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STEM Ecosystem Development Strategy

Henryk Brodaty Primary School no. 3 in Złotoryja

2025 - 2030

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1. Overarching goals, development vision and strategic direction of the educational institution. Background information

1.1. Summary of the educational establishment

We are a public primary school that teaches, educates and provides for students. We create the conditions necessary for children to develop, preparing them to fulfil their social and civic responsibilities and civic responsibilities based on the principles of solidarity, tolerance, democracy, justice and freedom. We provide conditions for pupils to develop their personality comprehensively and to be creative in discovering knowledge about the modern world. We nurture a good atmosphere in the classroom and at school. We actively work to improve the quality of school work. To meet the expectations of our students we offer a wide range of subject and interest circles. In order to stimulate their intellectual development and build motivation, we focus on interdisciplinary learning in our work - in the form of multidisciplinary projects, competitions, outdoor games and educational excursions.

The school has 740 children aged 5-15 - in pre-school departments, early childhood education, in grades 4-8. A group of about 45 pupils have special educational needs such as dyslexia, dysorthography, ADHD, Asperger's Syndrome or autism spectrum disorder and require the adaptation of teaching methods to their individual situation. Some pupils come from families of middle and lower social and economic status, which gives them fewer opportunities in life compared to others. This fact puts them at risk of social exclusion. This puts social barriers in front of them, which significantly limits future opportunities to study or travel, as their families cannot support them financially. Since the outbreak of war in Ukraine, our school has also been home to children who have experienced trauma and have left their homeland and family home. This is why we emphasise equal opportunities and raise pupils' awareness of tolerance and openness.

The teaching staff comprises 66 qualified teachers, including pedagogues, a psychologist, a speech therapist and educational therapists. Teachers carry out didactic, educational and caring work. They are responsible for the quality and results of this work, as well as for the safety of the pupils entrusted to their care.

The school works on the basis of the framework teaching plans prepared by the superior authority, the Ministry of Education. The curriculum covers mathematics, chemistry, biology, physics, geography, computer science, Polish, English and German, history, social studies, music, art, religion and physical education. We also have a wide range of extra-curricular activities to meet the expectations of our students. To stimulate students' intellectual development and build motivation, we focus on interdisciplinary learning in our work - in the form of various multidisciplinary school projects, outdoor games, numerous internal and external subject competitions and sports competitions, educational excursions, etc. Participation in international projects aims not only to improve the students' communication skills, but also to develop their multicultural awareness. The issue of combating discrimination is very important in Poland and efforts should be made to ensure that young people in our country are well informed and thus fully aware of the benefits of living in tolerance and peace.

1.2. School vision, STEM-related goals

The motto of the activities in our School is: "Every pupil can succeed to the best of his or her ability." The aim of our work and assistance is to support pupils in discovering their full potential by creating a developmentally appropriate environment at school. Other forms of supporting the pupils of our school are, for example: interest circles, the organisation of school competitions and the involvement of the extracurricular competitions, encouraging participation in educational projects and excursions, school and extracurricular events.

Each year our school creates a class with an extra hour of maths and computer science per week, which follows an extended curriculum with elements of programming and coding. Our pupils are well versed in ICT, and the school has two fully equipped computer labs. In grades 1-3 (pupils aged 7-9), an innovative robot coding course is run for young pupils. In addition to this, we work with an external educational foundation that organises the Young Engineer's Club - workshops on robot coding, programming basics, electronics, engineering. In grades 4-8 (pupils aged 10-15), IT is taught as a subject. However, information technology is also an integral part of teaching the other subjects. We also collaborate with universities as part of the Lower Silesian Science Festival - our students attend lectures and laboratories in science, physics, astronomy, mathematics and biology. In 2017-2019, we participated in a KA229 project of 4 countries (Germany, Italy, England and Poland) called EUROPLAY - based on rethinking our playgrounds as a learning environment and providing students with STEM power, with the following main goals of realising lifelong learning and mobility, improving the quality and efficiency of general education and fostering innovation and creativity, including entrepreneurial thinking, at all levels of general and vocational education. Many classrooms are equipped with electronic whiteboards, computers and tablets. We also put a lot of effort into being an energy-conscious school and reducing our carbon footprint on the environment. We participate in many competitions and projects with STEM education as a main priority. Our school participated in the Ministry of Education and Science and GovTech's 'Laboratories of the Future' initiative to support primary schools in purchasing equipment for laboratories in STEAM subjects (science, technology, engineering, arts and maths). As part of this initiative, schools were equipped with two special classrooms as science laboratories and many teaching aids, e.g. a 3D printer with accessories, VR goggles, microscopes, etc. Many educational excursions are organised: - Śnieżka Forestry Commission - Forest Gene Bank in Kostrzyca - Sudetic Educational Homestead - Ecological Education Centre in Myślibórz.

The school's vision for STEM (Science, Technology, Engineering, Mathematics) education is based on the belief that the development of competencies in these areas is key to preparing students for the challenges of the modern world, including the changing labour market and dynamic technologies. The aim of our school is not only to impart knowledge, but also to develop the skills of problem solving, critical thinking, creativity and collaboration that are fundamental in a STEM context.

This is why we strive for a vision of a school where STEM education is a priority:

- Interdisciplinary education: the school combines knowledge from different disciplines - mathematics, science, technology and engineering - encouraging students to solve problems holistically, through projects and challenges that integrate these disciplines.
- Practical skills orientation: The school emphasises experiential learning, introducing students to research and development projects, experiments and the use of technology in practice, such as in the form of laboratories, workshops and project activities.
- Promoting creativity and innovation: Gives students the tools to discover, create and test new ideas themselves, encouraging experimentation and exploration in science, technology, engineering and mathematics.
- Collaboration with industry and universities: Collaborates with the business sector, research institutions and universities to provide hands-on experience and access to new technologies, and closely links STEM education to real-world labour market needs.
- Equity and accessibility: Promote STEM education for all students, regardless of gender, background or social situation, by supporting diverse groups to succeed in these fields, particularly through initiatives targeting girls and other groups underrepresented in STEM.

Objectives related to STEM education

Development of analytical and problem-solving skills

Aim: To develop skills in solving complex problems, analysing data and drawing conclusions, which are key in science, technology and engineering.

Activities: Introduce project-based learning, interdisciplinary tasks and data analysis in the context of real-world problems.

Increasing digital competence

Aim: To prepare students to work with modern technologies and digital tools, including programming, robotics, artificial intelligence and data analysis.

Activities: Classes in programming, app development, game design, as well as an introduction to new technologies such as artificial intelligence and the Internet of Things (IoT).

Preparing for the professions of the future

Goal: To prepare students for careers that are related to the development of technology, such as engineers, data analysts, programmers or biotechnology specialists.

Activities: Enabling students to gain work experience and internships in technology companies, collaborating with technology and science companies.

Developing teamwork and communication skills

Aim: To develop the ability to work in teams, communicate, collaborate and share knowledge within complex interdisciplinary projects.

Activities: Group projects, working in a team on technical and scientific solutions, preparation for presentation of work results.

Stimulating creativity and innovation

Objective: To develop in pupils the ability to think creatively and innovatively, the ability to generate new ideas and take risks in the implementation of projects.

Activities: Creating space for experimentation, introducing science challenges and competitions, supporting student initiatives.

Equity and accessibility in STEM

Goal: Ensure equal access to STEM education for all students, with a particular focus on girls, who are often underrepresented in these fields.

Actions: Initiatives to promote STEM to girls, organising workshops, competitions and trainings that encourage the study of technical and mathematical subjects.

Integration of STEM with other educational fields

Aim: To create an education based on combining different fields of study, e.g. mathematics with literature, science with philosophy, in order to build a broader perspective on problem solving.

Actions: Interdisciplinary approach to teaching, organising projects that combine STEM with humanities, social sciences, arts and other disciplines.

Summary

The vision of a STEM-based school is a school that prepares students for the challenges of the future by developing their competence in science, technology, engineering and mathematics. The goals of this school include the development of practical skills, creativity, collaboration and readiness for the jobs of the future, with equity and accessibility for all students in mind.

1.3. National and local planning documents on STEM education and digital transformation

In Poland, planning documents on STEM (Science, Technology, Engineering, Mathematics) education and digital transformation are created at various administrative levels, both national and local. These documents set goals, strategies and actions to improve the quality of education and implement modern technologies in the education system. Here is an overview of the key documents:

National Documents

1. National Strategy for Education Development 2020-2030

This is a document outlining the goals and priorities of education policy in Poland. It contains provisions for the development of STEM education, including the promotion of science subjects, the development of digital competencies of students and teachers, and support for lifelong learning.

2. Strategy for Responsible Development (SOR) to 2020 with an Outlook to 2030

The SOR includes the development of modern technologies, including digitization in education, as part of Poland's economic development strategy. Among other things, the goal is to increase the number of people educated in STEM fields.

3. Operational Program Knowledge Education Development (POWER)

The program pursues goals related to the development of digital competencies, including through projects aimed at increasing the number of STEM learners. Numerous projects related to innovation in education and digitization of schools are implemented under POWER.

4. Strategy for the Development of Digital Competencies in Poland (2017)

This document defines policies for the development of digital competencies in Poland, including in education, and the implementation of technology in schools and universities. In the context of STEM, the strategy aims to equip teachers and students with the skills necessary to work in a digital environment.

