EDUCATIONAL MOBILE ROBOTS AS A TOOL FOR STEM EDUCATION THROUGH THE INTEGRATION OF TECHNOLOGY, MATHEMATICS, AND THE BULGARIAN LANGUAGE

Maya Staikova
Institute of Information and Communication Technology, Bulgarian Academy of Sciences, Bulgaria
ctaukoba@gmail.com

Nayden Chivarov
Institute of Information and Communication Technology, Bulgarian Academy of Sciences, Bulgaria
nchivarov@gmail.com

Abstract

To foster STEM education and the application of interdisciplinary approaches and research methods in teaching, well-chosen thematic units can serve as an effective foundation. This paper aims to present an interdisciplinary lesson unit, integrated with research methods, titled "Little Cartographers."

The unit establishes a multidisciplinary framework connecting the following academic disciplines: Mathematics, Bulgarian Language, Informatics, Computer Modelling, Art, History, and Geography. It features a series of student tasks designed around project-based and research-oriented learning approaches.

The applied tasks, which lead students to derive scientific findings, form the basis for building core scientific competencies and developing scientific literacy. This methodology represents a strategic fit for promoting active learning. It engages various hierarchical levels of Bloom's Taxonomy and creates a supportive intellectual and emotional environment conducive to cultivating research skills in the school setting.

Keywords: *STEM Education; Robot; Multidisciplinary; Project-based Approach.*

INTRODUCTION

The topic "Young Cartographers" enables the implementation of a STEM lesson that can be conducted in small segments during regular class hours or as an extracurricular activity within a one or two-term project. The lesson offers the opportunity to create diverse themes combining research, technology, and project-based activities in a STEM learning environment.

With the help of the provided materials, students expand their knowledge in Bulgarian language, mathematics, computer modelling, history, and geography (Human and Society, Human and Nature, Homeland Studies). At the initial stage, students acquire new knowledge. The manner in which they acquire it will leave an imprint on their consciousness. Therefore, an integrated lesson, combining various subjects into one, provides a clearer understanding not only of knowledge acquisition but also of the overall picture of an activity and critical thinking.

At the initial stage, "My Safe Route to School" is studied. Students create their own maps from their homes to the school, either independently or with parental assistance. The rules of the road, spatial orientation, and map reading are important lifelong knowledge and skills. This can start with a single lesson involving basic knowledge and a small amount of practical work.

This lesson can be expanded into several subtopics, such as:

- The Profession of Cartographer

- "Patko" – My Robot
- I Am a Cartographer
- I Am an Explorer
- The Role of a Map
- The Geometry of a Map
- My Tale of "The Shortest Route to the Future" and others.

EXPOSITION

The topic of cartography provides numerous opportunities for multidisciplinary learning, the development of practical skills, and creative expression. The theme requires interdisciplinary connections and diverse learning activities that motivate and sustain students' interest.

The topic can be explored briefly within one or two class periods, or expanded into a project with a subset of research and applied tasks culminating in the creation of a final product.

"Young Cartographers"

Primary Grades 1-4"

Objectives:

Students will:

- Understand what a geographical map is.
- Understand the parameters required for it to exist – meridians, parallels, geographical longitude and latitude, units of measurement, and scale.
- Understand measurement tools – the compass.
- Learn about the history of maps and their role/application in daily life.
- Learn key concepts for using maps.
- Distinguish between types of maps – geographical, transport, GPS, chip (embedded), banking.
- Describe the main technologies and engineering solutions for creating maps.
- Use mathematics and computer science to solve practical tasks related to map creation.

Interdisciplinarity: Computer Modelling, Technology and Entrepreneurship, The World Around Us – Geography, History, Bulgarian Language, Mathematics.

The connections that can be made regarding STEM education are shown in Table 1, and Table 2 lists the connections with the subjects in the curriculum.

Table 1. Potential Connections with STEM Fields

Fields	Topic Correlations with STEM Fields
Mathematics and Computer Science	Students will apply mathematical calculations in the process of map creation, utilizing the provided materials. Models will be developed to Canva, Google Jamboard, Word, scratch , app – map plus, GPS fields, area, measure; 3D map - GIS (Scratch).
Homeland Studies Man and Society	They will become familiar with various geographical terms, concepts, maps, regions, and the area around them.
Computer Modelling	Maps are to be drafted using information technology
Robotics and Cyber-Physical Systems	It is possible to examine the role of cyber-physical systems in map creation and the use of a writing robot.
Art	Drawing

Table 2. Potential Connections with Curriculum Subjects

Subject	Topics from the Curriculum	Competencies as Expected Learning Outcomes
Mathematics	Addition and Subtraction Multiplication of single-digit/multi-digit numbers by a single-digit/double-digit number (This appears to be a heading for a mathematics lesson or curriculum section. The translation is direct and unambiguous.)	Performs the arithmetic operation of addition and subtraction. Performs the arithmetic operation of multiplication of a single-digit/multi-digit number by a single-digit/double-digit number. Explains the obtained results from a solved problem. Composes a word problem based on data presented through drawings and diagrams.
Computer Modelling	Creating Models	Uses various software for drawing models of geographical and other maps. Knows how to utilize information from the internet.
Homeland Studies Man and Society	I recognize / familiarize myself with the settlements in Bulgaria. Orientation using a geographical map. The surface / terrain of Bulgaria – plains and lowlands.	Discovers the connection between the characteristics of the natural environment and the type of settlement (city, village) with the labor activities of people in our homeland. Knows the characteristics of the location and nature of the native region. Determines the cardinal directions when working with a geographical map. Points out the state borders of Bulgaria on a geographical map. Orients oneself on a geographical map regarding Bulgaria's location on the Balkan Peninsula. Understands the significance of Bulgaria's geographical location for its development. Recognizes map symbols. Draws basic types of map symbols. Describes the surface of the Republic of Bulgaria using the geographical map. Orients oneself using the colors on the geographical map to locate natural features. Describes the basic characteristics of natural features and their significance – plains, lowlands. Understands people's responsibility for preserving Bulgaria's natural resources. Explains the connection between natural conditions and the labor activities of people. Techniques for map orientation.
Technology and Entrepreneurship	Instruments and materials	Recognizes materials with high and low durability. Identifies materials that can be recycled. Processes paper and cardboard while using tools safely. Applies the operations of cutting, bending, and punching when working with accessible materials (paper, cardboard, metal foil, wire). Makes an independent selection of materials and tools for crafting a product and ensures safe working conditions.
Art	Colors, GPR, drawing techniques, tools.	Recognition of primary colors, palettes, knowledge of tools, types of writing instruments, drawing bases, materials.

