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Space age education**Introduction**

The practical space age began in the 1950s. Its origins are well known. It is generally accepted that the broader concept of modern space commercialization emerged at the beginning of the 21st century [3]. Development will continue in both the civilian and military spheres, as evidenced by the works included in this issue of "Przegląd Komunikacyjny" [1, 2]. A new industry is developing before our eyes. Countries wishing to build this type of business must not only provide adequate financial resources but also contribute to the training of human resources in the field of advanced technologies.

The development of space education in Poland to date has been spontaneous. Pioneers recognized emerging opportunities and undertook initiatives based on existing knowledge from other areas of human education and activity. For example, during a classic graduate seminar at the Faculty of Mechanical Engineering at Wrocław University of Science and Technology, "Future-oriented" fields of study were defined. In 2000, one of the graduate students at the time became interested in space issues and, along with colleagues from other institutions, became a founding member of the "Mars Society Polska," originally established by Robert Zubrin from the USA in 1998, focusing on Mars colonization and exploration projects. The then-student is currently among the founding members of the Mars Society.

Ten years later, the first private space companies began to emerge in Wrocław. Brave pioneers emerged, independently acquiring knowledge and financial resources, organizing teams and employing students and graduates from various fields of study, relying largely on space enthusiasts. Student training continued in parallel with the development of the companies. Today, we already have structures in space. The pioneering period is over. The time is coming for a broader, more systematic introduction of space topics into education.

Changes are also taking place in current growth centers. During a visit to Stanford University, the supposed capital of Silicon Valley, students were introduced to modern robotics competitions for high school students. This is preparing students from San Francisco and the surrounding area for universities and, later, for NASA space programs and private companies.

On the other side of the world, in China, primary school students are developing space robot projects, as evidenced by the work of Chinese children at the 2021/2022 Expo in Dubai, where the China pavilion showcased the work of Chinese children. During the International Astronautical Congress, which took place at the same time, several thousand participants from around the world were able to see these works. It's also worth noting that Chinese children are now familiarizing themselves with AI technologies from a very young age, just like children in the United States.

Based on these signals coming from both growth centers, this study presents some of the experiences gained in our country in the field of space education, as well as considerations that can be used in teaching not only by teams operating in Lower Silesia.

Selected trends in education

There are many studies on the development of education. This study will present ideas related to technology in its broadest sense. The choice is dictated by the fact that Poland is already the 20th largest economy in the world. Entering the top 15 will be possible provided that we maintain development comparable to what we have achieved over the last 30 years, taking into account global trends. Therefore, our choice is primarily related to further development in the field of technical sciences, which, as is widely known, are ahead of other fields [5, 6, 7, 8]. Regardless of culture, country, or part of the world, STEAM (Science – Technology – Engineering – Art – Mathematics) education is currently considered paramount to the further development of civilization. Sometimes, the development of TED (Technology – Entertainment – Design) is also discussed.

It is obvious that other areas, such as creative problem-solving techniques, teamwork, and healthy competition in areas related to new technologies, etc., contribute to significant development. However, they will not be considered here.

With decades of experience in technical creativity at the university level, following the example of top American technical universities such as Stanford and MIT, similar efforts were undertaken in Poland over 20 years ago to collaborate with schools. Some of these experiences are described below.

Examples of teaching experiments

Teaching and the time to implement innovation

Based on collaborations with companies such as TUV, Mercedes-Benz, Volkswagen, 3M, Porsche, and KGHM, more general conclusions can be drawn. Researchers' activities generally require rapid, effective implementation at the highest global level, ensuring the company's leadership in a specific area of activity. Implementation time should be short.

In the case of our students, we prepared them during their final years of studies to develop the companies they would join or to found their own academic companies in entirely new areas. This happened in the space industry. In this case, implementation and immediate success were virtually impossible. It took pioneers three to five years to achieve progress and significant success.