5. National Reading Development Program (2016)

While primarily focused on developing reading skills, this program also includes projects related to the integration of new technologies and digital support that can be applied to STEM education.

6. Polska Cyfrowa 2020 (Digitalization Development Program)

This program aims to bring digitization to various sectors, including education. Under this program, projects are being implemented to support teachers in digital competence and to implement innovative solutions in schools.

Local Education Plan documents

At the local level, provincial, district and municipal governments are also developing strategies and action plans that incorporate elements of STEM education and digital transformation. Examples of documents include:

1. Local education development strategies

Many municipalities and districts in Poland are developing their own educational strategy documents that take into account the development of STEM competences and the digitisation of schools, creating plans for the modernisation of IT infrastructure and the implementation of new technologies for learning.

2. Plans for the development of technology in education at the level of schools and educational institutions

Each school or network of schools, depending on demand, can develop a plan for the implementation of digital technologies, which includes the purchase of equipment, teacher training and the integration of new technologies in the teaching process.

3. Local projects under EU funding (e.g. Regional Operational Programmes)

At the local government level, there are numerous EU projects that aim to develop STEM education and integrate new technologies into the teaching process. Often these are initiatives to support schools in learning programming, robotics or engineering.

National and local documents on STEM education and digital transformation in Poland focus on the development of digital competences among students and teachers, the introduction of innovative teaching methods and increasing the availability of technology in schools. Achieving these goals requires cooperation between the government, local governments, schools and NGOs to provide comprehensive support for education in the face of the challenges of digitisation.

2. Analysis of the current situation

2.1. The learning process, its outcomes in STEM fields

The process of learning in STEM fields in Poland, as in other countries, is a key area to prepare young people for the technological, scientific and professional challenges of the future. At the same time, it is an important issue to analyse learning outcomes in the context of gender, as there are some inequalities between girls and boys in the STEM field.

The learning process in STEM fields

STEM education in Poland focuses on developing the analytical, logical thinking, problem-solving and creative skills that are the foundation of science, technology, engineering and mathematics. Contemporary teaching methods in the STEM field assume:

- Project-based education: Students engage in hands-on projects that require the application of knowledge from different STEM disciplines.

- Interdisciplinary approach: Combining science, mathematics and technology to solve problems in real-world situations.

- Creativity and innovation: Focusing on creative problem solving and developing the skills necessary to work in teams and design new solutions.

- Working with technologies: Using digital technologies such as programming, robotics, artificial intelligence to enable students to learn through experience and experimentation.

Selection of advanced STEM subjects and girls/boys split

The choice of STEM subjects in Polish secondary schools (high school, technical school) has a significant impact on students' later careers in these fields. Typically, subjects such as mathematics, physics, chemistry or computer science are considered 'advanced subjects' that require students to have high analytical and logical skills.

Gender breakdown:

Boys are more likely to choose subjects related to engineering, technology and science, such as mathematics, physics, computer science, as well as specialist engineering subjects.

Girls are still under-represented in some STEM subjects, especially in subjects related to engineering, computer science and technical subjects. Nevertheless, we are seeing an increasing number of girls choosing subjects related to biotechnology, chemistry or mathematics.

Percentage of girls and boys in STEM subjects:

- Mathematics - Chosen by around 40-50% of girls in secondary schools. Mathematics is one of the subjects in which the gender ratio is relatively even, although there is still a predominance of boys among winners of mathematics Olympiads.

- Physics - In physics, traditionally a subject associated with technology and engineering, the proportion of girls is much lower, at around 20-30%.

- Computer science - Girls account for only around 20-25% of students choosing computer science in secondary schools, despite the growing interest of girls in this subject, especially in the context of new technologies.

- Chemistry, biotechnology - There is a higher proportion of girls in these subjects than in other STEM subjects, as these areas are seen as more 'female friendly'. In chemistry or biotechnology, girls account for up to 60-70% of students.

STEM examination results (girls vs. boys)

The results of matriculation exams and subject Olympiads in Poland show the differences in performance between girls and boys in STEM fields.

Matura exam:

- Mathematics: Boys perform better than girls in mathematics, even though girls make up a larger proportion of the matriculation population in mathematics. Boys have higher average scores and are more likely to achieve the highest scores in mathematics Olympiads.

- Physics: Boys dominate the baccalaureate results in physics, which may be due to the fact that the subject is more often chosen by men.

● Computer science: In computer science, as in mathematics, boys achieve higher baccalaureate results, which may be due to a higher interest in this subject among boys.

● Chemistry: Baccalaureate results in chemistry are more evenly matched between the sexes, with a slight advantage for girls, who tend to perform better.

Subject Olympiads and competitions:

● Mathematics Olympiad: Traditionally, mathematics Olympiads are dominated by boys, who are more likely to win top places and represent Poland at international competitions.

● Physics Olympiad: As in mathematics, boys predominate in this subject and their results are better than those of girls.

Comparison with national results

Nationally, the differences in performance between girls and boys in STEM subjects are well documented. According to data from the Central Examination Commission and international studies, in Poland:

Boys have higher average results in subjects such as mathematics, physics and computer science.

Girls dominate in subjects such as chemistry, biology and are slightly more likely to achieve better results in some secondary schools, especially in science-oriented schools.

Analysis of our students' performance in STEM subjects, disaggregated by gender, in the 2023/24 annual classification is in line with national statistics and is as follows:

Wszystkie przedmioty													
	klasy												
	6A	6B	6C	6D	kl. 6	7A	7B	7C	kl. 7	8A	8B	kl. 8	Szkoła
l. uczniów	21	19	23	22	**85**	26	26	24	**76**	26	26	**52**	**213**
l. dziewcząt	13	10	14	8	**45**	13	13	14	**40**	18	14	**32**	**117**
l. chłopców	8	9	9	14	**40**	13	13	10	**36**	8	12	**20**	**96**
średnia DZ	4,09	4,18	4,59	4,25	**4,28**	4,08	4,18	4,04	**4,10**	3,77	4,73	**4,25**	**4,21**
średnia CH	4,23	4,28	4,55	4,37	**4,36**	4	4,18	4,22	**4,13**	4,25	4,31	**4,28**	**4,26**
średnia klasy	4,16	4,23	4,57	4,31	**4,32**	4,04	4,18	4,13	**4,12**	4,01	4,52	**4,27**	**4,23**

Przedmioty przyrodnicze	natematyka, informatyka, technika, biologia, geografia) - klasa (matematyka, informatyka, fizyka, chemia, biologia, geografia) - klasy 7 i 8												
	klasy												
	6A	6B	6C	6D	kl. 6	7A	7B	7C	kl. 7	8A	8B	kl. 8	Szkoła
średnia DZ	4,09	4	4,1	4,17	**4,09**	3,88	3,81	3,62	**3,77**	3,58	4,54	**4,06**	**3,97**
średnia CH	4,07	4,12	4,94	4,29	**4,36**	3,86	3,93	3,58	**3,79**	4,12	4,12	**4,12**	**4,09**
średnia klasy	4,08	4,06	4,52	4,23	**4,22**	3,87	3,87	3,6	**3,78**	3,85	4,33	**4,09**	**4,03**

Challenges and recommendations

Increasing girls' participation in STEM subjects: There is a need to take action to increase the number of girls choosing technology, engineering and computer science subjects. This could include educational initiatives such as science camps for girls, programming and technology workshops.

Encourage STEM education among boys in 'soft' subjects: Efforts should also be made to encourage boys to develop their skills in STEM areas that are traditionally dominated by girls, such as biology or chemistry.

Increase accessibility for students from diverse backgrounds: Work should continue to improve access to STEM education for all students, regardless of their social background, gender or family resources.

In STEM education in Poland, there are noticeable differences in subject choices and exam results between girls and boys, especially in subjects such as mathematics, physics and computer science, where boys achieve higher results. In contrast, girls are more likely to choose subjects related to chemistry and biotechnology. There is a need to continue to support girls in areas traditionally dominated by boys and to encourage boys to become more involved in subjects related to biology and chemistry.

2.2. Competence of STEM teachers

The competencies of STEM (Science, Technology, Engineering, Mathematics) teachers are key to the effective delivery of knowledge in the areas of science, technology, engineering and mathematics. Today's STEM teacher not only needs to have sound content knowledge, but also pedagogical skills to work effectively with students and digital skills to use modern technology in teaching.

Below is an analysis of the results of a survey of our school's teachers:

https://sp3.zlotoryja.pl/erasmus/diversifying-the-stem-ecosystem.html

Digital skills of STEM teachers

In this age of digital transformation, STEM teachers need to be well prepared to use technology tools in education. Digital skills include both the use of computer tools and the use of technology in teaching and assessment.

A. Operation of digital tools:

Basic computer skills: STEM teachers must be proficient in the use of computers, office applications (e.g. Word, Excel, PowerPoint) and school management systems (e.g. e-journal, learning platforms).

Learning platforms and e-learning tools: Teachers should be familiar and proficient in using learning platforms such as Moodle, Google Classroom, Microsoft Teams, Edmodo, which support the organisation of remote, hybrid classes and communication with students and parents.

Interactive teaching tools: Ability to use interactive whiteboards (e.g. SMART Board), educational apps (e.g. Kahoot!, Quizizz) and visualisation tools (e.g. GeoGebra, PhET).

Managing data and analysing results: STEM teachers should be able to use tools to collect, analyse and interpret data (e.g. Excel, Google Sheets, data analysis tools for science and mathematics).

