STEM education LLC

National STEM Competition 2025

Open Category

(Middle School)

Rules and scoring

2nd Edition (February 2025)

Content

Description of the topic

The desire to explore is an inherent characteristic of human nature. Since ancient times, people began to explore the Earth and at the same time turned their gaze towards the sky. The search for other habitable planets is the natural extension of this desire.

Mars is the most Earth-like planet in our solar system. Studying it may provide a unique opportunity to understand the evolution of planets and the possibility of life.

The colonization of Mars is an ambitious effort that faces many challenges and requires solutions to various problems. While technology continues to advance, humans will have to resolve many critical issues before they can establish viable colonies on Mars.

Some of the main problems to be solved:

1. Transition and Landing

- **Travel Space:** The trip to Mars takes about 6-9 months with current technology. This requires robust spacecraft that can protect passengers from radiation and other hazards.
- **Landing:** Landing on Mars is complicated due to the thin atmosphere, which makes it difficult to slow down spacecraft.

2. Radiation

- **Cosmic Radiation:** Without the protection of Earth's magnetosphere and atmosphere, people on Mars will be exposed to high levels of radiation.
- **Solar Storms:** Explosions on the Sun can increase radiation in space, affecting astronauts.

3. Air and Water Supply

- **Oxygen Production:** Technologies need to be developed that will produce oxygen from carbon dioxide in the Martian atmosphere.
- **Water Supply:** Finding and extracting underground ice and recycling water is vital for survival.

4. Diet

- **Food Cultivation:** Growing food in a hostile environment with low gravity and limited resources is a big challenge.
- **Food Storage and Transportation:** Food must be kept fresh and nutritious during travel and stay.

5. Housing and Infrastructure

- **Radiation Protection:** Homes must provide protection from radiation and extreme temperatures.
- **Infrastructure Construction and Maintenance:** The construction and maintenance of houses and other structures require the use of local materials and advanced robotics.

6. Energy

- **Energy Production and Storage:** Colonies will need energy sources to meet their needs.

7. Contact

- **Communication Delays:** Communication with Earth has a delay of 4-24 minutes, which can affect operational decisions and daily life.
- **Autonomy:** Colonies should be sufficiently autonomous and able to make decisions without direct communication with Earth.

8. Environmental Challenges

- **Extreme Temperatures:** Temperatures on Mars can range from -125°C at night to 20°C in the day.
- **Dust and Dust Storms:** Dust storms can last for weeks and cover the planet, affecting energy production and respiration.

9. Health and Medical Care

- **Access to Medical Care:** Colonies must have equipment and medicines to treat diseases and injuries.
- **Mental Health:** Isolation and harsh living conditions can affect residents' mental health

10. Social Organization and Administration

- **Organization and Administration:** The colonies will need a system of administration that manages resources and resolves conflicts.
- **Legal and Ethical Issues:** Legal frameworks for ownership, resource use, and human activity on Mars must be established.

The requirements of the competition

Motivate students to study in detail the challenges of human settlement on Mars by seeking relevant information. Ask them to imagine and propose feasible solutions for one or more challenges.

They will be evaluated...

1. Functional representations from smart prototypes and as applicable solutions as possible
2. Demonstration of a fully functional project based on specifications
3. Proper presentation of the project which will include:
1. Verbal support in a spirit of cooperation of team members
2. Correct answers to the judges' technical questions
3. Complete documentation of the project with printed or digital supporting material.

Below is the description of the deliverables by a team participating in the Competition.

Output 1

Fully Functional Mock-up (evaluation day)

Help the children create a fully functional project (mock-up) that presents the problem and the proposed solution by incorporating the automations requested by the rules of the competition. Prepare the children for a group presentation of the project on the day of the presentation of the project to the judges.

The Model of the project

On the day of the assessment, the team should present a fully functional model that represents the scenario the students have dealt with. This project should highlight the issues that troubled the students and are related to the colonization of the planet Mars as well as the solutions they propose.

Both the representation of problems for our survival on Mars and the proposed solutions can include motion mechanisms and electronic automation.