For the topic to be effectively assimilated and for students to acquire new knowledge, they must possess foundational knowledge on which to build. In this case, the prerequisite knowledge necessary for cartography includes:

- Spatial orientation and directionality – turning left, turning right, moving forward, moving backward;
- Scaling and proportional representation (scale);
- Materials and their fundamental properties;
- Diverse drawing techniques and technologies;
- Technologies for map construction;
- Research into materials for map production (thickness, strength, durability, decomposition, water resistance, moisture resistance);
- Challenges and risks associated with map creation;
- The role of engineering in the creation and maintenance of maps;
- Geometry and design principles in cartography;
- Engineering solutions to ensure map durability and stability;
- Drawing inspiration from nature for sustainable technologies (biomimicry).

IMPLEMENTATION OF THE TOPIC

1. Motivation

1.1. Connection with Objects and Fundamental Scientific Principles of Space and Motion

The creation of a geographical map will require understanding and applying concepts of movement direction, cardinal directions, and material properties such as thickness, strength, durability, decomposition, water resistance, and moisture resistance. Children will learn how these properties influence people's daily lives, including their critical importance in creating various objects essential to our everyday existence. This will stimulate their interest in science and technology from a very early age.

1.2. Creativity and Manual Dexterity

Designing maps is not only a technological challenge but also a creative process. Children will create their own map plans using various materials and techniques. This develops their imagination as well as their skills in working with different materials and tools.

1.3. Cultural and Historical Enrichment

The topic of maps is connected to the study and creation of different map formats. Children will learn about the history of maps—geographical, transport, banking, and others. This will enrich them culturally.

1.4. Emotional and Social Benefit

Developing ideas and solving map-related tasks can be a team activity that encourages cooperation and communication among children. They will work together to create plans and solutions that can help future generations navigate space correctly. This develops their spatial orientation, social skills, and creates a sense of shared purpose.

1.5. Practical Application

Children will learn how to use mathematical and scientific principles to solve real-life, everyday problems, which includes performing calculations to create map models. This knowledge will prepare them for the future of science and technology.

2. Introduction and Theoretical Framework

2.1. Building Future Environment(s)

Life and the environment around us are in a constant process of development and change. In our daily lives and personal growth, we use various tools to navigate the surrounding world. Studying maps for orientation will provide future generations with a foundation for understanding the world around them—how to search, observe, and apply their surrounding environment to their daily lives. This new knowledge will foster their creativity to build their own models.

3. The Genesis of Maps

The map represents a transition from drawing to cartography. Cartographic works reflect a people's vision of the world and their place within it.

3.1. Ancient Eastern Cartographic School

The Babylonian Map (Fig. 1), also known as the Imago Mundi, is considered the world's oldest known map. It was discovered in Iraq, crafted from clay, and depicts the entire known world as understood by its creators. It is housed in the British Museum in London and is dated to approximately the 6th to 5th centuries BCE [1].

Fig. 1 Babylonian Map of the World

Around the central part of the map, seven triangles resembling rays are depicted. They indicate directions and distances from Babylon to various features.

Another example, cited by some archaeologists as the world's oldest map, is a clay tablet measuring 7.6 × 6.8 cm, discovered near the Iraqi city of Kirkuk in 1930. It depicts a map of a river valley extending between two hills. The cartographer Leo Bagrow dated it to 7000 BC (History of Cartography Project, Volume 1, 1987).

3.2. Cartography in Ancient Greece and the Hellenistic World

The scientific foundation of Western cartographic traditions was shaped by classical Greek theories about the nature and shape of the Earth (Ehrenberg, 2006) [1]. The Pythagoreans introduced the concept of a spherical Earth around the 5th century BCE (Kanev, 1965). The first map of the Earth's surface known to the ancient Greeks was created by the Greek mathematician and philosopher Anaximander (610–540 BCE) (Fig. 2). He depicted the Earth as a flat disk, surrounded by an ocean. The central part features the Mediterranean Sea, bordered by Europe, Asia, and Libya (Africa). This same image of the Earth can be seen described in Homer's Iliad [2].

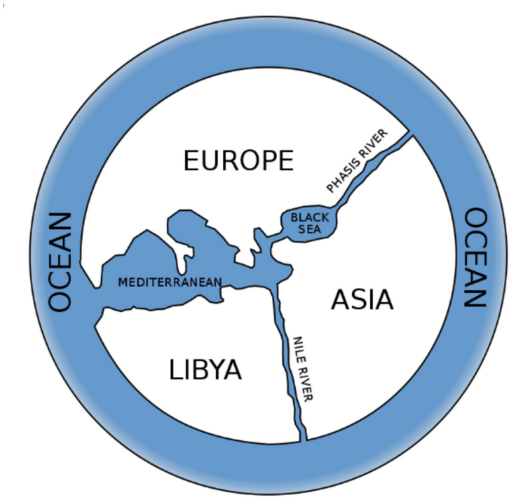

Fig. 2 The World According to Anaximander

Numerous other diverse map variations can be presented and discussed with the students. Five different maps can be displayed, the class divided into five teams (groups), and each team assigned to research information about their map and present their findings to the other groups, either orally, with the aid of a presentation, or by creating a poster board to visualize the information. For this purpose, resources from a Cartography textbook [1] can be utilized. The material is freely accessible, or the teacher can select and provide the information in a suitable manner.

