we calculated the mean scores for each variable and mean scores for male and female participants. The results of this analysis can be found in Table 1. The analysis showed that the engagement intention is low despite a generally positive attitude towards space exploration. Among participants, the familiarity and domain importance were not too high, and conversely, the perception of goal affordance (both communal and agentic) and goal facilitation were moderately high. The considerably low results in the studied sample were found for self-efficacy and

a sense of social belonging. Regarding gender differences, as Table 1 shows, we found statistically significant differences for many factors. Male participants had significantly higher self-efficacy, sense of social belonging, perception of space exploration importance, relative importance, and facilitation. Surprisingly, we found no differences between male and female participants regarding general attitude towards space exploration, familiarity with it and the intention to engage in the domain.

Next, we made the correlation analysis (Table 2). We found numerous factors correlated positively with the engagement intention: familiarity with the field, self-efficacy, and social belonging, but also importance, general attitude, facilitation, and to a lesser extent, communal goal affordance.

Table 1. Means, standard deviations and t-test for male and female patricipants

Variable	Female			Male					
	n	M	SD	n	M	SD	t	df	p
Attitude	75	5.9	0.76	76	6.1	0.85	-1.53	147.8	0.127
Familiarity	74	3.42	1.39	71	3.77	1.04	-1.74	135.3	0.084
Difficulty	75	2.09	1.07	76	2.33	1.26	-1.24	145.7	0.218
Communal goals	74	4.64	1.07	73	4.88	1.03	-1.38	144.9	0.170
Agentic goals	74	5.57	0.75	73	5.56	0.91	0.02	139.6	0.988
Importance	75	3.15	1.02	76	3.93	1.32	-4.02	140.9	0.000
Relative importance	75	4.01	0.99	76	4.36	1.16	-2.00	146.2	0.048
Efficacy	74	3.86	1.49	76	4.6	1.39	-3.14	146.5	0.002
Belonging	75	4.33	1.2	76	4.92	1.24	-2.99	149.0	0.003
Facilitation	75	4.86	1.06	76	5.49	1.02	-3.77	148.6	0.000
Engagement	74	3.25	1.46	71	3.66	1.43	-1.71	143.0	0.089

Table 2. Means, standard deviations and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Attitude	6.00	0.81										
2. Familiarity	3.59	1.24	.32**									
3. Difficulty	2.21	1.17	.05	.23**								
4. Communal goals	4.76	1.05	.52**	.21**	-.05							
5. Agentic goals	5.57	0.83	.42**	.11	-.15	.37**						
6. Importance	3.54	1.24	.47**	.39**	.22**	.41**	.18*					
7. Relative importance	4.19	1.09	.22**	.05	.03	.12	.07	.17*				
8. Efficacy	4.23	1.48	.34**	.47**	.29**	.25**	.18*	.40**	.24**			
9. Belonging	4.63	1.25	.49**	.46**	.13	.43**	.32**	.40**	.15	.52**		
10. Facilitation	5.18	1.08	.59**	.41**	.01	.46**	.18*	.62**	.24**	.28**	.49**	
11. Engagement	3.45	1.45	.39**	.66**	.32**	.38**	.14	.51**	.19*	.66**	.62**	.44**

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * Indicates $p < .05$. ** indicates $p < .01$.