The model of the project The work should be supported by a "script narrative" that will unfold in some space. This space will be represented in the work with a model that will be the backdrop in which the automations will be integrated. On the day of the competition, each team will be allocated a space measuring approximately 150 cm x 150 cm and with a vertical back height of approximately 2m. Printed material can be glued on the back or the presentation can be projected (with a projection of the team). In the booth there will be a workbench measuring approximately 100cm x 60cm. In this space the model should be installed along with the automations. Alternatively, the team can place its work on the floor, as long as it does not exceed the boundaries of the stand. Electricity supply with power strips will be available at the kiosk. There will be no wired internet or wifi capability.

Mock-up Materials

The robotics systems with the ability to develop free precision mechanical constructions that exist in schools for the age category we refer to are of the Lego type. Given this, all parts of the structure that involve mechanical automation or motor-driven mechanical parts should be made with Lego plastic building blocks. The remaining parts of the structure can be made with any other material (such as foam, paper, wood, etc.) as long as it does not pose any risk to children.

The automation of the model

S1 and S2 Automation

S1 and S2 automations should be implemented according to the following requirements:

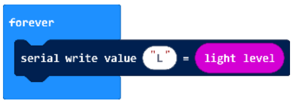
1. Each automation includes at least one sensor, the processor and at least one actuator.
2. The sensor of the automation can be analog or digital.
3. The sensor can be internal micro:bit sensor or external sensor.
4. The actuator can be for example motor, led, buzzer or relay

In both S1 and S2 automation, the corresponding actuator activated in the automation should be part of the overall mock-up of the project and serve a purpose in terms of project functionality.

E1 Automation

Automation E1 must be implemented according to the following requirements:

1. Automation includes at least one sensor, the processor and at least one motor.
2. The automation sensor takes measurements of a physical quantity (e.g. Length, Angle, Temperature, Mass, Electric Voltage, Luminous Intensity, Magnetic field strength, Sound Volume)
3. The sensor is: internal micro:bit sensor or external sensor.
4. Physical quantity measurements are presented on a computer screen in real-time graphics (graph) vs Time



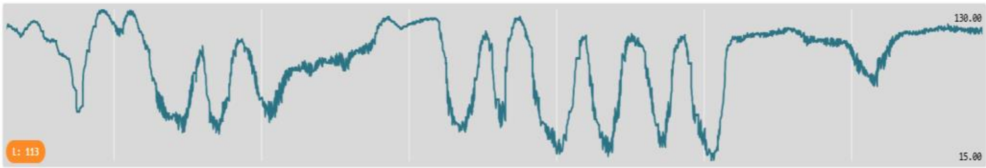


Figure 1 Graph in MakeCode

5. The automation is activated by comparing the sensor measurement with a specific value of the physical quantity (threshold).
6. In E1 automation, the corresponding motor that is activated should drive a mechanical structure with a specific function, or it should be part of a robotic system that includes a mechanical construction with a specific function in the project. The use of simple machines (wheel, screw, pulley, gear, lever, inclined plane, wedge) in any case is required. Robotic or mechanical construction is also part of the evaluation with increased gravity.

In these automations, the following are evaluated:

1. The originality of automation
2. The correct measurement and use of the physical quantity associated with the sensor
3. The mechanical construction or construction of the robotic system that includes the **motor – actuator** of the mechanism.

For example:
For the measurement and graphical display of physical size can be used
Micro:bit with internal sensor
Micro:bit with external sensor and interface board
Nezha System (Micro:bit)
IoT:bit system

For the creation of a Robotic System-Mechanism, the following systems.
Nezha System
Wonder Building Kit

The programmable environment for S1, S2, E1 automation can be **MakeCode** or software based on **the MIT Scratch** environment such as **Mind+** or **e-code.**

The educational benefits of using electronic measurements of physical quantities

Along with the knowledge that children gain about the scientific field to which the topic of their project refers, E1 automation is a very good opportunity to teach the following concepts:

1. Analog and digital signals digitize the analogue magnitudes of nature.
2. Units of measurement
3. Measuring ranges
4. Application of the concept of proportion taught in primary school
5. Measurement errors
6. Change in physical quantities over time
7. Cartesian reference system and graph
8. Dependence of physical quantities on other physical quantities

E1, S1 and S2 automation helps children understand in depth how modern electronic devices around us use electronic sensors to make useful decisions.