4. Reasons for Creating Maps

The first international definition of the science of cartography and its subject of study was given by the International Cartographic Association (ICA) and published in 1973:

"Cartography is the art, science, and technology of making maps, together with their study as scientific documents and works of art."

Within this context, cartographic products can include all types of maps, plans, charts and profiles, three-dimensional models, and globes representing the Earth or any celestial body at any scale.

A map is most frequently defined as:

"A reduced, generalized, symbolic, and mathematically determined representation of the Earth's surface on a plane, which shows the distribution, state, and interrelationships of various objects and phenomena of nature and society, selected according to the purpose of each map."

The contemporary level of cartography has expanded its scope beyond the boundaries of our planet. For these reasons, some authors offer the following broader definition of a map:

"A reduced, generalized representation of the Earth's surface or other celestial bodies, depicted on a plane using a defined projection and conventional symbols."

5. Bulgaria in Old Maps

Conduct research on Bulgaria – how and where it is located on old maps. Online resources can be used [3].

6. Navigational Charts of the Marshall Islands

Acquainting students with the Marshall Islands. Brief information – what is an island, where they are located, finding them on a globe or map. Creation of a model map based on Fig.3 [2].

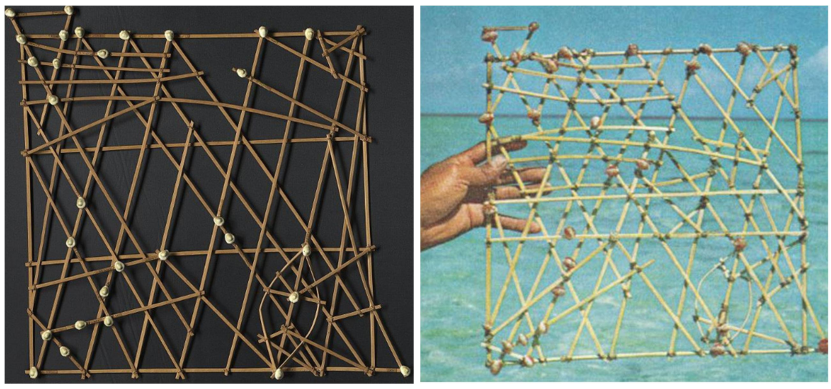

Fig.3 Navigational Charts – Marshall Islands

How Marie Tharp (Fig. 4) Mapped the Ocean Floor

Marie Tharp was an American geologist and oceanographer who helped create the first comprehensive map of the world's ocean floors [4].

Fig. 4 Marie Tharp

7. The Colonial Era: Maps as a Tool for 'Claiming' Territories

An engaging tale about the conquest of territories and how they were 'claimed' and subjugated. A history of wars driven by a thirst for governance, possession, and expansion [2].

8. Project Concepts for Maps

Students are to become acquainted with types of maps and their purposes, missions, and vision. Fig. 5. The topic unfolds with an art-oriented focus—drawing, drafting, and design.

Fig. 5. Types of Maps

9. Tools Aiding the Map – The Compass

9.1 The First Compass Fig. 6 – History. It was invented during the Han Dynasty, 300-200 BCE. Its primary direction was south, known as "south-governor" (sīnán 司南). In Europe – 13th-14th centuries.

Fig. 6 Chinese Compass

The compass was invented over 2,000 years ago during the Han Dynasty (汉朝). An interesting fact is that it was initially used not as an instrument for determining direction, but for the purpose of conducting divination. These divination practices were aimed at finding happiness, which gave rise to the ancient Chinese art of harmony known to the world as Feng Shui (风水).

In its earliest days, the compass was called sīnán (司南, lit. 'south-pointing'). Its use expanded, and its spread to Arabia and Europe only became a fact during the 13th century.

The earliest compasses were made from lodestone, a naturally magnetized rock. The lodestone was shaped into a form resembling a spoon and placed upon a bronze plate marked with the cardinal directions. This apparatus was called the "Sinän".

However, over time, people began to realize its practical applications for navigation. By the 11th century, compasses were being used on Chinese ships to find their way across the seas. This was a game-changer for maritime trade and exploration. With the compass, sailors could venture farther from shore and explore new lands with greater confidence.

9.2 Widespread in the Islamic World and Europe

The "compass" technology gradually made its way from China to the Islamic world. Arab merchants and sailors readily adopted this useful instrument. They improved its design, making it more accurate and portable. The Islamic world played a crucial role in disseminating the compass to Europe.

By the 12th century, European sailors began to use compasses. Initially, they were somewhat skeptical of this new technology. However, once they saw how it could help them navigate more safely and effectively, the compass became an essential part of their equipment. The compass revolutionized European exploration. It enabled explorers like Christopher Columbus and Ferdinand Magellan to embark on their epic voyages and discover new continents.

9.3 Modern Innovations and the Evolution of the Compass

Over the centuries, compasses have undergone numerous changes and improvements. Today, we have a wide variety of compasses to meet different needs. For instance, if you are in the outdoor or tourism sector, you might use a waterproof digital compass.

There is also a waterproof metal baseplate compass with a sighting mirror and a map measurer. Another is a miniature flip-lid compass with a metal cover. It is small enough to carry in your pocket yet remains highly accurate.

9.4 Cartographic Content – This is the main element of a map, representing the cartographically depicted territory.

Mathematical Basis of a Map – Includes scale, the neat line (inner border), the cartographic grid of meridians and parallels, and the coordinate grid.

Additional Content – Contains the outer border, title, legend, photograph, diagrams, and references.

