Acta Astronautica 219 (2024) 91–96

Contents lists available at ScienceDirect

Acta Astronautica

journal homepage: www.elsevier.com/locate/actaastro

Need for an education model for adolescents, specifically in rural areas

Sri Venkata Vathsala Musunuri

Department of Aerospace Engineering, Polytechnique Montreal, 2500 Chem. de Polytechnique, Montréal, Quebec, H3T 1J4, Canada

ARTICLE INFO

Keywords:
Aerospace
Education
Students
Data-evaluation
Impact
Action-plans

ABSTRACT

Secondary and High School students are usually adolescents, most of them in the urban areas and metropolitan cities are aware about the existence, various opportunities, career paths and advancements of the space industry. They are constantly updated, given they have access to quality and organized education models and a competitive environment. Although, the students in the rural areas who are equally ambitious and talented yet are not fortunate enough to have access to the state of art facilities like the counterparts. Even if they try and gain access with their self-interest, they do not have the motivation to sustain the passion, given their lack of clarity in subject, lack of awareness about engaging in various ways and fields in space other than technological related and mainly lack of driving force. The purpose of this paper is to develop and present an education model, exclusively for the high school students of the rural areas and inculcate sustainable passion for space. As opposed to the primary school students, the secondary school students have a consciousness of the space industry. This paper will talk about various plans and strategies, that will allow them to gain exposure, guide them about the existence of different career paths which are not entirely technological related, yet are still essential in the space like, administrative framework for example. This opens a new dimension in their brain helping them realize how they can be part of the industry in countless ways, and this shall assist them in being on the right track to space. In addition to, hosting creative space themed exhibitions, fun and engaging model design competitions, workshops, all of these would widen their knowledge boundaries and help them challenge their skills. A real time case study example from a school located in the rural southern of India shall be focused on this paper. Including data from a survey thereby the results, with action plans shall be presented in detail, which will aid in the analysis of the need, feasibility, and long-term sustenance of this approach and the requirement to scale it over different rural areas globally.

1. Introduction

The space industry doesn't only involve the design, fabrication and launching rockets, satellites, and space shuttles with astronauts training to land in the outer space. The diversity and depth of this industry is under glorified, and its research that amalgamates various other industries into the picture, is often undervalued or overvalued from the minds of developing or the rural populace. Often, the demographic of this industry is perceived and preconcerted to be elite and unsociable to the general public's reach [1]. Because of this, the commoner's opinion is aligned with pursuing a career in alternative and mainstream occupations. Subsequently, this restricts and narrows the children and young demographics' imaginative mind space. This startles the author, given the alarming situation of the lack of awareness and consequently, a significantly lower interest of space in the young blood.

This paper will present, how the author tries to substantiate the need for an education model that would add space to the curriculum. The author conducts two surveys for students, ages 10 through 16 that fall under the adolescent category. One, for students aged 10 to 12 and the other, for students aged 13 to 16. Both are customized to the cognitive and academic levels of the students to their corresponding age in order to create a robust basis, that stands in need for a revamp in the pedagogical practices in schools of the rural India.

The author carries out this survey in two different demographics setting, one in a school which has access to a reasonably high margin educational standards and the other from a completely rural school that only has access to basic education or the bare minimum.

Consequently, the author believes, this allows a viable comparison, and the data will help us establish and highlight the desideratum of the proposed framework. Post survey, the author also brings into light how the global Pandemic, Coronavirus disease 2019 (COVID-19) has affected the current students' aspirations.

Adolescent Students are our significant potential of tomorrow's space industry. Inclining their primary focus, towards educating and

E-mail addresses: sri-venkata-vathsala.musunuri@polymtl.ca, srivenkata.vathsala@gmail.com.

https://doi.org/10.1016/j.actaastro.2024.02.029
Received 6 January 2024; Received in revised form 15 February 2024; Accepted 21 February 2024
Available online 8 March 2024
0094-5765/© 2024 The Author. Published by Elsevier Ltd on behalf of IAA. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

