

# T3ki Mars-rover in physics class - STEM project for high school students

**Abstract.** The following paper present a school project which helps to combine theoretical knowledge and students' brainstorming and engineering skills in a STEM activity. The topic is applied in the classroom through inquiry- and project-based teaching methods, and in the Science Club activity. The goal is to develop students' competencies in such a way that is attractive and fascinating for them. It is also excellent for physics classes where certain chapters of mechanics, optics or electromagnetic waves are taught, as it connects the observations and laws of different phenomena to accomplish the tasks at a wider level than in the curriculum.

## 1 Introduction

Introducing the matter of space research at the high school level is not an easy job for the teacher, because even those students interested in this topic do not necessarily hold enough patience to investigate alone and thoroughly the theoretical background, and thus their lack of academic knowledge (regarding mathematics, physics, or computer science) results in not being able to understand subjects related to space exploration. Therefore, these deficits need to be bridged by the teacher who initiates the display of an issue similar to this one. In this case, the relevant ESA - ESERO projects and their applications in the given school context could be a good help. The main target of students is to build a controllable rover (the one that is used to discover the surface of the planet, Mars), a robot capable of exploring an unknown area, performing special measurements, and transmitting the obtained data to the control centre.

The teaching method used in the implementation of the project is based on the 4Cs (creativity, critical thinking, communication, and collaboration) principle, serving as the foundation of the active learning strategies. Classes are built in a way to provide a flipped classroom, a peer instruction session, problem solving tasks, and many hands-on activities. The teacher does not act as a source or transmitter of information, but rather as a mentor and facilitator, who supports each group allowing them to work in their own rhythm (according to students' personal abilities, skills) in developing, understanding, and demonstrating the topic.

## 2 T3ki Mars-rover project

The major stages of the project are the followings: making the design of the rover, writing the rover motion control programs, designing and developing hypothetical foundation of the measurement tasks (design of the electrical circuits), construction of the rover and coordination of individual modules, and of course, the testing.

In the design phase, students apply their computer skills and use C ++ learned in school to write test programs. During the time of the teamwork, they become familiar with the Python language. A special microcontroller unit needs to be built into the rover's remote-control panel and data transmission unit, followed by an easy-to-use control device. Samples, images, and data collected from the unknown area are saved by the rover to an SD card. Returned to the control centre, the data is processed and displayed on a webpage.



Fig. 1 The T3ki Mars-rover

The project is very complex, takes up a lot of time and effort, but is very popular among students because of the many entertaining and challenging activities. They have the possibility to constantly test new ideas to improve the movement, control, or data processing of the unit which in the long run helps them learn new skills and improve existing abilities.

### 3 Conclusion

The building of the T3ki-rovers provides a non-traditional learning opportunity for high-school students to work freely on their own, giving rein to their ingenuity, but at the same time keep deadlines and follow the rules. The teacher can observe how the acquired knowledge is utilized, how the young people have become more confident in working the tasks out, and how the created rover - the end-product – becomes more and more efficient and reliable day by day. Although, more males are involved in IT projects, some female students find the building of the Mars-rovers exciting, as well. They could also easily find creative objectives and achieve success in this field.

The experience has shown that students who are involved in solving such tasks for at least one academic year are more confident in their career choices, mostly in technical, IT-based undergraduate studies. These students are more open to technical innovations, easily engage in managing highly challenging problems, have advanced critical thinking, and are more inventive.

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