PRACTICAL TASKS

Task 1: Creation of a Mini-Map

Students are divided into 5 groups. The teacher assigns them based on their place of residence, aiming to combine students with a greater distance between their homes and from the school. Each student must draw the route from their home to school, including streets (names if known), buildings, and other landmarks. The drawing is executed on A4 tracing paper with an HB pencil and a ruler. Afterwards, students overlay their sheets so that the school is positioned at a single point, allowing them to see how a map of the neighborhood is formed according to their individual homes.

Resources for the task:

- A4 Tracing Paper
- HB Graphite Pencil
- Ruler(s)

Task 2: Creation of a Larger Map

Students fix the maps from Task 1 at the school's point and collaboratively create a larger map where the school is in the center, and relative to it, they outline the map toward their homes. The work is done on a flipchart paper sheet.

Resources for the task:

- Flipchart paper
- HB Graphite Pencil
- Rulers

- Colored Pencils

Task 3: Creating a More Complete Geographical Map

Students discuss the collected data, deliberate within the team on how the map should look, distribute tasks among themselves; measure and mark the corresponding points – scaling – determining the map scale. Color saturation, harmony – the significance of colors: mountains, lowlands, rivers, roads, buildings, parks, parking spaces (Fig. 7).

Fig. 7 Map Creation

Task 4: Map Orientation

The mathematical method of Azimuth is addressed. Fig. 8. It is not necessary to explain the theory to students at the initial stage. However, after the task, a conclusion should be drawn that they have worked with a map by orienting themselves using specific points.

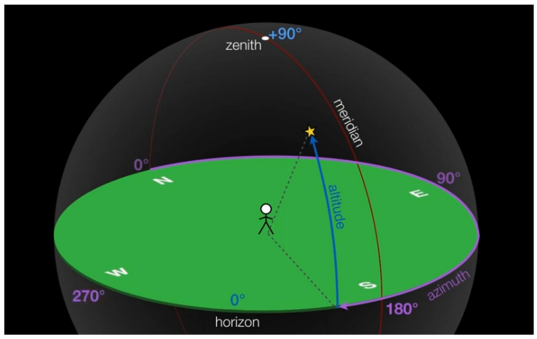

Fig.. 8 Azimuth

Students are divided into teams. Each team has a name. They work in groups. A specific starting point is designated, from which the students begin. The teacher may send the location of the initial point to their phones. They are given a map of the schoolyard with marked points. They are provided with instructions – a worksheet (Table 3) and a route map (Fig. 9). Using the map, they are given instructions to pass through all points and have the task of finding a "treasure" at each point.

The instructions for the worksheet are:

- In the first column, they record the coordinates according to the two-dimensional coordinate system on their map – a letter (x) and a number (y).
- In the second column, they use a compass and record the degrees it shows at each point.

- In the third column, they mark the number of steps from point to point (it can be discussed beforehand how one step is measured).
- In the fourth column, on the printed map, they draw lines from point to point and measure the distance in centimeters, converting it to meters or millimeters.
- In the fifth column, it is specified that one step equals 2 cm, and they must calculate the distance according to the data in the fourth column.
- In the final column, they note the discovered "treasure."

The treasure can be:

- Pictures of people related to cartography. They must find a way to identify them, find information about them, and present it.
- It could also be a single person, cut into a puzzle for them to assemble, and again research (find out) who the personality is and information about them (e.g., Magellan, Columbus, etc., someone from stories related to voyages).

Use both paper-based versions and video materials. The song "Everything Flows" – to be learned as a reward for successfully completing the tasks [5], [6], [7], [8].

Table 3 Orientation Worksheet

Worksheet

Coordinate position	Compass in degrees	Number of steps	Distance in cm/ m	Distance in centimeters from point to point	Whom did I find?
2/Z	230 SW	0	0	2 cm	Person photo

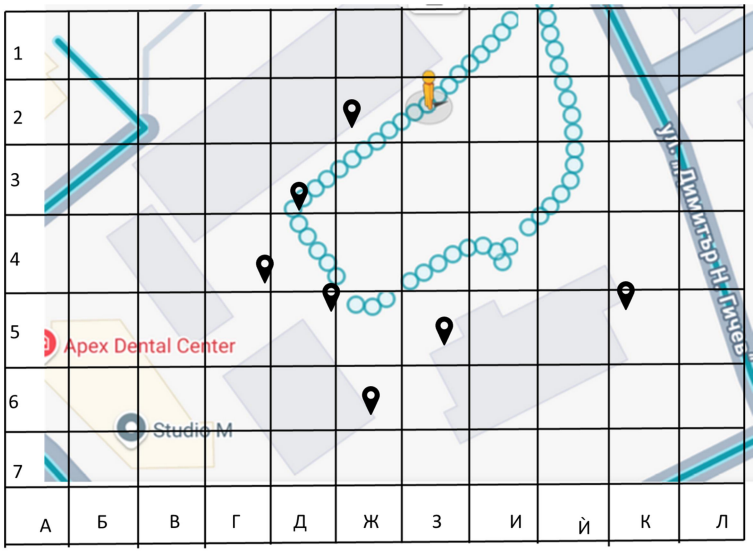

Fig. 9 Route Map

Task 5: Angle Measurement

After they have drawn lines from point to point, they measure the angles with a protractor from both sides (external and internal).

Task 6: How Do We Measure Steps?

How many cm, mm, m is one step? From point A to point B there are 15 steps, how many cm/mm/m is that?

Solution: Measuring with a ruler, measuring tape, or a tape measure – 1 step is 20 cm.

1 step is 200 mm, 0.2 m

From point A to point B: 15 (steps) x 20 cm = 300 cm / 3000 mm / 0.3 m

From point B to point C: 5 (steps) x 20 cm = 100 cm / 1000 mm / 0.1 m

From point C to point D: 20 (steps) x 20 cm = 400 cm / 4000 mm / 0.4 m

Task 7: Map for a Phone Application / Technical Map

Students are to draw a grid on an A4 sheet, with each square being 2 x 2 cm. They are to plot (transfer) the points they passed through from the other map. And again, state where each point is located in the coordinate system. For a break, a game: "Battleship".