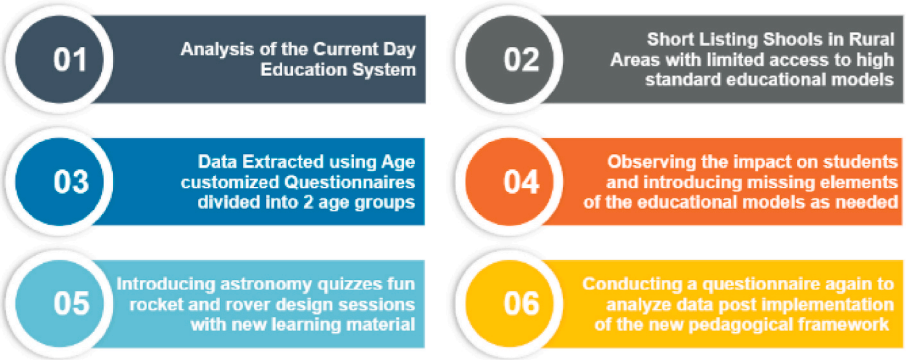

Fig. 1. Overview of the paper structure and analysis model carried out.

evolving their thoughts would help us create an impactful mindset shift in future. Let alone, university students taking up space as their career interest might not result in optimal growth of the industry. Whereas, sparking the young minds by creating awareness of the existence of various space fields like astronomy, rocket science, space law, space medicine, would drastically impact the number of students considering space as their career. As the world-famous scholar, Albert Einstein says "Imagination is more important than knowledge" [2] specially for young minds whose knowledge would be limited, yet when indoctrinated through imagination the same young minds would relish the existence of the realm of astronomy and aerospace. As the author believes that from the young engineers to the space leaders, images produced through space programmes are constantly evoking passion and motivation in the daily work [3].

This paper discusses, various creative changes and unique additions to the current day curriculum that are fun, stress free, experimental, imaginative for the student's mind which are anticipated to be enjoyed by the student's mind at the same time, they will be gaining the basic and sufficient awareness about the industry. The uniqueness of the proposed framework is that it stems from the responses given by the students themselves. Progressively, the author portrays, how the collaboration between schools and emerging space education companies would create a two-way benefit and thereby bloom the industry in cross functional pathways.

2. Conceptual framework and methodology

In this section, the author talks about the specifics why and how the data analysis was carried out in detail. A thorough conceptual methodology was drafted, before conducting the surveys keeping in mind, various aspects and stages of the methodology and constraints given like, gaining access to students and schools or a particular school of choice. Provided below is the overview of the analysis model in brief in Fig. 1.

A set of two schools were selected by the author one which the author is an alumnus herself which is, Indian School Al Ghubra (ISG), located in Muscat, Oman, in one of the middle eastern countries of Asia. The other school being, Zilla Praja Parishad (ZPP) school, Hamsavaram (HVM), which the author had picked was in the southern rural India, which had access to the most basic or bare minimum education, at which the authors parents were the alumni.

The inspiration to choose this school stems from an event dating back to January 2021 where the author had given a motivational talk to the grade 10 students of Zilla Praja Parishad (ZPP) school the author noticed how there was no consciousness of space education.

The author's parents annually host and sponsor an award ceremony in recognition of excellent academic achievers, for top three grade 10 students to motivate their will to study hard, excel and walk out of the school to higher educational

Fig. 2. Headmaster of the school on the left most, along with students holding cheques and certificates along with the author's mother in the centre in the year 2021 on the Republic Day of India.

Fig. 3. Author along with her mother and school students post the award ceremony.

Institutions. Figs. 2–4, show us a glimpse of the award ceremony for excellent academic performers of the year 2021 and the students gathered for the ceremony.

The author had access to high quality and standards of education

Fig. 4. Focused Students while giving a motivational talk on the right picture.

Table 1
Lists the corresponding number of students and their age groups for categorizing the questionnaires.

S.No	School Name	Grade	Age range	Age Group
1	I·S.G	7	11 to 13	Group 1
2	Z.P·P HVM	6	10 to 13	
3	I·S.G	9	13 to 15	Group 2
4	Z.P·P HVM	10	14 to 16	

Table 2
Lists the corresponding number of students and their age groups for questionnaire 1.

S.No	Title	I·S.G	Z.P·P HVM
1	Grade	7	6
2	Total No. of Students	44	32
3	Age 10	0	5
4	Age 11	12	12
5	Age 12	30	13
6	Age 13	2	2

throughout her life whereas her parents did not and many students across the globes situated in rural areas don't. The author wanted to gain perspective of the current day education levels, student aspirations and goals to critically analyse the break-even points and come with the right educational models which are simple to execute and that do not require much government or stakeholders' involvement.