Resources for learning programming and robotics: Familiarity with programming learning platforms (e.g. Scratch, Python, Arduino) and technologies to support robotics learning (e.g. Lego Mindstorms, Raspberry Pi).

B. Integration of technology into the learning process:

Use of technology in learning STEM subjects: The ability to integrate technology into the teaching of mathematics, physics, chemistry, biology and other STEM subjects, e.g. using simulations, data visualisation or virtual labs.

Gamification and educational games: Familiarity with tools to support teaching through educational games and activities that engage students (e.g. Minecraft Education Edition, making interactive quizzes).

Remote teaching tools: Proficiency in online teaching, knowledge of tools such as Zoom, Google Meet, Microsoft Teams that support distance learning.

Pedagogical skills of STEM teachers

In addition to digital skills, STEM teachers should also have the pedagogical skills to effectively impart knowledge and inspire students to develop competencies in science and technology.

A. Adapting teaching methods to students' needs:

An individualised approach to the student: Teachers should be able to adapt teaching methods to the individual needs of students, including those with learning difficulties and those who need a greater challenge.

Learner-centred education: Using an approach that engages students in the learning process through discussion, problem solving, research projects and experimentation. Instead of the traditional lecture method of teaching, teachers should promote students' independence and creativity.

Active methods (e.g. project-based learning): The ability to use active teaching methods that engage students in group work, interdisciplinary projects and experimentation.

Group work and collaboration skills: Teachers should support students to work in teams, developing communication, collaboration and negotiation skills that are essential for future careers in STEM fields.

B. Use of formative assessment:

Ongoing feedback: STEM teachers should use formative assessment methods to monitor students' progress on an ongoing basis and provide constructive feedback, allowing students to correct errors and develop skills more quickly.

Student portfolios: The ability to use a student portfolio that collects a variety of student work, projects and achievements in STEM fields.

Project-based assessments: Supporting students to complete projects that are assessed on the complexity of the task, creativity, collaboration and application of knowledge to practice.

C. Fostering creativity and innovation:

Innovative approaches to STEM teaching: Teachers should inspire students to think creatively and take risks in scientific exploration. It is important that teachers not only impart knowledge but also support creative thinking and innovation in problem solving.

Application of experiment-based learning: Teachers should introduce students to the world of experiments, hands-on investigations and trials that enable them to discover scientific principles on their own.

D. Motivating students to learn STEM:

Fostering an interest in science: Teachers should aim to foster students' passion in STEM fields by organising workshops, Olympiads, competitions or research projects. They should also be role models for their approach to learning and working in technical fields.

Increasing gender equality in STEM: Teachers should pay attention to the differences in boys' and girls' interests in STEM fields and actively work towards gender equality in science and technology, e.g. by organising workshops and projects specifically for girls.

Challenges to the competence of STEM teachers

The introduction of technology into STEM education poses a number of challenges for teachers, such as:

Continuous need to update knowledge: Technologies and teaching methods in the STEM field are evolving rapidly, requiring teachers to continually update their skills in both new technologies and modern teaching methods.

Training and support: Systematic training is needed for STEM teachers in educational technologies, teaching methods and digital classroom management.

Increasing motivation for STEM learning: There is a need for programmes to help teachers engage students in science and technology, especially in the context of increasing the number of girls in technical and mathematical subjects.

STEM teacher competencies are key to effective teaching in science, technology, engineering and mathematics. Teachers should have both digital skills that enable the use of modern educational tools and pedagogical competencies that support the development of students' creativity, independence and innovation. Maintaining a balance between digital and pedagogical skills is crucial for the successful implementation of STEM education in schools.

2.3. Offer of interest-related education and extracurricular activities

Below is a list of the educational activities taking place in our school:

https://sp3.zlotoryja.pl/oferta-edukacyjna.html

The offer of interest-related education and extra-curricular activities in the context of STEM (Science, Technology, Engineering, Mathematics) is an important part of supporting students' development, allowing them to deepen their knowledge and develop their passions beyond the standard curriculum. Extra-curricular activities and interest-related offerings give students the opportunity to participate in a variety of projects, competitions, workshops or meetings that align with their passions and help them develop the skills necessary for future careers. In the next school year, we want to focus on:

STEM-related extracurricular activities

A. Science circles and subject clubs

Maths club: Pupils taking part in the maths circle develop their maths skills by solving more difficult tasks, preparing for maths Olympiads or participating in research projects.

Physics and chemistry club: Activities that allow students to experiment, carry out experiments and explore more advanced physics and chemistry topics.

Computer science/programming club: Directed towards learning programming, creating applications, computer games, and developing skills in artificial intelligence, robotics or data analysis.

Biology/ecology club: Classes that focus on biological, ecological, environmental issues and organising field research projects.

B. **Workshops and practical activities**

Programming and robotics workshops: Classes that teach children and young people the basics of programming (e.g. in languages such as Python, Scratch) and building and programming robots, using educational platforms such as Arduino, Raspberry Pi or Lego Mindstorms.

3D printing workshops: Activities that teach students to design 3D models and print them on 3D printers, developing skills in engineering and technology.

Data analysis workshop: Classes that allow students to learn how to work with data, for example using tools such as Excel, Google Sheets or programming in R and Python.

C. Olympiads and subject competitions

Mathematics, physics, chemistry and computer science competitions and Olympiads: Pupils have the opportunity to take part in national and international subject Olympiads, which develop their skills and motivate them to continue their studies.

Robotics and programming competitions: Participation in competitions such as FIRST LEGO League, RoboCup or Hackathons gives students the opportunity to work in teams, solve technical and scientific problems.

Environmental and biological competitions: Students can participate in competitions related to environmental protection, biodiversity or health issues.

D. Entrepreneurship and innovation activities

Technological entrepreneurship workshops: Classes that teach students how to create startups, develop new technologies and bring innovations to market. Students can work on their own technology projects, product or service prototypes.

Hackathons: Classes or events in which students work in groups to solve specific technical or social problems, creating prototype solutions in a short period of time.

Startup labs: Activities based on the creation of innovative products or solutions that can be applied in practice. In such projects, students learn not only technology but also project management skills.

Educational offerings related to interests in STEM fields

A. Activities to develop pupils' interests

Natural science classes: Practical classes in chemistry, physics, biology, which are enriched by laboratory experiments, field trips, organisation of workshops and lectures by specialists.

Mathematics classes: Classes that develop students' mathematical abilities in the context of problem solving, data analysis, mathematical programming and practical application of mathematics in various fields.

Technology and engineering: Classes that teach the basics of construction, design and operation of machines, equipment or systems. Students can create projects in mechanical, electrical or automation engineering.

B. Interdisciplinary classes

Research projects: Students carry out research projects that combine different STEM fields (e.g. investigating the impact of technology on the environment, designing innovative health solutions).

Programming and computer game development: Students learn to program and design computer games and mobile applications, which develops their computer science skills and creativity.

The role of teachers and mentors in extra-curricular activities

All STEM-related extracurricular activities require the involvement of teachers who act as guides, mentors and organisers. They:

-Motivate students to engage in extra-curricular projects.

-They support them in completing individual and group projects.

-They give students the opportunity to develop practical skills that are not always possible in regular lessons.

-They provide feedback and help them prepare for competitions, Olympiads or research projects.

Extra-curricular activities and interest-related offerings in the STEM area are an important part of pupils' development. They offer opportunities to explore passions, develop practical skills and prepare for careers in science and technology fields. Schools, teachers and educational institutions should create a conducive environment for such activities, involving students in projects, competitions and workshops that will inspire them to develop and further their education in STEM fields.

2.4. Vocational education in STEM

Below is an analysis of the results of the surveys of students and their parents about vocational education in STEM:

https://sp3.zlotoryja.pl/erasmus/diversifying-the-stem-ecosystem.html

Career counselling in STEM (Science, Technology, Engineering, Mathematics) plays a key role in helping students choose their careers and educational pathways, especially in the context of the dynamic development of technology and the changing demands of the labour market. Career counselors, teachers and mentors help young people to understand what opportunities are available in STEM fields, what skills are required for particular occupations and what steps need to be taken to succeed in these areas.

The role of career counselling in STEM

Career counselling in STEM aims to:

-Help students explore their interests in science and technology fields that match their talents and passions.

-Support decisions about career paths, both at secondary education level (e.g. choosing a technical school or baccalaureate profile) and at tertiary level (e.g. choosing to study engineering, computer science, mathematics, biology).

-Increase awareness of STEM professions: students may not be aware of all the career options available, especially those related to emerging technologies such as artificial intelligence, data analytics or biotechnology.

-Increase interest in STEM subjects, especially among underrepresented groups, such as girls in technical sciences or people from smaller towns.

Steps of career guidance in STEM

A. Identifying talents and interests

Career counsellors and educators help students discover their STEM-related talents and passions through a variety of methods, such as:

Career interest tests: Diagnostic tools that allow students to identify in which STEM areas they have a natural aptitude.

One-to-one interviews: Career counselors conduct sessions where they ask students about their interests, strengths, and how they see their career future in the context of technology and science.

Thematic workshops: Meetings with representatives from different STEM industries that allow students to gain a better understanding of the specific work in these areas.

B. Understanding the labour market and future career opportunities

Career counselors help students understand what occupations and skills are most in demand in the STEM job market. They deal with:

Presenting the available STEM occupations: From traditional engineering occupations to modern professions related to programming, data analytics, artificial intelligence, robotics, or biotechnology.