Output 2

Documentation File

5 working days before the assessment

Help the children create digital documentation of their work and share the electronic material using a network drive (e.g. google or Dropbox) sending the link at the following email: **nationalstemcontest@gmail.com**

Each team should submit electronically a portfolio file containing:

1. A brief description of the project (word document) highlighting the problem it solves.
2. Photos showing the stages of the construction of the project and especially the constructions of the mechanisms.
3. Optional Video where students will present describing and showing the operation of the construction, with emphasis on automation (zoom-in to show the automation) in operation and its size should not exceed 80MB. Attention: Projects whose video size will exceed 80 MB will not be included in the portfolio evaluation process.

Under the responsibility of the coach, the portfolio file is submitted electronically and on time with a specific date communicated by STEM Education (at least 5 days before their participation in the competition). Projects submitted after the deadline are at the discretion of the Jury to decide whether they will participate in the ***Competition*** and will be evaluated.

The presentation of the project by the students

On the day of the Competition (Regional or Final) teams must:

1. install in the "booth" that will be allocated to them the mock-up, automations and sets transported prefabricated and pre-assembled,
2. ensure that the establishment complies with the regulations,
3. demonstrate and present their work to the public (if requested).

A limited amount **of time is allocated to each team for judging** projects (resulting from a compromise between the number of teams and the total evaluation time allocated). **Indicatively, this time may be 10 minutes**, of which a part, e.g. five minutes, will be for the presentation and the rest of the time for questions from the judges.

During the evaluation of their work by the judges, the teams present their work by narrating their "innovative idea" and their invented scenario in a "theatrical way". The presentation can be supported either with a short brochure or with a Power Point in which the basic characteristics of the project are mentioned.

In a collaborative atmosphere, each member of the team, depending on the role he played during the development of the project, takes the floor and:

1. mentions how their work relates to its subject
2. Competition
3. narrates the "script" on which the play is based and guides the judges to the
4. model
5. explains how automation solves the problem
6. demonstrates the operation of automation

Indicative project evaluation criteria

In the evaluation of the medals the judges may consult the following rubric.

Rubric with indicative evaluation criteria

CATEGORIES CRITERIA GRADES				
Exploration / Conception of Idea	**TOTAL POINTS: 60**			
	1	Research and Development of Ideas		20
	2	Challenge solving thinking correctness - feasibility		20
	3	Multifaceted development of the topic / Completeness		20
Construction Mechanisms Automation	**TOTAL POINTS: 140**			
	1	Artistic image of a model, rendering environmental representation		40
	2	Mechanical constructions, use of simple machines, proper operation		20
	3	E1 Automation	Correct measurement/use of physical quantities	10
			Originality	10
			Mechanical-Robotic construction related to actuator motor	20
	5	S1 Automation	Functionality	10
			Originality	10
	6	S2 Automation	Functionality	10
			Originality	10
Knowledge-Understanding	**TOTAL POINTS: 60**			
	1	Understanding of scientific concepts related to the project		30
	2	Good knowledge of the code, team response to relevant questions		30
Presentation	**TOTAL POINTS: 40**			
	1	Communication Skills - Expression		10
		Member participation		10
		Collaboration		10
	2	Decor, Videos, Posters		10
				Total Points 300