Another viable reason to pick these two schools as case studies are, the author has an experience of the environment of the school, the curriculum, the familiarity of the activities that take place throughout the academic year and the demographics of the students that attend the schools are also kept in mind. This helped the author to critically evaluate and come up with questions.

3. Design and structure of the questionnaire

As the primary focus is on adolescent young students, they were divided into two groups based on their age and were handed out two customized questionnaires for two different age groups as mentioned in Table 1 below. The questionnaires were handed out to grade 7 and grade 9 students in Indian School Al Ghubra (ISG) and to grade 6 and grade 10 students in Zilla Praja Parishad (ZPP) based on their availability and exam schedules.

The total number of students who took the survey in ISG were 84, out of which 44 were, grade 7 students and 40 were grade 9 students, which was slightly higher than the total number of students that answered the questionnaire in ZPP. The total number of students were 62, with 32 in grade 6, and 30 in grade 9. The detail split up age wise, grade wise and school wise is listed in Table 2 and Table 3 below.

Table 3
Lists the corresponding number of students and their age groups for questionnaire 2.

S.No	Title	I·S.G	Z.P·P HVM
1	Grade	9	10
2	Total No. of Students	40	30
3	Age 13	11	0
4	Age 14	28	4
5	Age 15	1	19
6	Age 16	0	6
7	Age 17	0	1

The questionnaires were kept simple yet thought inducing, included questions pre-dominantly that had straightforward answers like, yes or no and few of them with writing one or two sentences and filling in with one or two words.

3.1. First set of questions for ages 10–12

The first set of questions included were, about their future goals, their current hobbies, interests and to test their participation in activities like science exhibitions or watching space themed cartoons or reading any science magazines. To test cognitive engagement, the author had specifically included a question that connects with, the students' cognitive ability to an inspirational thought process which was about, what movie or fictional character from books or Television shows that might have intrigued them. The cognitive engagement in classroom is interlinked to motivation of the student and induces a self-regulated learning processes [4]. These questions were included to get an overview of the students'

Aspirations and future goals like what their dream goals are like, without influencing them about space or any related domain as such, in the first half of the questionnaire. The original questionnaire is included in Appendix B.1.

3.2. Second set of questions for ages 10 - 12

The second set of questions were completely straight forward, asking the student if they want to know more about planets its properties, and if they wanted to become an astronaut when they grew up and if they would enjoy going on more field trips to space museums or planetariums and if they wanted to build rockets and satellites. Also mentioned a question that asked for names of two famous who inspires them in daily life, for which some interesting answers were given, which shall be discussed under the outcomes section 4. The exact questionnaire is included in Appendix B.1.

3.3. First set of questions for ages 13 - 16

The first set included questions like, their dream goals and things they are passionate about, which was common to both age groups. Then came questions like, "does your educational institution create sufficient awareness about the aerospace industry" and "do you know that you can be part of the industry without essentially having technical or STEM background". The first set ended with this question, "have you ever taken part in any astronomical quizzes or science Olympiads, if yes mention names." The original questionnaire is added in Appendix B.2.

3.4. Second set of questions for ages 13–16

For the last set of this age group, questions like, if they had built any

Table 4
Shows the percentage distribution of student aspired occupation in both the schools for age group 1 and 2.

Questions	ISG	ZPP HVM
What is your dream goal? What do you want to be when you finish school?	4% Astronaut or space related 5% Artificial Intelligence 17% Engineering 12% Business 49% Doctor and healthcare 10% Literature and Arts 3% Did not know	30% Army 30% Police 10% Teacher 2% Lawyer 23% Doctor 5 % Other

CubeSat/satellite/rocket/rover challenges or had attended related workshops were asked. Furthermore, any fictional character who they associate themselves with, was also asked. Another question about the consciousness of the astronomy, rockets and aerospace industry was asked, which implied, if they had more awareness in this domain, would they have different goals than their current ones, which may be inclined with this industry.