Preparation for the requirements of the labour market: Counsellors help students understand what competences (e.g. technical skills, analytical skills, creativity) are required for different professions and how to strengthen these skills.

Information on industry trends: Changing labour market needs, e.g. developments in artificial intelligence, automation, renewable energy or cyber security, are discussed in the context of the student's future career development.

C. Creating individual educational pathways

Career counsellors help students with their education and career planning:

Choosing the right schools and universities: Guidance on choosing the right technical school, high school with STEM subjects, university, industry courses or training that is related to the chosen profession.

Assistance in developing practical skills: Students can be encouraged to participate in internships, apprenticeships, research and development projects, subject competitions or online courses to develop their technical skills and knowledge.

D. Cooperation with employers and industry institutions

An important element of career guidance in STEM is collaboration with the industrial sector and scientific research institutions:

Work observation: Counsellors organise meetings in technological, industrial companies where students can observe work and gain practical experience.

Industry projects and competitions: Students can be encouraged to participate in competitions and projects related to technology and science (e.g. mathematics Olympiads, robotics competitions or hackathons), which develop their skills and make them more attractive on the labour market.

Supporting young people in the STEM field - specific target groups

Career counselling in STEM is particularly relevant for students who may not have easy access to the technology and science industries:

Girls in STEM: Careers counselors help encourage girls to choose careers in the STEM area by promoting female role models in science and technology and showing them the career paths available in these fields.

Students from smaller towns: Counsellors help students from rural areas or small towns to access STEM education by offering information about available scholarship programmes, online courses or educational travel opportunities.

Students with learning difficulties: For students with learning difficulties in STEM subjects, counsellors can offer support in the form of one-to-one counselling, mentoring and assistance in developing learning methods.

The role of teachers and mentors in STEM career guidance

STEM subject teachers and industry mentors also play a key role in career guidance in STEM. Their tasks are:

Motivating students to develop their interests in scientific and technical fields and to overcome the difficulties of learning difficult subjects.

Providing practical guidance on the choice of further education and career paths, based on their own work experience or contacts with industry representatives.

Supporting students in the development of soft skills that are equally important in STEM industries, such as teamwork skills, creativity, problem solving or communication.

Career guidance tools and methods in STEM

A. Use of new technologies

Online career counselling platforms: Use digital platforms to provide career counselling, offering interest tests, career opportunities in STEM and access to webinars with industry representatives.

Educational programmes and mobile apps: Apps to support the development of STEM skills, such as online courses (e.g. in programming, data analysis) that can be suggested to students for guidance.

B. Collaboration with universities and industry organisations

Schools and colleges working with industry: Organise meetings with employers where students can learn about specific labour market requirements and become familiar with the technologies and tools used in the industry.

Mentoring and professional networks: Students can be encouraged to take advantage of mentoring programmes where they can meet experienced professionals who will share their knowledge and experience.

Career guidance in STEM is key to helping young people choose careers that match their passions, aptitudes and the demands of today's labour market. By supporting students in discovering and developing their technical and scientific skills, career counselors play a guiding role to help create educational and career

pathways in the rapidly evolving STEM fields. By working in partnership with industry, colleges and professional bodies, career counselling can significantly improve students' chances of future career success.

2.5. Partners for collaboration in the STEM/ STEAM ecosystem

Here is a list of selected educational institutions, companies and associations working in the STEM/STEAM field in Lower Silesia:

SOWA

It is a local science centre promoting the idea of learning based on self-exploration, discovery and experimentation. Independence, creativity and the ability to work together are just some of the competences that this unconventional venue reinforces. Learning through independent and free experimentation is the most effective form of acquiring knowledge. The Discovery, Imagination and Activity Zone features interactive exhibits and a DIY space.

Robisz.to Association

An organisation offering STEAM workshops and educational tools, collaborating with various institutions to promote hands-on education.

Code for Green

Polish non-profit organisation that has been bringing environmental education into schools since 2017, combining it with digital technologies.

Wrocław University of Technology

The university implements projects that promote lifelong learning and the development of STEM skills. Collaboration can include the organisation of workshops, lectures or joint educational initiatives.

PFR Foundation - 'STEAM Education at School' programme.

A programme aimed at teachers and educators to support the development of competence in the STEAM method. Participation in the programme can enrich the educational offer of the school and improve the qualifications of the teaching staff.

Polish Association for STEM Education

An organisation offering "eXperiment STEM" science workshops, created on the basis of the school core curriculum. The cooperation may include the organisation of additional activities for students.

Mentor Poland

A company collaborating with Makeblock, offering state-of-the-art solutions for learning programming and robotics, such as the Codey Rocky robot. The cooperation may include the provision of educational tools and training for teachers.

It is also worth noting the programmes implemented under the European Funds for Lower Silesia 2021-2027, which support the development of education in the STEM/STEAM field.

fundseuropejskie.gov.pl

Establishing cooperation with the above-mentioned entities may contribute to enriching the educational offer of the school and increasing the competences of both students and teachers in the STEM/STEAM field.

2.6. STEAM (interdisciplinarity)

STEAM (Science, Technology, Engineering, Arts, Mathematics) is an approach to education that combines science, technology, engineering, art and mathematics, emphasising interdisciplinarity and the development of not only technical but also creative skills. As a result, students are able to solve complex problems using a wide range of tools and perspectives that develop their analytical skills, creativity and teamwork skills.

Interdisciplinarity in STEAM learning

In the STEAM approach, subjects are not taught in isolation, but are combined into projects that bring together different disciplines. In this context, interdisciplinarity allows students to learn in a more coherent and realistic way, bringing them closer to the real-life challenges faced by professionals in different industries.

A. Themes and Research Projects in STEAM

Within STEAM, students can undertake projects and research that require the application of knowledge from various fields. This approach helps develop problem-solving skills in a creative and comprehensive way. Examples of themes and research projects that can be implemented within STEAM include:

Sustainable Development and Ecological Technologies:

- **Research Project:** "Designing Energy-Efficient Devices and Technical Solutions." Students can combine knowledge from engineering, mathematics (calculations), natural sciences (ecology, chemistry), and art (design and aesthetics).
- **Project Theme:** "How to Utilize Renewable Energy in an Urban Environment?" Students design virtual or physical models of cities with renewable energy sources, using engineering technologies, data analysis (mathematics), and aesthetic and social aspects (art).

Robotics and Artificial Intelligence:

- **Research Project:** "Application of Artificial Intelligence Algorithms in Educational Robots." This project can involve learning programming (technology), mechanics (engineering), logic (mathematics), as well as ethical issues and societal impact (art).
- **Project Theme:** "Robots That Can Aid in Learning." Students can create prototypes of educational robots that use artificial intelligence technology to support the learning of STEM subjects in schools.

Digital Culture and Computer Graphics:

- **Research Project:** "Application of Computer Technologies in Creating Interactive Art Installations." Students can combine art, graphic design, technology (programming, 3D graphics), as well as mathematical algorithms and patterns used in computer graphics.
- **Project Theme:** "Designing Mobile Applications Supporting Education." Students learn programming (technology), user interface design (art), analyze user data (mathematics), and develop educational solutions.

B. Interdisciplinary Projects

Interdisciplinary projects are a key element of STEAM education because they allow students to:

- **Collaborate in groups:** Students from different areas of knowledge work together, combining their competencies and experiences.
- **Complete complex tasks:** Projects based on real-world challenges allow students to apply theoretical knowledge in practice.
- **Create multi-stage projects:** Students go through all stages of a project, from planning and research to execution and final presentation.

Collaboration with External Institutions

An important element in developing interests within STEAM is cooperation with various institutions that offer students additional educational opportunities:

- **Collaboration with universities:** Students can participate in workshops, lectures, or practical classes organized by universities, which allow them to become familiar with more advanced STEAM topics.
- **Collaboration with technology and art companies:** Partnering with companies that organize courses, workshops, or competitions for students allows them to learn about the latest technologies and industry trends.

STEAM in education enables students to develop interdisciplinary skills that combine technology, science, art, and mathematics. Through working on research projects and interest-developing activities, students learn how to combine different fields of knowledge to solve real-world problems. Additional extracurricular activities and collaboration with universities and industry allow students to develop creativity and innovation, which are essential in today's world.

2.7. Review of Resources, Materials, and Environment

As part of the conducted inventory, an overview of equipment in subject classrooms related to STEM education was carried out: mathematics, physics, computer science, chemistry, biology, and natural sciences. The goal was to identify available didactic and technological resources that support modern teaching methods.

A laptop connected to an interactive whiteboard or an overhead projector is available to the teacher in every classroom.

Teaching aids in the Physics classroom:

-communicating vessels,

- force gauges + weights,

- vacuum pump, electrostatics set,

- thermodynamics set,

-geometrical optics set,

- 2 camertones

Teaching aids in the IT labs:

- 3D printer

- 3D printing laboratory
- directional microphone
- Saramonic Blink microphone
- soldering station
- 5 drones
- 5 Lego education Spike Prime robotics kits with microcontroller for learning to program
- 10 SkriBot robotics kits
- 8 Jimu robotics kits (Trackbots kits)
- 50 laptops (25 per classroom)

Teaching aids in the Chemistry laboratory

- chemical models
- set of chemical reagents
- scales
- fume cupboard

Teaching aids in the Biology classrooms

- microscopes 15 pieces + microscope plates
- various anatomical models
- water testing kits
- 24 ClassVR cubes 24 pieces
- 24 Class VR 24

Summary

Our school is very well-equipped with modern equipment and teaching aids that support learning STEM subjects. However, a significant obstacle to their full and effective utilization remains the **lack of high-speed internet**.