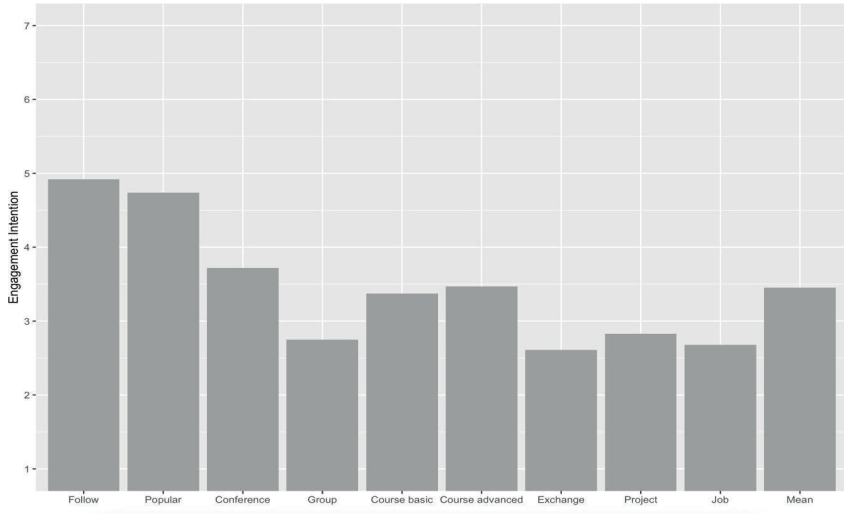

Fig.1. Engagement intention

Discussion

We found that the perception of space exploration is positive, and the domain is perceived as important even in relation to other socially important domains. However, we found that the intention to engage in various forms of space exploration was low among men and women in our sample. The least favourable form of engagement was joining the student's group or participating in international exchange, and the most likely were broadening general knowledge on the subject. These results show that even though there is an overall positive attitude towards space exploration among students, the attitude is not connected to the intention to extend engagement past basic interests. However, there is openness to participating in an academic course, either general or advanced.

We also found some gender differences. Men evaluated space exploration as more important than women and perceived it as more aligned with solving other earthly problems. The question remains if enhancing awareness of how space exploration facilitates solving important and difficult problems on Earth would raise the level of female appreciation of it. Interestingly, there were no gender differences in perceiving space exploration as affording communal goals, which additionally was rather high in the studied sample. This result is rather surprising but might stem from the fact that at the technical university, students are more

aware of the communality of technical occupations in terms of teamwork and the social importance of these domains.

We found self-efficacy in the domain to be higher among men in the studied sample. It is not uncommon that women's self-efficacy, especially in STEM, is lower than males' (Griffith 2010). Several studies previously showed that women do not feel they belong to STEM (Cheryan et al., 2017; Veelen et al., 2019), even those who already study at the technical university (Pyrkosz-Pacyna et al., 2019). Again – the interest is there, but the sense of own capabilities and fit might prevent female students from retaining a more open attitude towards education or a career in the space industry.

Other factors correlating with engagement intentions were familiarity, importance, general attitude and facilitation. Since, as we found, most of our subjects are interested in space sciences, providing opportunities for both male and female students to get more familiarised with this domain would be beneficial.

Conclusions

In the two studies, we found that there is already an interest in space exploration among students. Participants' attitude in the FGI and the survey was favourable towards the domain. It is a positive finding as usually, while looking for a way to engage students' effort is directed towards making said domain appealing. However, even though students find space relevant and interesting, they are not likely to extend their engagement. The reasons for that are not clear. Students do not foresee many career opportunities in this field in their surroundings (Poland or Europe). From a practical perspective, our participants do not want to invest in space education and instead treat it more like a hobby outside their career spectrum.

Previous studies focused mostly on younger kids (Pell & Jarvis, 2001), with some important exceptions (Afful et al., 2020). Additionally, most of the samples were collected in western countries. Our results can be used to plan interventions to enhance students' interest and engagement in space education and occupation. Therefore, future research in this area might also include innovative educational techniques like Problem Based Learning (Alexander & Bannova, 2021) or Virtual Reality (Noah & Das, 2021).

The space sector is expanding rapidly, and new career opportunities are appearing. It is well advised to gain a basic overview of the domain. Lastly, as with other disciplines perceived as complex and unattainable, space sciences ought to be portrayed as more open and egalitarian to avoid excluding those who usually feel

not competent enough to join in. These usually are women, minorities, people with disabilities, or people from modest backgrounds. In order to make this new frontier more diverse and inclusive, studies like ours might bring some useful information.

References

Afful, A. M., Hamilton, M., & Kootsookos, A. (2020). Towards space science education: A study of students' perceptions of the role and value of a space science program. *Acta Astronautica, 167*, 351–359. DOI: 10.1016/j.actaastro.2019.11.025

Ajzen, I. (2002). *Constructing a TPB questionnaire: Conceptual and methodological considerations*. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.601.956&rep=rep1&type=pdf

Alexander, S., & Bannova, O. (2021). University based interdisciplinary space lab: Designing for astronaut health and wellbeing. *Acta Astronautica, 186*, 382–395. DOI: 10.1016/j.actaastro.2021.05.043

Bandura, A. (2006). Guide for constructing self-efficacy scales. *Self-efficacy beliefs of adolescents, 5*(1), 307–337.