It is known that in the case of secondary schools, it is generally necessary to prepare young people for work more than 10 years in advance of completing school and higher education.

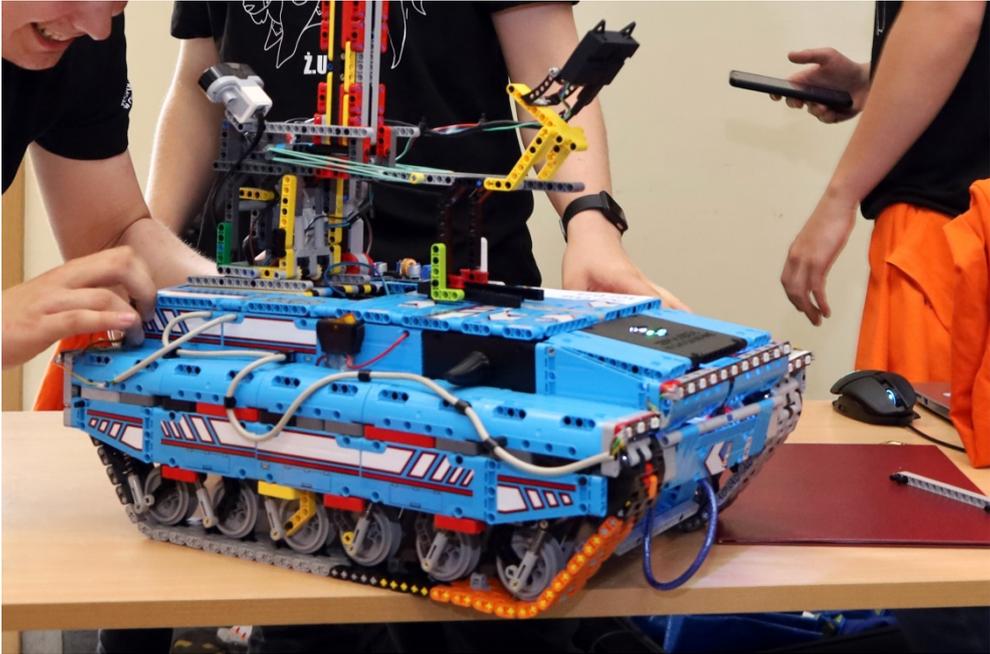
In the case of the first grades of primary school, this period is already over 15 years.

It is obvious that teachers do not have knowledge that far into the future.

Let us also remember that over the last half-century, there has been a transfer of knowledge in technical sciences, as shown in Figure 5.