Therefore, our priority when using funds from educational projects will be to **ensure a stable and fast fiber-optic connection**. This will allow for the full utilization of available technologies and the implementation of innovative teaching methods.

2.8. Digital transformation

Digital transformation in education is a process encompassing many aspects of educational institutions' operations, from administration to teaching methodology. In each of these areas, digitalization changes how

schools, universities, and other educational institutions function and carry out their activities. Below, I present examples of currently used digital tools and proposed plans for the near future.

In Administrative Work

The digitalization of administration in educational institutions streamlines management, communication, and work organization processes.

What the institution already does:

- **School management systems (Vulcan):** Used for managing student, teacher, and administrative staff data. They include features like e-journals, timetable planning, attendance monitoring, and organizing meetings.
- **Communication platforms (Microsoft Teams, Google Meet, Zoom):** Used for organizing online meetings (individual classes, virtual classrooms, remote teaching during the pandemic), both for administrative purposes (e.g., pedagogical staff meetings) and for consultations with parents.
- **E-platforms for document circulation (ePUAP, cloud platforms):** Used for archiving documents, submitting applications, signing contracts, and settling funds.

Future plans:

- **Development of data management and analytics systems (Big Data):** Utilizing advanced analytics to make data-driven administrative decisions (e.g., analyses regarding attendance, student results).
- **Automation of recruitment and documentation processes:** Introducing fully automated processes for recruitment, student enrollment, and personnel file storage, which will simplify administrative work and save time.

In the Learning Process

Digitalization in teaching involves introducing modern tools and teaching methods that support student and teacher activity.

What the institution already does:

- **Educational platforms (Integrated Educational Platform, Eduranga, Edesk, Google Classroom, Edmodo):** Used for managing courses, sharing educational materials, organizing homework, and communication between teachers and students.
- **Interactive whiteboards (SMART Board, Avtec):** Used for engaging lessons that combine technology with traditional teaching.
- **Remote and hybrid learning tools (Google Meet):** Used for conducting online lessons, conferences, and meetings with students, as well as for real-time collaborative work on assignments.
- **Formative assessment tools (Blooket, Quizizz, Kahoot!, Socrative):** Tools for conducting online tests and quizzes that allow for ongoing assessment of results.
- **Automated grading platforms (Google Forms):** Used for evaluating written assignments and online tests.

Future plans:

- **Utilization of Artificial Intelligence (AI) in teaching:** Tools that will personalize the learning process, adapting materials and tasks to individual student needs (e.g., AI-based recommendation systems).
- **Development of e-learning and MOOCs (Massive Open Online Courses):** Enabling students to participate in online courses offered by universities worldwide, thus expanding the educational offerings.

- **Introduction of educational games and gamification:** Applying game elements in teaching (e.g., Minecraft Education Edition) and tools for assessing student progress in the form of games and challenges.

In summary, the digitalization of the assessment process allows for quick and efficient tracking.

In Inclusive Education

Digitalization in inclusive education allows for better adaptation of materials and teaching methods to the needs of students with various types of disabilities.

What the institution already does:

- **Platforms with learning facilitation features (Learning Apps, Nearpod):** Used for creating interactive exercises that adapt to the student's level.
- **AI tools supporting individualized learning:** Implementation of artificial intelligence that personalizes educational materials and teaching methods based on individual student needs.

Future plans:

- **Utilization of AR/VR in inclusive education:** Introducing augmented reality (AR) and virtual reality (VR) technologies into learning, enabling students with various types of disabilities to access virtual educational environments.
- **Adapted learning tools (TalkType, Ghotit):** Software to support students with writing and reading difficulties, such as speech recognition programs.
- **Applications supporting students with dyslexia and other difficulties (e.g., Kurzweil 3000, ClaroRead):** Text-to-speech tools that provide students with dyslexia easier access to materials.

In Project Implementation

Digitalization in educational project implementation allows for better collaboration, organization, and documentation of activities.

What the institution already does:

- **Collaboration platforms (Google Workspace, Microsoft Teams, Trello):** Tools for project management, student collaboration, organizing group work, and sharing materials and progress.
- **Cloud-based data storage tools (Google Drive, OneDrive):** Used for storing documents, presentations, and materials related to educational projects.

Future plans:

- **Utilization of project management tools in STEM education:** Development of systems enabling the management of research and development projects that integrate students from different schools and institutions within common initiatives.
- **Introduction of VR platforms for working on educational projects:** Allowing students to work in virtual laboratories or virtual environments for carrying out STEM projects.

Digitalization in various areas of education, from administration to learning, offers enormous possibilities. In the future, technologies such as artificial intelligence, virtual reality, data analytics, and e-learning platforms can further revolutionize how schools are managed, teaching is conducted, assessments are made, and educational projects are implemented.

2.9. Internationalization

We have successfully completed **three Erasmus+ projects** to date.

Our most recent project was a **KA229 multilateral partnership (2020-2023, extended by one year due to the pandemic)** titled "**The Little Prince Embracing His European Friends on Earth**." This project involved six countries: Spain, Italy, Greece, Ireland, Croatia, and Poland. Its aim was to encourage students to reflect on current global issues, foster sensitivity to diversity, and engage in the fight for human rights and the environment. It sought to develop children's critical thinking and creativity skills, promote social, digital, linguistic skills, and autonomy. By reimagining the classic "Little Prince," children had to research, analyze, compare, and suggest solutions to 21st-century societal problems. Through the journey of six young galactic explorers across Europe, all school communities explored and reflected on issues such as climate change, wars and refugees, gender inequality, irresponsible and unhealthy eating habits, screen addiction, and a lack of social skills. They were asked to devise solutions to be shared with other partner schools. This cooperation allowed all participants to better understand and appreciate European heritage. You can find more information at: https://w5qplzmmitmao8wr0snvkq.on.drv.tw/erasmus%202022-2023/www.estelerasmus23.com/

Previously, we simultaneously participated in two different projects:

- A **KA229 project (2017-2019)** involving four countries (Germany, Italy, England, and Poland) called "**EUROPLAY**." This project focused on rethinking our playgrounds as learning environments and utilizing STEM skills. Its main objectives were:
    - Improving the quality and efficiency of general education.
    - Implementing lifelong learning and mobility.
    - Promoting equity, social cohesion, and active citizenship.
    - Counteracting disadvantages in education by providing high-quality learning opportunities for young children and promoting inclusive education in schools.
    - Supporting innovation and creativity, including entrepreneurial thinking, at all levels of general and vocational education.

  You can visit our project website here: https://erasmuseuroplay.wordpress.com/mission-jv/

- A **KA201 project** involving three countries (Germany, Italy, and Poland) called "**Learning Democracy through School**." This project focused on young people and their role in society. The project aimed to explore knowledge about democracy and shape democratic attitudes among students, teachers, and others involved in "Learning Democracy through School," encouraging them to form their own opinions, engage in politics, and delve into important topics and issues concerning our societies. You can find our project blog here: https://learndemocracy.wordpress.com/

We are currently applying for **Erasmus+ Accreditation**. Our main goals are to:

- Expand the language competencies of teachers, reduce linguistic exclusion, and support the professional development of teachers, school leaders, and other school staff.
- Introduce innovative assessment methods, promote the exchange and transfer of best practices in teaching and school development, and foster the use of new technologies.
- Prioritize mental health in the school environment.

3. A Collection of Ideas, Innovative Practices, and Solutions

To effectively interest teenagers, especially girls, in studying **STEM (Science, Technology, Engineering, Mathematics)** fields, it's beneficial to implement innovative educational practices and approaches. Below is a collection of ideas and solutions that can inspire teachers and educators:

- **Interdisciplinary Projects Based on the STEAM Method:** Integrating STEM with elements of **Art (STEAM)** allows students to approach problem-solving creatively. An example could be designing and building architectural models that combine principles of mathematics, physics, and aesthetics. Such projects develop creativity and critical thinking skills.

- **Workshops with Women Working in STEM:** Organizing meetings with successful women in STEM fields can inspire girls to pursue similar career paths. Through such workshops, students can see real-world examples and understand that STEM is not exclusively for men.

- **Participation in Competitions and Programs Promoting STEM:** Engaging students in educational competitions and programs, such as **Odyssey of the Mind** or **Technovation Girls**, can increase their interest in science. Competition and the opportunity to win prizes motivate them to deepen their knowledge and develop skills.

- **Utilizing Modern Technologies and Educational Tools:** Introducing tools like **educational robots, programming applications, or 3D printers** into teaching can make learning more appealing. The practical application of technology allows students to better understand abstract concepts and develop practical skills.

- **Projects Related to Environmental Protection and Sustainable Development:** Involving students in ecological projects, such as creating solutions for environmental problems, can increase their awareness and interest in natural sciences. Such initiatives develop empathy and a sense of responsibility for the surrounding world.

- **Experience-Based Learning and Experiments:** Using teaching methods based on practical experiences, such as **laboratory experiments or research projects**, allows students to independently discover scientific principles. This approach increases engagement and helps in a better understanding of the material.

- **Creating STEM Clubs and Interest Groups:** Establishing school science clubs where students can carry out their own projects and share their passions fosters the development of interests. Regular meetings and collaborative project work build a sense of community and motivate further development.