Task 8: Calculate the total distance travelled in meters and kilometers.

Students refer to Task 4, where they drew and marked each segment from point to point. They need to perform the action of adding all the segments to find/calculate the total distance travelled and convert it into different units of measurement.

Task 9: Area of a surface/square or rectangle/

Students need to find the area of the figure formed by their path, taking only the squares from the grid where there is a point. This should be applied according to the students' capabilities. It may differ for each group. It can be calculated for a ready-made map, prepared in advance by the teacher, or for a map on a square grid with 2 x 2 cm squares.

Task 10: My Route

Let students propose their own route, with specific points, step measurement, angles, and terrain area:

- To be the flattest.
- To have one ascent.
- To have two ascents.

Task 11: Conversion to decares

How many decares is the terrain?

For older students, tasks with angle bisectors and triangles can be made.

Task 12: Quiz

You can use this ready-made quiz resource to check students' knowledge in a fun and interactive way [9]. Or create your own on the Kahoot platform. On this platform, you can register for free on a basic package and create quizzes, and you can also share them with colleagues [10]. There are two links: one for teacher registration and work, and one for students. It can be used on phones, tablets, and computers, where students enter a generated game pin when the teacher loads the quiz, and then enter their "name." Students can also choose an avatar (face).

Task 13: Write the school's name with Artie 3000.

Students have the task to use the Artie 3000 (BlueBot) robot to write the name of their school. School names are long, and coding a letter will take time. Therefore, the task can be divided into several lessons and completed letter by letter. The task requires planning the location where the name will be written, the size, calculating the dimensions of each letter, the distance between them, and the angles if present in the letters. In the provided example, the code for each letter is also marked. Fig. 10 and Fig. 11. In this way, we connect the Bulgarian language and writing with mathematics, programming, and robotics.

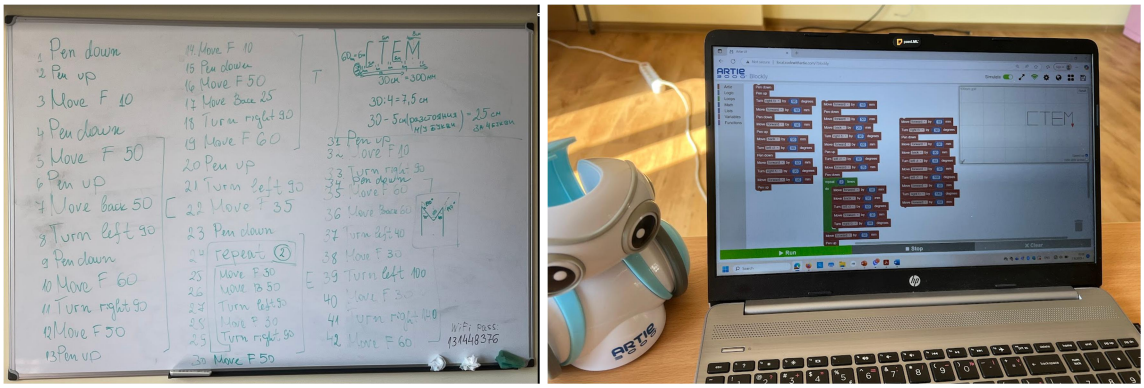

Fig. 10 School Name – CTEM

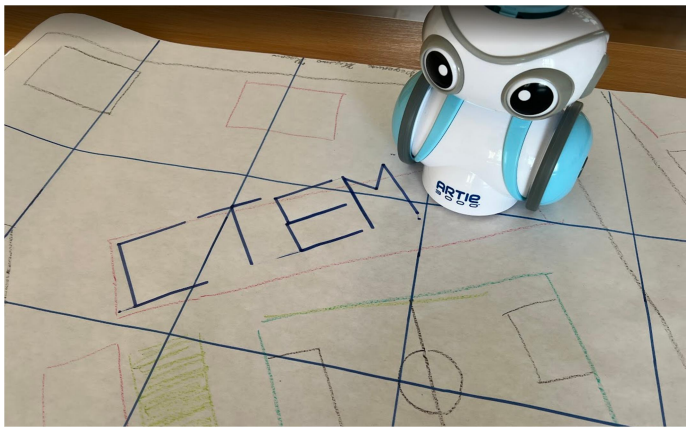

Fig. 11 School Name – CTEM_1

Task 14: "Traveler" Map

The task is to create a map using a computer program. Programs that could be used include: Scratch, Canva, Google Jamboard, or Word, apps – map plus, GPS fields, area, measure... 3D Mappa - GIS (Geographic Information System) Software. Depending on the chosen tool and the students' age, the task can be divided into sub-lessons. In this task, you will create a program that:

- Uses a grid as a background;
- Draws or places ready-made icons for objects (house, school, factory, playground);
- Adds roads;
- Colors appropriately – terrain, colors, meaning;
- Places a character that walks along a route;
- Tests the program.