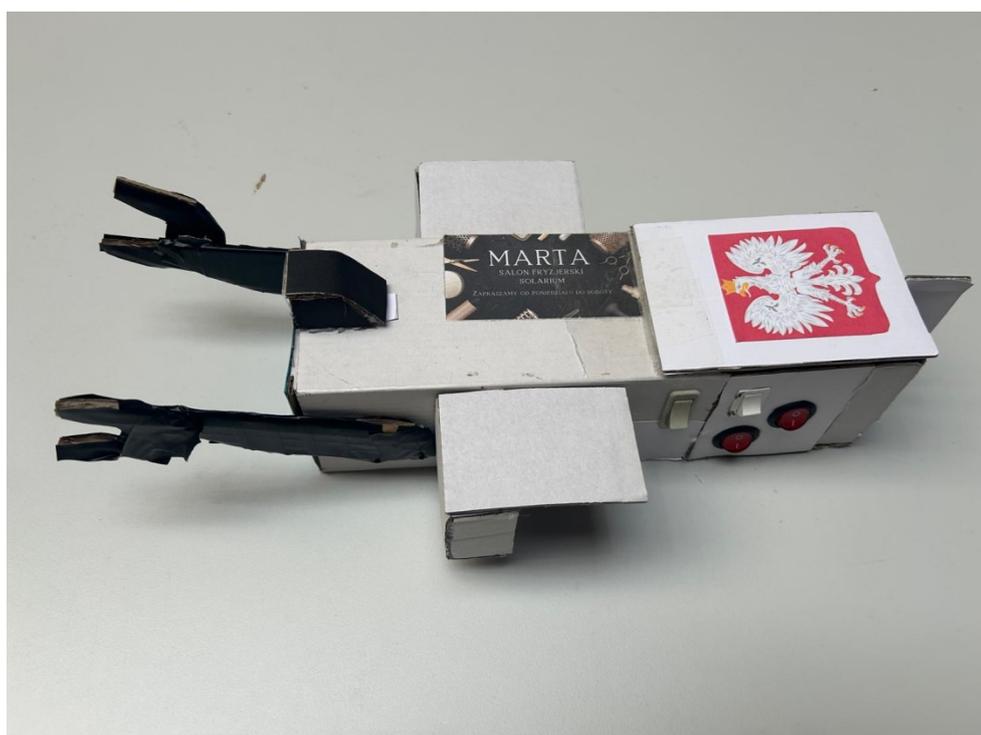
1. Collegium Witelona



2. Collegium Witelona



3. Collegium Witelona



4. Instytut Inwentyki

SPACE, AVIATION →, AUTOMOTIVE INDUSTRY →

5. Classic knowledge transfer



6. Instytut Inwentyki



7. Instytut Inwentyki

This transfer resulted from significant financing of space issues by state entities, and the use of technology took place in other sectors of the economy, including large-scale production.

Currently, in the era of space commercialization, companies are leveraging other areas of human activity and transferring knowledge in the opposite direction, i.e., to the space industry, for example, significantly reducing unit production costs. Therefore, the development and accelerated commercialization of space require a different approach to education. Linear development will take too long. A parallel model is required.

A description of sample activities is included in the next part of this text.

A Brief History of School Robotics [4]

This chapter presents milestones related to the general development of robotics (items 1-16) and, in more detail, practical activities in the field of school robotics (items 17-36), carried out in Wrocław, Lower Silesia, and finally throughout the country. It is clear how the transition from classical robotics to space robotics took place. This process took over 20 years.

1. Review the MITI reports on the future of robotics (Oxford 1985).
2. Initial design of a Polish autonomous vacuum cleaner based on the "Zelmer" brand (1992).
3. Design and construction of the first Polish autonomous robot "Wrocławik" (2004).
4. Design and construction of the first Polish anthropomorphic robot "Prof. Wrocławski" (2006).
5. Construction of a laboratory for collaborative autonomous robots at the Department of Vehicles of the Faculty of Mechanical Engineering of the Wrocław University of Science and Technology (2007-2010).
6. Construction of nanosumo, minisumo and sumo robots (2011).
7. Visit to Stanford University and NASA (2012).
8. The first Polish Autonomous Vehicle based on the Toyota Yaris car (2012).
9. Successful participation in the robotics competition in Vienna (2013).
10. Construction of a dual system: autonomous car + autonomous drone to participate in the Valeo program (Paris 2013).
11. Participation in the inauguration of the European Rover Challenge together with Prof. Howard Scott (NASA, Stanford University) and Dr. Robert Zubrin, founder of the "Mars Society" (Kielce 5-7.09.2014).
12. Pipeline inspection robot (2017).
13. Robot for qualitative testing of surfaces in construction (2017).
14. Since 2019, cooperation with SatRevolution in the field of satellite constellation and robotics in space.
15. Publishing a book on robotic hospitals of the future entitled "Hospital 4.0" based on conferences organized in 2016-2020 (Wrocław University of Science and Technology, 2020).
16. Presentation at the International Astronautical Congress in Dubai of development concepts for autonomous robotics on Mars and the Moon (2020, 2021).

In parallel, for over 20 years, topics directly related to school robotics were developed, transferring knowledge to schools, first in Wrocław and later throughout Poland.