- **Collaboration with Scientific Institutions and Businesses:** Partnering with local universities, technology companies, or research institutes enables the organization of educational trips, internships, or joint projects. Students have the opportunity to see the practical application of knowledge and explore diverse career paths in STEM.

- **Personalized Learning and Individual Approach:** Adapting teaching methods to the individual needs and interests of students can increase their motivation. Allowing choices in project topics or work formats leads to greater engagement and passion development.

- **Promoting Positive Role Models and Mentorship:** Implementing mentorship programs where older students or STEM professionals support younger ones can help build confidence and motivation. Girls, seeing successful women in science, can more easily envision themselves in such roles.

Implementing the above practices can significantly contribute to increasing teenagers' interest, especially girls', in STEM, while preparing them for future educational and professional challenges.

To effectively encourage teenagers, including girls, to pursue STEM studies and careers, it's important to adopt innovative teaching methods and approaches that combine theory with practice, engage them emotionally, and demonstrate how STEM can be both creative and socially impactful. The key is to motivate young people through inspiration, access to role models, and support in developing their skills in these fields.

Ideas and Innovative Practices in Primary School by Age Group

A. Age 10-12

- **Workshops and Practical Activities:** Children in this age group are more interested in learning when they can touch and feel it. Activities based on experiments, such as building simple robots, creating spatial models, or conducting physics and chemistry experiments, can capture their attention.
  - **Idea:** Activities involving building robots with LEGO bricks or programming computer games in simple languages like Scratch.
  - **Example:** Workshops focused on creating interactive art installations using technology, such as programming light or sound.
- **Role Model Showcases:** Students should have contact with female mentors working in STEM, for example, during meetings with women working in natural sciences, technology, and engineering.
  - **Idea:** Guest lectures or meetings with young women who share their careers and STEM projects.
  - **Example:** Presentations by programmers, engineers, or scientists.

B. Age 13-15

- **Interdisciplinary STEM Projects:** Students at this age begin to see greater connections between theory and practice, so it's worth proposing interdisciplinary projects that combine various STEM subjects with elements of art.
  - **Idea:** Designing videos, computer games, or mobile applications that utilize elements of mathematics, technology, engineering, and art.
  - **Example:** Collaborative design of posters, animations, and then coding applications that serve education or solve a specific social problem.
- **Participation in STEM Competitions:** Science and technology competitions (e.g., math Olympiads, hackathons, programming contests) provide opportunities for competition and teamwork.
  - **Idea:** Organizing school hackathons or programming challenges where students solve problems related to natural sciences, technology, and engineering.
  - **Example:** Hackathons dedicated to, for instance, solving ecological problems, such as creating applications for monitoring energy consumption.
- **Workshops with Inspiring Women in STEM:** Organizing regular meetings with women who have succeeded in the STEM industry can help break stereotypes and encourage girls to explore these fields.
  - **Idea:** Creating a series of meetings with mentors who share their career paths, talk about the challenges they overcame, and the projects they were involved in.
  - **Example:** Trips to technology conferences where girls can meet female leaders in the IT, engineering, or biology industries.

Ideas and Practices Specifically for Girls

A. Role Models

- **Role Models:** Women in STEM can serve as mentors, encouraging girls to decide to pursue further education in this direction. Students can meet representatives from various STEM fields who will share their experiences and show that success in these fields is achievable.
  - **Idea:** Organizing workshops with women who have achieved success in technology, mathematics, engineering, and science.
  - **Example:** Meetings with women who manage large technology companies or run their own technology-related startups.

B. Skill Development Activities

- **Programming and Engineering Workshops for Girls:** It's valuable to create educational programs that offer girls a safe space to learn programming, robotics, or design.
  - **Idea:** Programming courses with instructors who specialize in working with girls and support them in developing technical skills.
  - **Example:** Schools organizing STEM programs exclusively for girls that teach both technical and soft skills (e.g., teamwork, presentations).

C. Creative Use of Technology

- **Integration of Art with Technology:** Girls are often drawn to creativity and aesthetics. Activities that combine technical sciences with art creation can help break stereotypes about STEM as "dry" and "purely scientific" fields.
  - **Idea:** Organizing workshops on designing computer games, mobile applications, creating virtual works of art, where students can express their artistic ideas using technology.
  - **Example:** Competitions for creating an educational game or application that helps solve specific social problems, e.g., in ecological education.

Collaborative Approach – Strategies for Engaging Girls in STEM

- **Peer Initiatives:** Creating support groups and peer mentoring networks where girls can share experiences, develop their skills, and help each other.
- **Group and Project Activities:** Participating in team projects where girls can collaborate, share ideas, and draw inspiration from their peers.

To encourage teenagers, especially girls, to pursue advanced STEM studies, it is crucial to employ innovative teaching methods and approaches that combine learning with practice, engage them emotionally, and demonstrate how STEM can be both creative and socially significant. The key is to motivate youth to act through inspiration, access to role models, and support in developing their skills in these fields.

4. Needs Analysis for Improving the STEM Ecosystem

A **SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis** of the STEM ecosystem and digitalization within an educational institution allows for an understanding of the strengths and weaknesses, opportunities, and threats associated with the implementation and development of these areas. Below is a SWOT analysis that takes into account previously presented survey results from teachers, students, and parents, as well as human resources, infrastructure, educational offerings, and other aspects.

SWOT Analysis of the STEM Ecosystem and Digitalization in an Educational Institution

1. Strengths

Human Resources:

- **Qualified STEM Teachers:** The institution may employ teachers with high qualifications in STEM (science, technology, engineering, mathematics) who possess a passion and skills for conveying knowledge in an engaging manner.
- **Collaboration with External Mentors and Experts:** By establishing cooperation with technology companies and universities, the institution can provide students with access to the experiences of professionals in the STEM industry.

Infrastructure:

- **Modern Educational Technologies:** Access to computers, tablets, educational software, and remote learning platforms (e.g., Moodle, Google Classroom) enabling the development of digital competencies.
- **STEM Laboratories and Workshops:** Well-equipped biology, chemistry, and physics laboratories, as well as programming and robotics workshops.

Educational Offerings:

- **Interdisciplinary STEM Projects:** The ability to implement projects that combine science with technology, engineering, and mathematics, allowing students to develop practical skills and solve real-world problems.
- **Extracurricular and Additional Activities:** Workshops, science clubs, hackathons that develop students' interests in STEM and promote group collaboration.

2. Weaknesses

Human Resources:

- **Shortage of STEM Specialists:** The institution may lack teachers with appropriate qualifications in some STEM areas, especially in technical subjects or new technologies.
- **Lack of Experience in Working with Technologies:** Some teachers may have difficulty integrating new technologies into teaching or working with advanced digital tools.

Infrastructure:

- **Limited Financial Resources:** The institution's budget may be insufficient to purchase the latest technologies, tools, and software that support STEM development and digitalization.
- **Outdated Equipment:** Some equipment may not be modern enough, hindering the full utilization of digitalization's potential, e.g., in programming, data analysis, or 3D project creation.

Educational Offerings:

- **Lack of Diversity in STEM Offerings:** Offering only basic STEM subjects without adapting the curriculum to changing technological trends, such as artificial intelligence, big data, or blockchain.
- **Lack of Systematic Student Support:** Insufficient mentoring and counseling programs that would help students develop STEM careers or work on individual projects.

3. Opportunities

Human Resources:

- **Training and Courses for Teachers:** The possibility of organizing training for teachers in new technologies, STEM teaching methods, and the development of digital competencies.
- **Collaboration with Universities and Companies:** Establishing partnerships with universities, research institutes, and companies from the technology industry, enabling the implementation of practical research and development projects.

Infrastructure:

- **Access to Modern Technologies:** Growing availability of advanced tools and online educational platforms that can support STEM teaching and the development of students' digital competencies.
- **Remote and Hybrid Education:** The development of online education allows reaching a larger number of students and providing them with a wide range of courses and educational materials.

Educational Offerings:

- **Increased Interest in STEM Subjects:** Increased demand for STEM specialists in the job market can create greater motivation for students to develop their skills in these fields.
- **International Competitions and Projects:** Participation in international competitions (e.g., Olympiads, hackathons) and research and development projects provides an opportunity to gain experience and develop creativity.

4. Threats

Human Resources:

- **Low Student Motivation for STEM Learning:** Students, especially girls, may be less interested in STEM subjects due to a lack of inspiring role models, stereotypes, or difficulties in adapting teaching methods to different learning styles.
- **Lack of Staff Adaptation to Changing Labor Market Needs:** Difficulties in retaining STEM teachers with experience in rapidly developing new technologies.

Infrastructure:

- **Problems with Technology Accessibility:** Unequal access to modern technological tools, especially in institutions with lower budgets, may limit learning opportunities using digitalization.
- **Too Rapid Pace of Technological Change:** Difficulties in keeping up with rapidly changing technologies can lead to educational infrastructure becoming obsolete, which may negatively affect teaching quality.

Educational Offerings:

- **Insufficient Adaptation to Labor Market Realities:** If curricula do not account for current labor market needs (e.g., skills related to AI, machine learning, or IoT), students may not acquire the knowledge desired by employers.
- **Ineffective Integration of STEM with Other Subjects:** Lack of effective cooperation between teachers of different subjects to implement interdisciplinary STEM projects, which can lead to a "siloed" approach to teaching.