Solution: Fig. 12 and Fig. 13

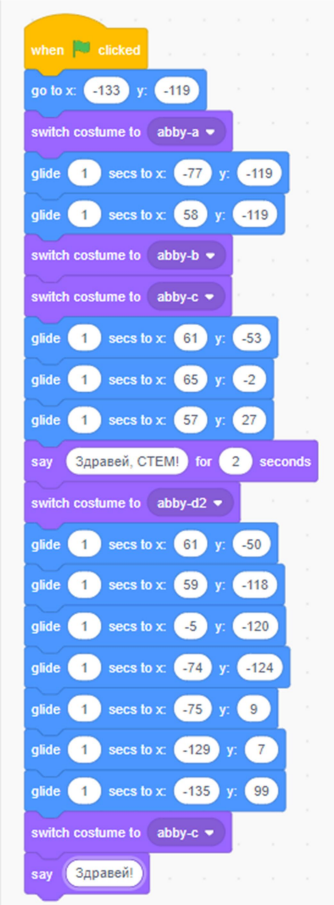

Fig. 12 Code - Blocks

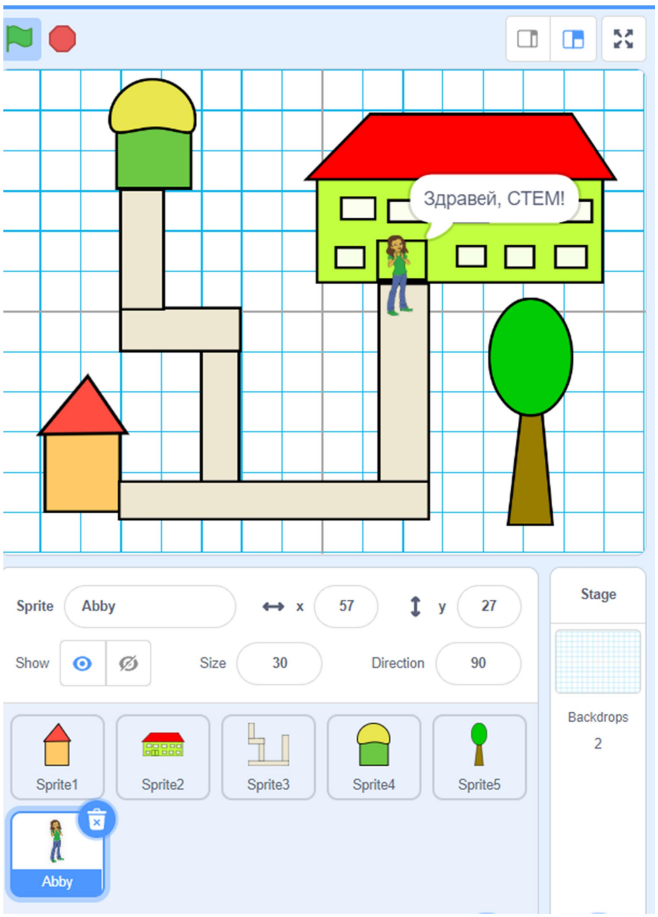

Fig. 13 "Traveler" Map

Task 15: Construction of a Water Compass
Required materials (Fig. 14):

- Needle
- Magnet
- Piece of stiff paper/cosmetic cotton pad/small piece of Styrofoam/plastic bottle cap
- Scissors
- Adhesive tape (e.g., duct tape)
- Bowl
- Water

Instructions:

1. Cut out a circle with a diameter of 5 cm.
2. Attach the needle to the center of the circle using tape.
3. Fill the bowl with water.
4. Take the magnet and rub it along the needle in the same direction approximately 20 times.
5. Gently place the piece of paper (or other float) on the water's surface so it remains afloat.
6. Observe how it rotates; the needle should align to point north, acting as a compass.

Scientific Explanation:

Rubbing the needle with the magnet magnetizes it, giving it a north and south pole. The needle then begins to interact with the Earth's magnetic field. The paper (Styrofoam, cap, cotton pad) floating on the water allows the needle to move freely. The experiment is successful when one end of the needle, placed in the water, consistently points in the same direction (see Fig. 15). Its accuracy also depends on the magnetization process through rubbing; longer rubbing typically yields more precise results.

Fig. 14 Materials for Water Compass

Fig. 15 Water Compass

Task 16: Construction of a Sundial / Sun Compass

A sundial can be constructed in reality, depending on the permitted meteorological conditions. And/or using a program to visualize the experiment.

Required materials (Fig. 16):

- A straight wooden stick/twig;
- Pebbles – 4 pieces;

Instructions:

1. Drive the stick into a suitable location—soft soil/sand—and in a sunny spot.
2. Place one pebble at the end of the cast shadow.
3. Wait 15-20 minutes and place another pebble at the end of the shadow.

Accordingly, the first two pebbles opposite each other will outline the east-west direction, and a perpendicular line can be drawn to delineate south-north. Fig. 17.

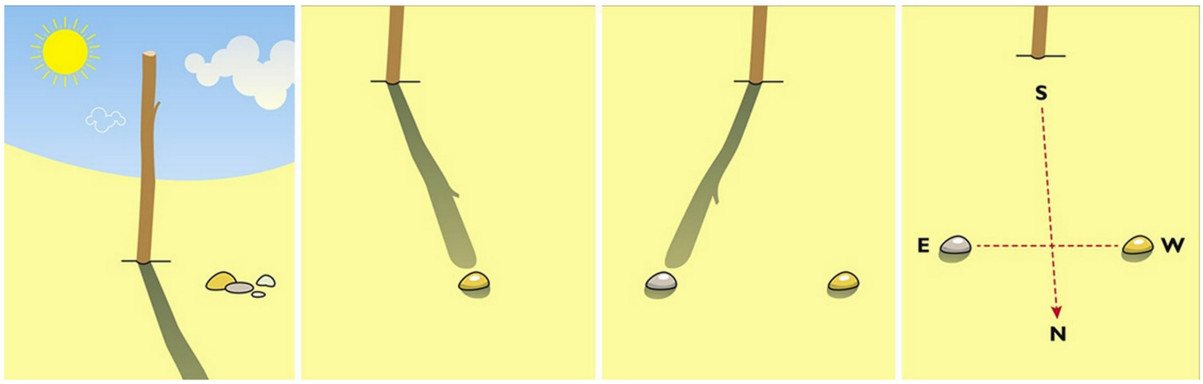

Fig. 16 Sun Compass in Paint / Scratch

Task 17: "My Robot's Neighborhood Tour" / "Navigating My Neighbourhood with My Robot"

Students incorporate a task using the BlueBot/Artie 3000/Ozobot robot into their project. Fig. 17. Fig. 18. Fig. 19. Fig. 20. All three robots are suitable for work at the primary level.