Furthermore, the questionnaire was ended by asking, two creative questions, which would make the students think and answer uniquely from their current apprehensive imagination. Out of the two, one was related to, designing as a hobby, meaning, if the children enjoyed building and designing new things with innovation in the science domain. The other, that is the last question was, "if they are the chief decision maker of the educational institution, how would their ideology to include space as a curriculum be?", for which some astonishing answers were recorded by the students of ISG, which will be discussed under the results section 4.2. The original questionnaire is to be found in Appendix B.2.

4. Survey outcomes for age groups 1 and 2

On a bigger picture, the survey results were dispersed, yet ISG, had an upper hand in comparison two ZPP but still could use a degree of curriculum advancement when compared globally, given their access to world class education, the students responses and ideologies were clear and crisp, even though more than 70% were not interested in the industry they suggested some really considerable ideas and ways to include space in the curriculum and they wanted to explore more through activities, workshops, through fun design or astronomy related classes on weekly basis.

Subsequently, as anticipated, the responses from ZPP school were not very favourable to the fulfilment of the awareness of the industry as most of the students lacked the basic framework and overview of the industry, 100% of their responses to the future goals question, were straight forward and mainstream occupations as we disused and suspected in the introduction of this paper become a police official, doctor, join the army or a computer science engineer or a teacher at school, unfortunately none of their responses included any direct relation to the industry.

4.1. Results of questions

After assessing and evaluating the data numerically for both the schools and analysing the responses given by the students, it was comprehended that, since the students of ISG had access to advanced pedagogy structure they were aware about the existence of the various industrial and occupational fields in grade 9 itself. However, the students of grade 10 from ZPP.

HVM only had the basic awareness of their career opportunities given access to only a remote and primitive education model. Table 4 and Table 5 show detailed comparison on numerical basis.

Table 5
Indicates the percentage split up of responses answered by students' school and question wise, for age group 1.

Questions	ISG	ZPP HVM
I want to know more about planets and their properties. (Yes/No)	59% Yes 41% No	92% Yes 8% No
I want to learn how to build rockets and satellites! (Yes/No)	81% Yes 19% No	100% No
I want to become an astronaut when I grow up! (Yes/No)	6% Yes 94% No	100% No
I want to go on more field trips to planetariums and learn more about astronomy (Yes/No)	95% Yes 5% No	100% Yes
Participated in quizzes related to science, astronomy or taken the astronomical Olympiad or exhibitions? (Yes/No)	8% Yes 92% No	100% No
I want to work in companies like National Aeronautics and Space Administration (NASA) or Indian Space Research Organization (ISRO) one day! (Yes/No)	30% Yes 70% No	Did not know the existence of these organisations

Table 6
Indicates the percentage split up of responses answered by students' school and question wise. Common to both age groups 1 and 2.

Questions	ISG	ZPP HVM
Name two famous personalities who inspire you or you look up to.	Elon Musk Sudha Murthy Cristiano Ronaldo APJ Abdul Kalam Steve Jobs Jeff Bezos Neil Amstrong Albert Einstein	APJ Abdul Kalam Satish Dhawan

As we can see in the above Table 5, the students from ZPP HVM, due to lack of awareness, they had answered some questions with no interest and didn't know the meaning of some questions so had to answer them a "No" instead. In contrast, the students of ISG had sufficient awareness, consequently they knew the meaning of and gave it a thought, if it was relevant to them or not and then responded with an answer. The same situation is observed with Table 6 as well, the students of ISG were able to name many famous personalities all over the world in different fields and industry, but due to restricted knowledge boundaries the students of ZPP HVM, were only able to name two famous personalities both, being national level figures. This consciousness is seemed to be missing the students of ZPP HVM, school and is

Anticipated that it will be missing in other schools of rural India as well. As part of future the author plans to collaborate with more educational institutions and government to execute the action plans proposed.

5. Impact and discussion of the outcomes and proposal of action plans and pedagogical framework

Now, that we have seen how drastically the situation is devastating for the students in rural areas, how can we cope up with this and come out of the dark place and how do we improvise the curriculum? This section will present intricate pathways and action plans for age group 1 and age group 2 separately, and a common action plan for both the age groups combined will be proposed in conclusion.