Summary

The SWOT analysis of the STEM ecosystem and digitalization in the educational institution indicates numerous strengths, such as qualified teaching staff, access to modern educational technologies, and an extensive offering of STEM projects. At the same time, there are challenges, such as a lack of adequate human resources in certain STEM areas, infrastructural limitations, and the need to adapt educational offerings to the dynamically changing needs of the labor market. Key will be leveraging opportunities related to developing cooperation with external institutions, as well as focusing on continuous teacher training and integrating modern technologies into daily teaching.

5. Program for the 2025/2026 School Year with Innovative Solutions

The program for the 2025/2026 school year, featuring innovative solutions in STEM education, has been developed in three sample versions. This multi-variant approach is necessary for **flexible school planning**, which must consider a range of variables such as:

- **Timetable structure**
- **Available teaching hours**
- **Staffing changes** (e.g., number and specializations of teachers)
- **Availability of classrooms and labs**
- **Ongoing international projects and local initiatives**

The specific version of the program chosen will be adapted to the school's current organizational conditions and capabilities for the upcoming school year. This will ensure the **effective and realistic implementation** of the program's objectives, maintaining high-quality education while simultaneously supporting innovative teaching methods.

Version 1: "STEM is for You!" Educational Program

School Year 2025/2026

For grades 7–8 of primary school Duration: 80 lesson hours over the school year

Program Objectives

- **Diversify** the school's STEM educational offerings.
- **Engage students** in science and technical subjects through modern teaching methods.
- **Increase the number of students**, especially girls, considering careers in STEM fields.
- **Boost girls' confidence** in working with technology and science.
- **Break down gender stereotypes** related to career choices.

Core Program Assumptions

- **Learning by doing** (experiential learning)
- **Interdisciplinary projects** (combining mathematics, physics, computer science, biology, chemistry, and career counseling)
- **Mentorship from women scientists and STEM specialists**
- **Teamwork** with equal participation from girls and boys

- **Regular evaluation** of student progress and interests

Main Program Components

1. **Innovative Themed STEM Labs (1x/month)**

   - Themed workshops, e.g.:
     - "Cosmetics Chemistry" (girls create their own cosmetics and analyze their composition)
     - "Physics of Fashion" (how LED lights work in clothing, conductivity)
     - "Biology in Motion" – analyzing the impact of physical activity on the body
     - "3D Printing for Everyone" – designing and printing custom models
   - **Project-based learning** where students create something tangible.
2. **STEM Girls Club (extracurricular activities exclusively for girls)**

   - A club supporting girls' development in STEM.
   - Meetings with women working in engineering, scientific, and IT professions.
   - Practical activities: coding, robotics, experiments, social projects.
3. **Hackathons and Technological Challenges**

   - School-wide mini-hackathons with prizes.
   - Working on solutions to local problems using STEM.
   - Group tasks supporting creativity and collaboration.
4. **Virtual Reality in Learning (ClassVR)**

   - Using VR headsets to explore biological structures, chemical processes, space expeditions, and visualize physical phenomena.
5. **STEM+ART – i.e., STEAM**

   - Introducing artistic elements into STEM learning (graphic design in programming, bio-art, artistic-technical installations).
6. **"STEM Without Barriers" Campaign**

   - Posters, podcasts, and school newspaper promoting equal access to STEM education.
   - History of women scientists – presentations, exhibitions, video materials.
   - Breaking down stereotypes and discussions about the role of women in science.

Schedule of Key Activities

Here's the schedule of key activities for the "STEM is for You!" program:

Month	Key Activities

Month	Key Activities
September	Program inauguration, recruitment for the STEM Girls Club
October	"Cosmetics Chemistry" workshop + special guest
November	"Youth for the Planet" Hackathon (sustainable development)
December	Virtual biology lesson using ClassVR
January	"Robots Helping in Everyday Life" project
February	STEM ART: creative use of science and art
March	Women in STEM Day – meeting with mentors
April	Drone challenge + environmental observations
May	Experiment Week – student science demonstrations
June	Program summary, diploma awarding

Program Evaluation Methods

To gauge the effectiveness of the "STEM is for You!" program, we'll use the following methods:

- **Pre and Post-Program Surveys:** These surveys will assess changes in students' **interest in STEM** and their **self-perception as future scientists or engineers**.
- **Observation of Girls' Attendance and Engagement:** We'll monitor **participation rates and active involvement** of girls in all program components.
- **Competency Development:** We'll track the improvement of key skills such as **logical thinking, teamwork, and presentation of results**.

Why Is It Worth It?

Because STEM isn't just about subjects; it's a **way of thinking** that opens doors to **creative and future-proof careers** for everyone, regardless of gender.

Version 2: "STEM is for You!" Educational Program

2025/2026 School Year

For students in grades 7–8 of primary school Duration: 80 lesson hours over the school year

Program Objectives

- **Make learning mathematics, chemistry, biology, and computer science more engaging.**
- **Encourage students—especially girls—to consider careers in STEM fields.**
- **Develop 21st-century competencies:** logical thinking, problem-solving, collaboration, and creativity.
- **Effectively utilize the school's modern equipment.**

Thematic Scope and Hour Plan

Mathematics in Action – 20 hours

- **Logic games and programming** using SkriBots and LEGO Spike (4 hours)
- **Spatial mathematics and 3D design** (3D printer) (4 hours)
- **Mathematical modeling** using Excel and experimental data (4 hours)
- **VR activities:** spatial figures, symmetry, proportions in nature (4 hours)
- **Mathematical escape rooms and puzzles** (4 hours)

Experimental and Practical Chemistry – 20 hours

- **Creating and analyzing DIY cosmetics** – working with reagents, models, scales (4 hours)
- **Experiments with household chemistry** and analyzing everyday substances (4 hours)
- **Designing chemical compounds and their 3D structures** (models + VR) (4 hours)
- **Working with a fume hood:** safety and laboratory technique (4 hours)
- **Chemical game using microcontrollers and ClassVR** – "Become a Young Chemist!" (4 hours)

Biology in the Modern World – 20 hours

- **Microscopic observations** + analysis of prepared slides (4 hours)
- **Water quality testing** + comparison of samples from different sources (4 hours)
- **Anatomy in VR** – exploring human body systems (4 hours)
- **Project: "Design a Superorganism"** – creative biology and genetics (4 hours)
- **Impact of movement and nutrition** – biological and mathematical data analysis (4 hours)

Computer Science and Robotics in Practice – 20 hours

- **Programming SkriBot and Jimu Trackbots robots** – logical thinking and planning (4 hours)
- **3D design and printing** – your own keychain, gadget, robot part (4 hours)
- **Drone control** – precision, algorithms, collaboration (4 hours)
- **Creating a scientific mini-podcast** using Saramonic microphones (2 hours)
- **Basic soldering** – technical workshops (2 hours)
- **Final team project: "STEM for the Good of the World"** (4 hours)

Emphasis on Girls

- **Creating groups with equal gender representation.**
- **Having parts of the activities led by invited female mentors** – women from the IT, science, and engineering industries.
- **Additional "Girls in STEM" workshops.**
- **A visible information campaign showcasing women's successes in science.**

Teaching Methods

- **Learning by doing** (experiential learning)
- **Project-based learning**
- **Learning through play and competition** (gamification)
- **Virtual Reality (VR) and Augmented Reality (AR)**
- **Flipped classroom** (online materials before practical sessions)

Program Evaluation

- **Preliminary and final surveys** for students and teachers.
- **Student reflections** after each module.
- **Documentation of project work** (student portfolio).
- **Observation of increased engagement and confidence in girls.**

Version 3: STEM Educational Program "Discover and Create the Future" for Grades 7-8 of Primary School (School Year 2025/26)

Motto: Science is an adventure, and technology is the key to the future!

Introduction

The "Discover and Create the Future" program is an **innovative educational initiative** aimed at students in grades 7-8 of primary school. Its goal is to spark their **curiosity and interest in STEM** subjects (Science, Technology, Engineering, Mathematics). We place a special emphasis on **engaging girls** by presenting them with attractive career paths and inspiring examples of women in the world of science and technology. The program utilizes **modern teaching methods**, the school's **rich equipment**, and **collaboration with the local SOWA Science Center in Złotoryja** to create an inspiring and practical learning environment.

Program Objectives

- **Diversify STEM offerings:** Propose diverse and engaging activities in STEM, extending beyond traditional lessons.
- **Foster future interest in STEM:** Ignite a passion for science and technology, encouraging students to pursue further education and careers in STEM fields.
- **Increase the number of girls in STEM:** Break down gender stereotypes in STEM and inspire girls to actively participate and develop their interests in these areas.
- **Utilize effective and innovative teaching methods:** Employ active, project-based, problem-solving, experimental methods, and modern technologies to make learning attractive and effective.

Program Assumptions and Teaching Methods (80 lesson hours)

The program will be implemented within existing lesson hours for mathematics, chemistry, biology, and computer science with elements of robotics, through content integration and the application of innovative methods.

Block 1: Mathematics – Logic, Algorithms, and Modeling (20 hours)

Methods: Logic games, mathematical puzzles, data-driven research projects, mathematical modeling using spreadsheets, elements of visual programming (e.g., Scratch) to visualize mathematical concepts. **Topics:**

- Logical thinking and problem-solving.
- Introduction to algorithms and their applications.
- Descriptive statistics and data analysis (using real-world data).
- Mathematical modeling of natural and social phenomena.
- Fractal geometry and its visualizations (e.g., using programming). **Equipment Used:** Laptops, interactive whiteboard/multimedia projector. **Engaging Girls:** Projects involving the analysis of data related to social or environmental problems, aesthetically pleasing mathematical visualizations.