The students' task is to program their robot to travel from their home to school. Various routes can be created, such as:

- The robot is a school bus. Whom should it pick up first to create the shortest possible route?
- I am going to Child X's house, and together we go to school. Find the shortest path.
- What is the step length of the robot?
- How many steps does it take on the map to reach a given target?
- How long is the path it travels?
- Etc.

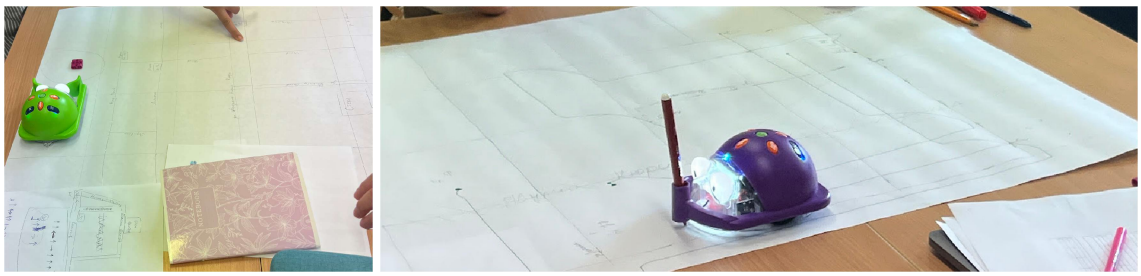

Fig. 17 Path with BlueBot

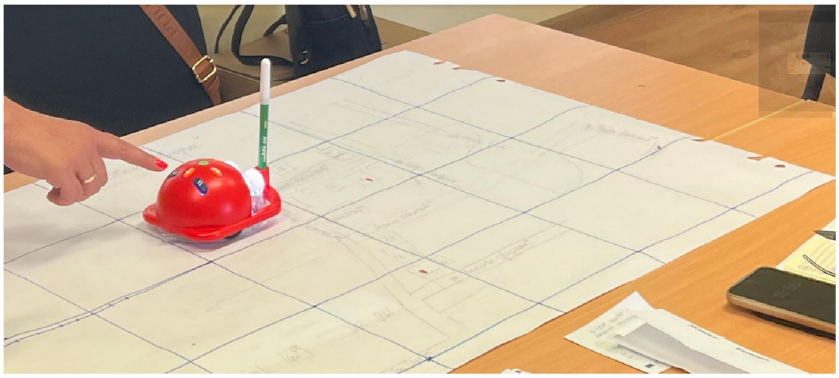

Fig. 18 Path with BlueBot 1

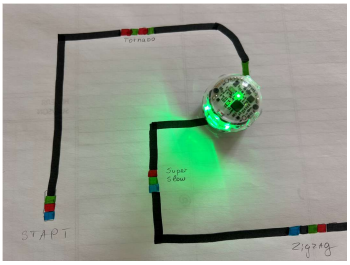

Fig. 19 Path with Ozobot Evo

Fig. 20 Path with Artie 3000

Task 18: Let's Light Up the Path

Now that we have several different maps and grid layouts, it's time for something interesting: an elementary electrical circuit. We can present the motivation to the students: "Would you like to light up our projects now, and how could that happen? Are there street lamps when you walk in the evening? Do they know who the person famous for illuminating the Earth is? (Nikola Tesla)." The project can consist of one lamp or several.

- Standard electrical circuit: Fig. 21.
- Electrical circuit for young students: Fig. 22 and Fig. 23.

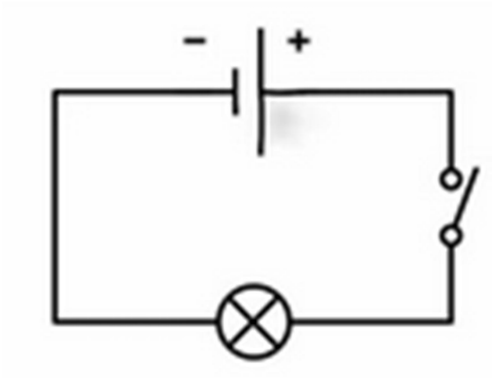

Fig. 21 Classic Electrical Circuit

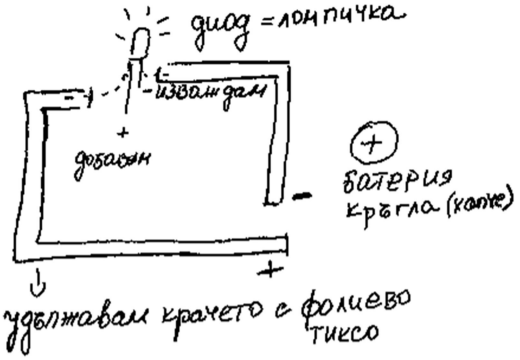

Fig. 22 Electrical Circuit for Primary Level

Fig. 23 Electrical Circuit for a Map

If several LEDs are used, as in Fig. 24, a more complex electrical circuit is created. The basic rule is for all positive (+) legs to be on one side, placed on a foil strip and secured, and all negative (-) legs to be on the other side, placed on another foil strip. Consideration should be given to where the battery is best positioned.

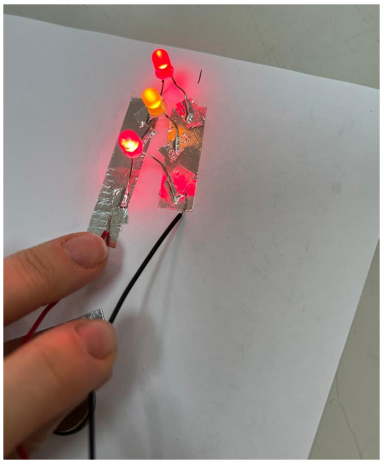

Fig. 24 Electrical Circuit with Multiple Bulbs

Fig. 25 9V Battery with Connector

In Fig.24, a 9V battery with a connector (Fig.25) was used to test the circuit, but it can also be used instead of a regular round battery.