Bergstrom, Z., Sadler, P., & Sonnert, G. (2016). Evolution and persistence of students' astronomy career interests: A gender study. *Journal of Astronomy & Earth Sciences Education (JAESE), 3*(1), 77–92. DOI: 10.19030/jaese.v3i1.9690

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin, 143*(1), 1. DOI: 10.1037/bul0000052

Diekman, A. B., Brown, E. R., Johnston, A. M., & Clark, E. K. (2010). Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers. *Psychological science, 21*(8), 1051–1057.

ESA. (2018). *European Space Agency, Europeans and space activities*. Harris Interactive. https://esamultimedia.esa.int/docs/corporate/European_and_space_activities_Harris_results.pdf

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt-out? Sense of belonging and women's representation in mathematics. *Journal of personality and social psychology, 102*(4), 700.

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review, 29*(6), 911–922.

Hines, R. L. (2022). Heavenly Mandate: Public Opinion and China's Space Activities. *Space Policy, 60*, 101460. DOI: 10.1016/j.spacepol.2021.101460

Launius, R. D. (2003). Public opinion polls and perceptions of US human spaceflight. *Space Policy, 19*(3), 163–175.

Marušić, M., & Hadžibegović, Z. (2018). Student attitudes towards astronomy: A bi-coun-

try questionnaire results. *Revista mexicana de física E, 64*(1), 61–69. DOI: 10.31349/revmexfise.64.61

Montecalvo, D. R., & Larkin, T. L. (2018). Voices of the Millennial Generation: Connections Between Physics, Scientific Literacy and Attitudes towards Future Space Exploration. In 2018 ASEE Annual Conference & Exposition.

Noah, N., & Das, S. (2021). Exploring evolution of augmented and virtual reality education space in 2020 through systematic literature review. *Computer Animation and Virtual Worlds, 32*(3-4), e2020. DOI: 10.1002/cav.2020

Ottavianelli, G., & Good, M. (2002). Space education: a step forward. *Space Policy, 18*(2), 117–127.

Pell, T., & Jarvis, T. (2001). Developing attitude to science scales for use with children of ages from five to eleven years. *International Journal of Science Education, 23*(8), 847–862.

Pew Research Center. (2019, October). *Public Expresses Favorable Views of a Number of Federal Agencies*. https://www.pewresearch.org/politics/2019/10/01/public-expresses-favorable-views-of-a-number-of-federal-agencies/

Pyrkosz-Pacyna, J., Szastok, M., & Dukała, K. (2019). Men and Women on the STEM track. Similar or diverse. *Studia Humanistyczne AGH, 18*(4), 31–44. DOI: 10.7494/human.2019.18.4.31

Reid, N., & Skryabina, E. A. (2002). Attitudes towards physics. *Research in Science & Technological Education, 20*(1), 67–81.

Van Veelen, R., Derks, B., & Endedijk, M. D. (2019). Double trouble: How being outnumbered and negatively stereotyped threatens career outcomes of women in STEM. *Frontiers in psychology, 10*, 150. DOI: 10.3389/fpsyg.2019.00150

AUTHORS

PYRKOSZ-PACYNA JOANNA

PhD, AGH University of Science and Technology, Faculty of Humanities, Kraków, Poland
e-mail: jpyrkosz@agh.edu.pl
ORCID: 0000-0002-9112-8629

CIEŚLAK KATARZYNA

AGH University of Science and Technology, Faculty of Humanities, Kraków, Poland
e-mail: kcieslak@agh.edu.pl
ORCID: 0000-0002-5539-4313

ZWIERŻDŻYŃSKI MARCIN K.

PhD, AGH University of Science and Technology, Faculty of Humanities, Kraków, Poland
e-mail: marcinz@agh.edu.pl
ORCID: 0000-0003-4248-5897