Block 2: Chemistry – Experiment and Discover the World of Matter (20 hours)

Methods: Laboratory experiments (safe and age-appropriate), chemical demonstrations, creating molecule models (using physical models and software), computer simulations of chemical processes, water quality analysis (using kits). **Topics:**

- Basic chemical concepts: substances, mixtures, elements, chemical compounds.
- Chemical reactions in everyday life.
- Properties of matter and their study.
- Environmental chemistry – pollutants and their detection.
- Introduction to organic chemistry (basic functional groups). **Equipment Used:** Chemical reagent set, laboratory scales, fume hood, chemical molecule models, laptops, interactive whiteboard/multimedia projector, water quality testing kits. **Engaging Girls:** Experiments related to natural cosmetics, dyes, examining the properties of substances used in daily life.

Block 3: Biology – The World of Life in Detail and Interdependencies (20 hours)

Methods: Microscopic observations, creating biological models (e.g., DNA, cells), simulations of biological processes using ClassVR, research projects on local ecology, environmental sample analysis, using anatomical models. **Topics:**

- Cell structure and function.
- Diversity of life on Earth.
- Ecosystems and interdependencies among organisms.
- Basics of genetics and heredity.
- Human anatomy and physiology (using models and ClassVR). **Equipment Used:** Microscopes + slides, anatomical models, water quality testing kits, laptops, interactive whiteboard/multimedia projector, ClassVR (virtual reality goggles). **Engaging Girls:** Projects related to environmental protection, human health, molecular biology, and its applications in medicine.

Block 4: Computer Science with Robotics Elements – Coding, Creation, and Automation (20 hours)

Methods: Visual programming (Scratch, Blockly), textual programming (introduction to Python), 3D design and printing, building and programming LEGO Education Spike Prime, SkriBot, and Jimu Trackbots robots, drone operation (simulations and safe flights), creating multimedia project presentations. **Topics:**

- Basics of algorithms and programming.
- User interface design.
- Introduction to robotics and control.
- 3D printing technologies and their applications.
- Basics of drone operation and applications. **Equipment Used:** 50 laptops, 3D printer and 3D printing lab, 5 LEGO Education Spike Prime kits, 10 SkriBot robotic kits, 8 Jimu Trackbots kits, 5 drones, directional microphone, Saramonic Blink microphone, soldering station, interactive whiteboard/multimedia projector. **Engaging Girls:** Projects related to creating educational games, mobile applications with social or ecological themes, designing and 3D printing utility or artistic objects, programming robots to solve specific problems.

Collaboration with the Local SOWA Center in Złotoryja

Collaboration with the SOWA Center in Złotoryja will be an **integral part of the program**, offering students unique opportunities to learn through experimentation and discovery.

Examples of Collaboration:

- **Workshops at SOWA:** Organizing regular trips to SOWA where students will participate in specially prepared workshops in mathematics, physics, chemistry, biology, and technology, using interactive exhibits and the "Majsternia" (makerspace) area.
- **Conducting classes by SOWA experts at school:** Inviting SOWA staff to the school to deliver guest lectures, workshops, and science demonstrations, inspiring students and teachers.
- **Collaborative research projects:** Implementing joint research projects where students can utilize the resources and expertise of SOWA experts.
- **Using the Majsternia space:** Organizing activities in SOWA's Majsternia space, where students can develop their manual skills and creativity by building, constructing, and experimenting with various materials and tools.
- **Participation in events organized by SOWA:** Encouraging students to participate in science festivals, open days, and other science popularization events organized by SOWA.
- **Consultations and exchange of experience:** Establishing ongoing cooperation between school teachers and SOWA staff to exchange experiences, share best practices, and jointly create innovative educational materials.

Program Evaluation

Program evaluation will be conducted on an ongoing basis and after the end of the school year. The following methods will be used:

- **Student Surveys:** Assessing the level of interest in STEM subjects, opinions on the activities conducted, and the program's impact on their perception of science and technology.
- **Observation of Student Engagement:** Monitoring student activity and involvement during STEM classes.
- **Analysis of Academic Results:** Comparing student performance in STEM subjects before and after program implementation.
- **Interviews with Students (especially girls):** Gathering feedback on factors that interested or discouraged them from STEM learning.
- **Discussions with Teachers:** Evaluating the effectiveness of teaching methods and didactic materials.

- **Analysis of Student Project Portfolios:** Assessing the level of knowledge and practical skills acquired by students.

Next Steps and Maintaining Program Effects

- **Continued collaboration with SOWA:** Maintaining and developing partnership relations with the local science center.
- **Acquiring additional funding:** Applying for grants and funds to further develop the STEM educational base.
- **Teacher training:** Organizing training to enhance teachers' competencies in innovative STEM teaching methods and working with modern technologies.
- **Creating a cooperation network:** Establishing contacts with other schools and institutions operating in the STEM field.
- **Promoting student achievements:** Presenting student projects and their successes at school and within the local community.

9. Action Plan to 2030

Priority Goal: Encourage teenagers, especially girls, to study STEM subjects and plan a career in this field.

Tasks:

- "STEM is for You!" promotional campaign aimed at all students, with the participation of mentors – women working in science, technology, engineering, and IT.
- Mentoring program – meetings of students with people from the world of science and technology, with particular emphasis on women.
- Inclusion of a gender equality perspective in every STEM project at school.
- Organization of dedicated STEM workshops and clubs for girls (e.g., "Girls in Tech", "Young Engineers").

Results by 2030:

- 50% increase in participation in extracurricular STEM activities.
- At least 1 annual project at school dedicated to the role of women in science and technology.
- At least 2 mentoring meetings per year with women working in STEM professions.
- 30% increase in girls' participation in STEM Olympiads and competitions.

1. Teacher Competencies

Tasks:

- Regular training in the use of digital tools, programming, AI, 3D printing, VR.
- Workshops on STEAM methodology, project work, and interdisciplinary teaching.
- Creation of a development path for STEM leader teachers.

Results by 2030:

- 100% of STEM subject teachers trained in modern teaching tools.
- 2 teachers acting as digital innovation leaders.
- Each STEM teacher develops at least 1 interdisciplinary project per year.

2. Developing Interests and Vocational Training

Tasks:

- Expansion of the range of scientific clubs (e.g., bioengineering, data analysis, robotics).
- Permanent cooperation with employers and universities.
- Organization of "Future Professions Week" and STEM career counseling.

Results by 2030:

- Students participate in a minimum of 3 research and practical projects per year.
- 100% of older students participate in career counseling focused on STEM-related industries.
- Min. 5 meetings with representatives of STEM professions, taking into account equal opportunities and gender perspective.

3. Learning Process

Tasks:

- Implementation of project-based learning as a mandatory approach at the level of grades 4–8.
- Personalization of learning using AI and educational data analytics.
- Gamification of the learning process – use of quizzes, VR/AR platforms.

Results by 2030:

- 100% of students complete a minimum of 2 interdisciplinary STEM projects per year.
- 80% of students use digital resources and applications to support learning.
- Increase in motivation and engagement – 10% increase in average STEM subject scores.

4. Internationalization

Tasks:

- Participation in international Erasmus+ projects.
- Organization of student and teacher exchanges.
- eTwinning projects and online cooperation with students from other countries.

Results by 2030:

- Min. 4 international projects implemented by 2030.
- Students participate in a minimum of 2 international exchanges or projects during their education.
- Each STEM teacher involved in at least 1 mobility or international project.

5. Use of Digital Resources

Tasks:

- Expansion of access to educational platforms, simulations, online laboratories.
- Systematic updating of digital content and multimedia.

Results by 2030:

- 100% of STEM lessons are conducted using digital tools.
- Min. 1 digital student project from each STEM subject per semester.
- School library integrated with digital resources for students and teachers.

6. Investments in IT Tools and Infrastructure

Tasks:

- Modernization of the network (fiber optics) to fully utilize the potential of the equipment.
- Creation of a space for project and workshop activities.
- Ensuring 1:1 – access to digital equipment for each student during lessons.

Results by 2030:

- Network infrastructure with 100% coverage in the school with access to fast Internet.
- Full use of the available equipment in planning lessons and projects.

10. STEM Ecosystem Implementation Plan

Here's the plan for building our STEM ecosystem:

Age Stages:

- **0-6 years (Preschool education):** Focus on sensory-experimental play and the fundamentals of logical thinking.
- **7-9 years (Grades 1-3):** Introduce coding through play, and basic robotics (e.g., BeeBot, ScratchJr).
- **10–12 years (Grades 4-6):** Implement extended interdisciplinary projects and emphasize experiential learning.
- **13–15 years (Grades 7-8):** Dive into programming, AI, 3D design, and encourage participation in competitions and research projects.

Forms of Learning:

- **Formal learning:** Through regular subject lessons.
- **Informal learning:** Via clubs, workshops, and labs.
- **Non-formal learning:** Through field trips, science festivals, and e-learning platforms.

External Partners:

- **Universities:** Wrocław University of Science and Technology, Wrocław University of Environmental and Life Sciences.
- **Business/Industry:** Mentor Polska, Code for Green.
- **NGOs:** PFR Foundation, STEMantyka, Robisz.to.
- **Local Initiatives:** SOWA, Lower Silesian Science Festival.