Indicative proposals to be implemented

1. **Automatic Greenhouse**: System that controls temperature, humidity and light for growing food.
2. **Water Recycler**: Unit that recycles water for reuse in everyday needs.
3. **Robotic Resource Extraction System**: Robot that collects minerals and other materials from the soil of Mars.
4. **Oxygen Plant**: System that produces oxygen from carbon dioxide in the Martian atmosphere.
5. **Radiation Resistant Residence**: Model of a house that protects against the radiation of Mars.
6. **Robotic Exploration Vehicle**: A vehicle that explores the surface of Mars and collects data.
7. **Solar Energy Plant**: Solar panels and energy storage system.
8. **Life Support System**: Automatic unit that manages air, water and waste.
9. **Robotic Assistant for Construction**: Robot that helps in the construction of buildings and other structures.
10. **Autonomous Navigation System**: Robots that can advance on the surface of Mars without human intervention.
11. **Fuel Plant**: System that generates fuel from Mars resources for future missions.
12. **Robotic Transport System**: A vehicle that transports materials and equipment to the surface of Mars.
13. **Communication System**: Network for communication between the inhabitants of Mars and Earth.
14. **Automatic Waste Management System**: Unit that manages and recycles waste.
15. **Food Production Unit**: A complex that produces food through hydroponics or other methods.
16. **Robotic Research Laboratory**: Mobile laboratory for scientific research on the surface of Mars.
17. **Climate Control System**: Unit that maintains temperature and humidity in homes and laboratories.
18. **Robotic Hazard Detection System**: System that detects physical hazards such as dust storms.
19. **Autonomous Air Purification System**: Unit that purifies and filters the air indoors.
20. **Robotic Repair Unit**: Robot that repairs equipment and buildings.
21. **Algae Food Production Unit**: Algae cultivation system for food and oxygen.
22. **Waste Recycling System**: A plant that converts waste into useful raw materials.
23. **Robotic Groundwater Research System**: Robot that detects and extracts groundwater.
24. **Automatic Building Materials Production Unit**: System that produces bricks and other materials from the soil of Mars.

25. **Robotic Health Care System**: Robot that provides medical services and care.
26. **Inventory Management System**: Automatic unit that monitors and manages food and material stocks.
27. **Robotic Hydrogen Unit**: Robot that collects, produces, uses hydrogen for energy.
28. **Energy Storage and Management System**: Batteries and energy management system.
29. **Autonomous Environmental Monitoring System**: Module that monitors environmental conditions on Mars.
30. **Robotic Road Construction Unit**: Robot that builds and maintains roads.
31. **Thermal Loss Management System**: Unit that minimizes heat losses in buildings.
32. **Autonomous Freshwater Production System**: A plant that produces fresh water from salt water.
33. **Robotic Life Detection System**: Robot that detects possible microbial life on Mars.
34. **Dust Protection System**: Unit that protects equipment from Martian dust.
35. **Autonomous Heat Generator**: System that generates heat for homes and workshops.
36. **Emergency Management System**: Unit that manages emergency and rescue situations.
37. **Autonomous Clean Fuel Production Unit**: A system that produces clean fuel from renewable sources.
38. **Robotic Ice Water or Subsoil Water Detection and Extraction System**: Robot that detects and mines ice for water.

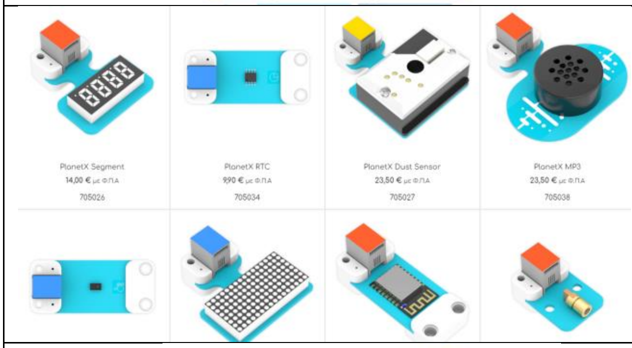
ANNEX

Featured Competition Materials

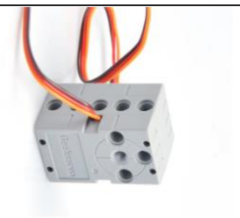
The materials proposed to be used for the implementation of automation are the materials that schools have occasionally purchased from robotics equipment programs and are compatible with the software allowed in this competition category.

The materials are described in the following tables.

Recommended materials compatible with Micro:bit processor

	729039 Micro:bit v2
	708232 NEZHA Inventor's kit for micro:bit
	PlanetX Modules
	708239 32 in 1 micro:bit Wonder Building Kit

	[Micro:bit Smart Agriculture Kit]()
	[Micro:bit Smart Home Kit]()
	[Micro:bit Smart Science IOT Kit]()

	Micro:bit Smart City Kit
	Micro:bit Smart Health Kit
  	710155 Geekservo angle 360 Degrees 710156 Geekservo Continuous rotation 360 Degrees 710154 DC rotation Motor