17. Developing interest in robotics in your own children, starting from kindergarten and ending with higher education (from the beginning of the 21st century).
18. Developing students' interests in the specially established Inter-Faculty Scientific Club of Vehicles and Mobile Robots (KNPiRM) at the Faculty of Mechanical Engineering of the Wrocław University of Science and Technology (abbreviated name LEM – Light Electric Motorcycle, from the beginning of the 21st century).

19. Participation in the first robotics competition in Lower Silesia, "Polish Championships of Robot Models and Rescue Units" (Rob-Rat), organized by the Nicolaus Copernicus Youth Cultural Center in Wrocław (2003).
20. Creation of over 30 robotics clubs in cooperation with the City Hall in Wrocław schools (2010).
21. Organizing the first "Robot League" in Poland, as above (2011-2014).
22. Organisation of the 1st Polish Robot Championships (Wrocław 2012).
23. Participation in the program "From a small school into the big world" - 119 schools, 641 teachers, 8343 participants throughout Poland (2010-2013).
24. Establishment of over 40 robotics clubs across the country by 2018.
25. Organizing the first conference on teaching robotics in primary and secondary schools at the LZN in Wrocław (2018).
26. Reactivation of the "Robotics in Lower Silesian schools" program after the pandemic (Legnica 18/06/2021).
27. Strategic study of the Inwentyki Institute entitled "School Robotics in Poland" (28/07/2021).
28. Launch of the "Laboratories of the Future" program by the Ministry of Education and Science, over PLN 1 billion for primary schools throughout the country (from September 15, 2021).
29. Conferences on school robotics organized jointly with the Lower Silesian Teacher Training Center in Wrocław (15/11/2021; 21/06/2022; 20/10/2022; 15/12/2022).
30. Regional conferences organized jointly with the Lower Silesian Education Superintendent (August 2022), during which information was provided about the "Robotics in Lower Silesian schools" program (Wrocław, Legnica, Wałbrzych, Jelenia Góra).
31. Conducting a cooperation survey among Lower Silesian schools (August 2022).
32. Creation of a list of schools participating in the program (November 2022).
33. Formation of the Leadership Team of the "Robotics in Lower Silesian Schools" program (15/12/2022).
34. Appointment of the Team of Experts for the "Robotics in Lower Silesian Schools" program (15/12/2022).
35. Presentation of curricula for primary schools in the field of school robotics (31/01/2023).
36. Presentation of the action plan for 2023 (31/01/2023).
37. Organizing the Polish Robot Championships under the patronage of KGHM (Wrocław – 01.06.2023, Legnica 19.06.2023).
38. Organizing the Polish Robot Championships with the participation of the Marshal's Office of the Lower Silesian Voivodeship, universities, the National Committee for Space Technologies, NOT and students, as well as primary school pupils (Wrocław – Legnica, October 2025).

Space robotics [9]

Space robotics projects were developed after the COVID pandemic in 2022 and launched in Legnica for the first time during the Polish Robotics Championships in 2023. The robotics competition was organized under the patronage of the Prime Minister of the Republic of Poland with financial support from Lower Silesia's largest company, KGHM. Below are sample photos from the event, as well as selected works by primary school students.

In 2024, no support was received and the project was not launched. In 2025, the Polish Robotics Championships, held in Wrocław and Legnica, included competitions on space projects. They were organized with the support of the Marshal's Office of the Lower Silesian Voivodeship, the National Committee for Space Technologies, and with the participation of NOT Wrocław and NOT Legnica. The following photos show selected student projects.

The "Key to Space" Program

In 2025, the POLSA project was launched, aimed at primary and secondary school students aged 12 and over. The kit includes an instructional video, assembly instructions, basic soldering exercises, lesson plans, and 3D projects. The program launched on November 7, 2025. There is currently no information on the project's practical results.

This article does not discuss the "Rover Challenge" competition for students of higher education institutions, hoping that the topic will be presented by the organizers also in the pages of this "Przegląd Komunikacyjny", as it is worth popularizing this success not only in Poland.