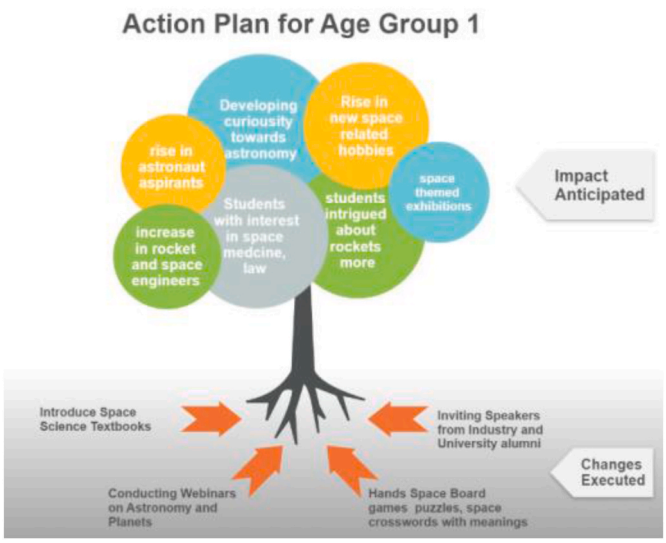

Fig. 5. Action plans for Age group 1 students.

For the second set of questions asked for group 2, about suggesting changes to the current pedagogy model to, the students of ISG gave diverse and exciting answers to the questions given their broad knowledge bar.

The inability of the students of ZPP HVM, to give a specific answer to the question "what advancements should be made" shows how they lack in cognitive though process when compared to the ISG students.

Many students at ISG, had given specific and detailed ideas like integrating astronomy to daily curriculum through library session, quizzes, learning projects, astronomy book fairs and most of them had suggested to create space as a 6th subject given their curriculum currently operates with 5 subjects. They also mentioned about bringing, in university alumni and professors from various colleges and universities, if possible, to give seminars and webinars or conduct remote interactive sessions. Whereas the students of ZPP HVM have given a unanimous and a monotonous answer, which being "update schools and update educational system" which was very unfortunate to witness.

We can observe how not only access to advanced educational models affects the numbers but also, attain knowledge as to how the cognitive development plays a vital role in the student's ability to perceive visual, spatial, audio and environment around them [5]. In order to counter and surpass the current situation the action plans for different age groups are proposed in Figs. 5 and 6 below.

As we can see from Fig. 5 the action plan for age group 1 students who are grades 6 and 7, where it mentions about inviting student alumni this can be broadened to a possible similar an existing model as an example, referenced in Ref. [6], that is about graduate students from Massachusetts Institute of Technology (MIT) collaborating with grade 7 students as a part of the MIT Zero-G outreach initiative in order to help students experience and engage with parabolic flight and learn further about the design process.

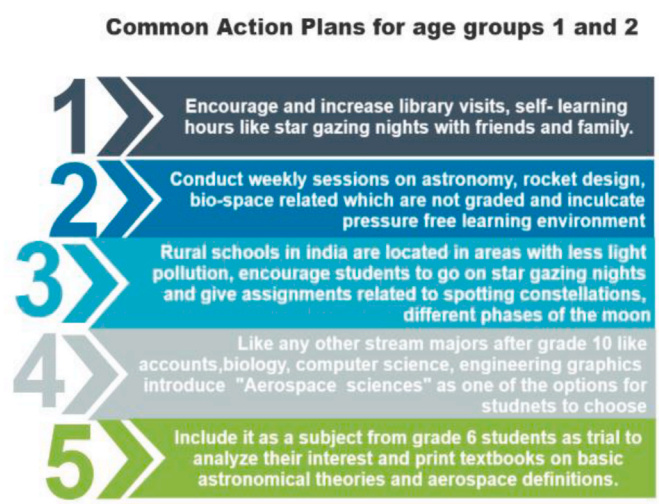

Fig. 7. Combined Action plans for Age group wise.