Necessary materials:

- LEDs (Light Emitting Diodes);
- Aluminum foil;
- Batteries.

Instructions:

The legs of the LED (bulb) are bent out to the sides. It is important to remember which is the long positive leg (anode) and which is the short negative leg (cathode). Since the legs are short, we extend them using aluminum foil tape. A brief discussion about foil as a material and its properties can be held: "From mom's kitchen, why is it put on a tray and then in the oven? It prevents food from burning. But it is a conductor; electricity flows through it." The legs are placed on the foil and secured with regular tape. The end of the positive leg should be longer so it can be placed on the battery's positive (+) terminal. The battery is placed with its negative side on the negative leg. When the positive leg is placed on the positive terminal, the bulb lights up.

CONCLUSION

STEM education is transforming into a powerful tool for acquiring knowledge, understanding the world, having fun, and fostering motivation for exploration and deeper inquiry in life. Primary pedagogy has the task not only of teaching students new knowledge but also of igniting within them a spark for discovering the world around them. STEM education offers an open and comprehensive territory—one that does not close doors but opens them, provides diversity, gently presents new knowledge and understanding, aids memorization, and makes learning enjoyable. This very ease gives wings to new generations to create, solve global challenges, and make the world a better place for all of us.

A single lesson on cartography has traversed skills in mathematics, technology, artistry, robotics, language, music, geography, and history—even extending to career choices such as Cartographer, Mountain Guide, Tour Guide, Mountain Rescuer, Landscape Architect, and Navigation Engineer.

INTERNET RESOURCES

History of Bulgaria // [История на България]. Available at: https://istoria.bg/maps (last view: 01-08-2025).

Create a map: Available at: https://www.arcgis.com/apps/instant/atlas/index.html?appid=0cd1cdee853c413a84bfe4b9a6931f0d (last view: 01-08-2025).

"Make your own compass": Available at: https://www.youtube.com/watch?v=eksBnWVBRcc (last view: 01-08-2025).

"Make your own compass": Available at: https://www.youtube.com/watch?v=sFBj3veDrjo (last view: 01-08-2025).

Create Beautiful Maps with MapMaker. Available at: https://www.thetechieteacher.net/2014/11/map-maker-for-elementary.html (last view: 01-08-2025).

Padlet. Available at: https://padlet.com/dashboard/make?mobile_page=LayoutPicker (last view: 01-08-2025).

Math Manipulatives. Available at: https://docs.google.com/presentation/d/1jadIg9nk64U9gWtj4QEbd-AEzVtCXQeH-y44LPXlF3M/present#slide=id.g27b693dca5_0_261 (last view: 01-08-2025).

TreasureMapPack. Available at: https://www.teacherled.com/resources/mapmaker/TreasureMapPack.pdf (last view: 01-08-2025).

Compass: which direction is north? // [Компас: в коя посока е север?]. Available at: https://bg.khanacademy.org/science/fizika-11-klas/x9ee5a5eeacd2adc4:eksperimentalna-fizika/x9ee5a5eeacd2adc4:magnetizam-opiti/v/which-way-is-north (last view: 01-08-2025).

REFERENCES

1. Sarafova, E. (2023). 01. History of cartography. In Textbook on Cartography (01 ed.). Pixel Company, 2024. https://cartography.pubpub.org/pub/01-history/release/1 (last view: 01-08-2025). DOI: https://doi.org/10.21428/19802f4c.c0119158
2. cartography.bg 02_История-на-картографията, Available at: https://cartography.bg/wp-content/uploads/2019/11/02_%D0%98%D1%81%D1%82%D0%BE%D1%80%D0%B8%D1%8F-%D0%BD%D0%B0-%D0%BA%D0%B0%D1%80%D1%82%D0%BE%D0%B3%D1%80%D0%B0%D1%84%D0%B8%D1%8F%D1%82%D0%B0.pdf (last view: 01-08-2025).
3. WIX, Bulgaria in old geographical maps // [България в стари географски карти]. Available at: https://oldmaps.wixsite.com/bulgariainmaps/18century (last view: 01-08-2025).
4. cartography, Britannica. Available at: https://www.britannica.com/science/cartography (last view: 01-08-2025).
5. Audiobooks Bulgaria, Christopher Columbus: Available at: https://www.youtube.com/watch?v=bHx816KGgqk (last view: 01-08-2025).
6. Educational platform "Ucha.se", Fernando Magellan, section "Personalities": Available at: https://ucha.se/watch/12885/fernando-magelan (last view: 01-08-2025).

7. Television – btv, "Magellan's Journey 1080p BG audio": Available at: https://www.youtube.com/watch?v=Wc3Z3AY3TUs (last view: 01-08-2025).
8. "It flows, everything flows" - Song with lyrics: Available at: https://www.youtube.com/watch?v=MtfiRgfQvhs (last view: 01-08-2025).
9. Questionnaire: Available at: https://classbuddy.net/bg/play?code=08d82ecffea33608ed34e8b19a7c6321# (last view: 01-08-2025).
10. Interactive platform for creating questionnaires to test knowledge: Available at: https://kahoot.com/ for teacher and https://kahoot.it/ (last view: 01-08-2025).

Received: 08-08-2025 Accepted: 15-12-2025 Published: 31-12-2025

Cite as:
Staikova, M., Chivarov, N. (2025). "Educational Mobile Robots as a Tool for STEM Education through the Integration of Technology, Mathematics, and the Bulgarian Language", Science Series "Innovative STEM Education", volume 07, ISSN: 2683-1333, pp. 364-383, 2025. DOI: https://doi.org/10.55630/STEM.2025.0734