Conclusions

Direct conclusions from the Polish Robot Championships 2025

- Both the Wrocław and Legnica centers have been national pioneers and natural sites for the development of school robotics, including space robotics, for many years and should continue to be utilized to expand this field. These centers offer excellent conditions and are well-equipped to provide the necessary staff. The gathered robotics enthusiasts are also capable of developing principles that will ensure the development of this area of education [10].
- Robotics topics, which have already reached primary schools on a relatively large scale, should be continued.
- Consider incorporating military/war robots into future robotics competitions.
- Collaboration with NOT Wrocław and NOT Legnica, as well as with universities, should be continued and expanded. NOT structures across the country could be utilized for this purpose.
- The robotics program should cover kindergartens, primary schools and secondary schools and should become a permanent part of the support program for Marshal Offices across the country.
- Additional remuneration or special rewards should be provided for committed youth caregivers.
- Lower Silesia, as a major industrial center, should develop the proposed forms of activity, which will facilitate the region's high-level economic development in the near future. The ideas and initiatives born in Lower Silesia should be transferred through the KKTK throughout the country.

Conclusions of a general nature

Economic development and the future of societies rely heavily on technological advancement, as has been evident for many years in Silicon Valley and increasingly in the Far East. This is based on the introduction of STEAM and TED disciplines into teaching practices at the earliest possible stage. AI has been added to this mix over the past three years, as pioneers around the world have already discovered. The enormous funds spent on "Laboratories of the Future" have provided primary schools with appropriate equipment, including robotics kits and 3D printers, which are currently underutilized.

This is influenced by the overall situation in the education system, as evidenced by the basic data presented in the latest TIEMS report. In Poland, the education system is short of 15,000 to 30,000 teachers. Tens of thousands of people leave the profession every year. In 2024, this number reached 20,000. Nearly half of those with less than five years of experience are considering a career change. Teachers are the most burnt-out professional group. Only 30% declare job satisfaction. In Finland, it's 92%, and in Norway, 88%. Poland currently has the oldest teaching staff in Europe, which hinders the introduction of innovation. The authorities are preoccupied with ideological issues instead of solving problems related to

technological development. Poland is heading towards an educational disaster, as was heard at numerous conferences (ECC Katowice, Forum G2 in Wrocław). The recent changes to the core curriculum are generating a lot of unnecessary emotions, therefore, the positivist efforts of our team should be fully supported. We must continue to act and do our part. Based on the experience of MPR 2025, we have decided to organize the Polish Secondary School Robotics Championships again. Initial arrangements have been made with the Aviation Research Institute and SIMP NOT in Wrocław. We must continue to foster educational development in our region, and our example will undoubtedly be followed by others, as these are inevitable global development trends.

In an effort to accelerate the development of the space industry, it is also proposed to promote the idea of academic and school entrepreneurship among students and pupils. As in the past in the IT field, start-ups in the space industry should be established at the educational level, in accordance with Polish law, starting at the age of 16. To this end, among other things, Space Science Clubs should be established in secondary schools. School Science Clubs should be organized as the best clubs at universities in the automotive industry, operating like industrial companies.

Due to the scarcity of specialist academic staff at universities, consideration should be given to having classes taught by staff from several universities in order to cover the entire spectrum of issues at the highest possible level. Cooperation is essential.

In this way, space education will encompass all levels of education simultaneously. Poland will once again be able to achieve success, similarly to its IT sector, bringing us closer to our goal of becoming the 15th-largest economy in the world.

This appeal is addressed to all our readers, space enthusiasts, members of the National Committee for Space Technology, teachers, students, and pupils. NOT - the Chief Technical Organization, also known as the Independent Technical Organization. Regardless of views, past, gender, or political affiliation, we propose tomorrow's solutions today for all interested parties.

If you would like to cooperate, please contact us directly.

Source materials

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