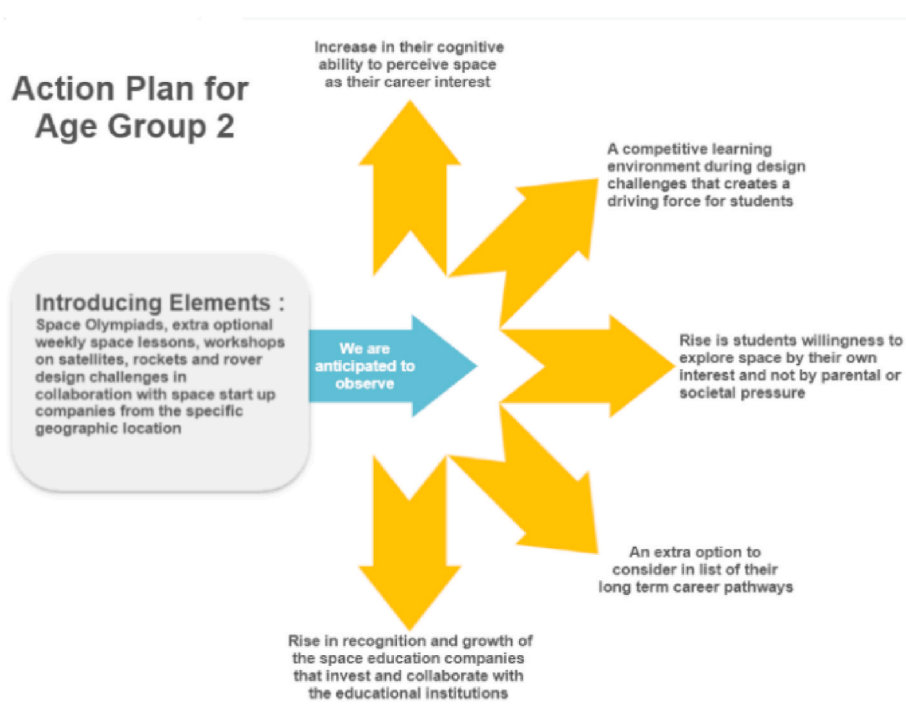

Fig. 6. Action plans for Age group 2 students.

6. Conclusion

In Conclusion, we have acquired the data, analysed, and evaluated the impact of the data and delivered the action plans profoundly. Since, we are standing at how unfavourable it is, for the growth of the industry. Soon we hope to see a headway in the rural areas given the through and successful implementation of these pedagogical models, inclusive to the combined action plan proposed in Fig. 7.

The action plans suggested above are to foresee and motivational classroom environment as described in Ref. [7], both for the teachers and students which would be the basic driving force for a heightened and magnified consciousness of the space education in everyday curriculum. This action plans can be useful to any educational institution or schools irrespective of urban and rural given their authenticity to customized and iterate depending upon the deliverables available at hand.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The author sincerely acknowledges the support and cooperation provided by the principal of Indian School Al Ghubra, Muscat, Oman, and the headmaster of Zilla Praja Parishad (ZPP) school, Hamsavaram, India for smooth organization of the survey in both the schools. Also, thankful to both my parents who helped mobilize and organize the hardcopies of the questionnaire sheets, at different geographic locations in short duration of time.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actaastro.2024.02.029.

References

[1] G. Ottavianelli, M. Good, Space education: a step forward, Space Pol. 18 (2002) 117–127.
[2] Nucleus_AI, Einstein's Insight, How Imagination Drives Human Achievement, 2023. https://yourstory.com/2023/05/transformative-power-imagination. (Accessed 11 June 2023).
[3] Pierre Comte, Sharon Lipsey, Philippe Willekens, Space art and education, Acta Astronaut. 41 (4– 10) (1997) 701–705, https://doi.org/10.1016/S0094-5765(98)00068-X. ISSN 0094-5765.
[4] Lyn Corno, Ellen B. Mandinach, The role of cognitive engagement in classroom learning and motivation, Educ. Psychol. 18 (2) (1983) 88–108, https://doi.org/10.1080/00461528309529266C.
[5] G. Vavoula O'Malley, J.P. Glew, J. Taylor, M. Sharples, P. Lefrere, P. Lonsdale, L. Naismith, J. Waycott, MOBI Learn Wp4–Pedagogical Methodologies and Paradigms, D4.1 Guidelines for Learning in a Mobile Environment, 2005.
[6] C. Paige, F. Ward, D.D. Haddad, J. MacNeil, P. McGaffigan, A. Ekblaw, D. Newman, MIT Zero-G outreach initiative: using experiment design and virtual reality to inspire the next generation of space scientists and engineers, Acta Astronaut. 212 (2023) 152–159 (3) Etc.
[7] P.R. Pintrich, A motivational science perspective on the role of student motivation in learning and teaching contexts, J. Educ. Psychol. 95 (4) (2003) 667–686.