Digirobo SummerCamp

Handbook for preparation, implementation and evaluation

Co-funded by the European Union

DIGIROBO

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Erasmus+ KA2 project
"Next generation digital manufacturing and robotics schools"
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Introduction

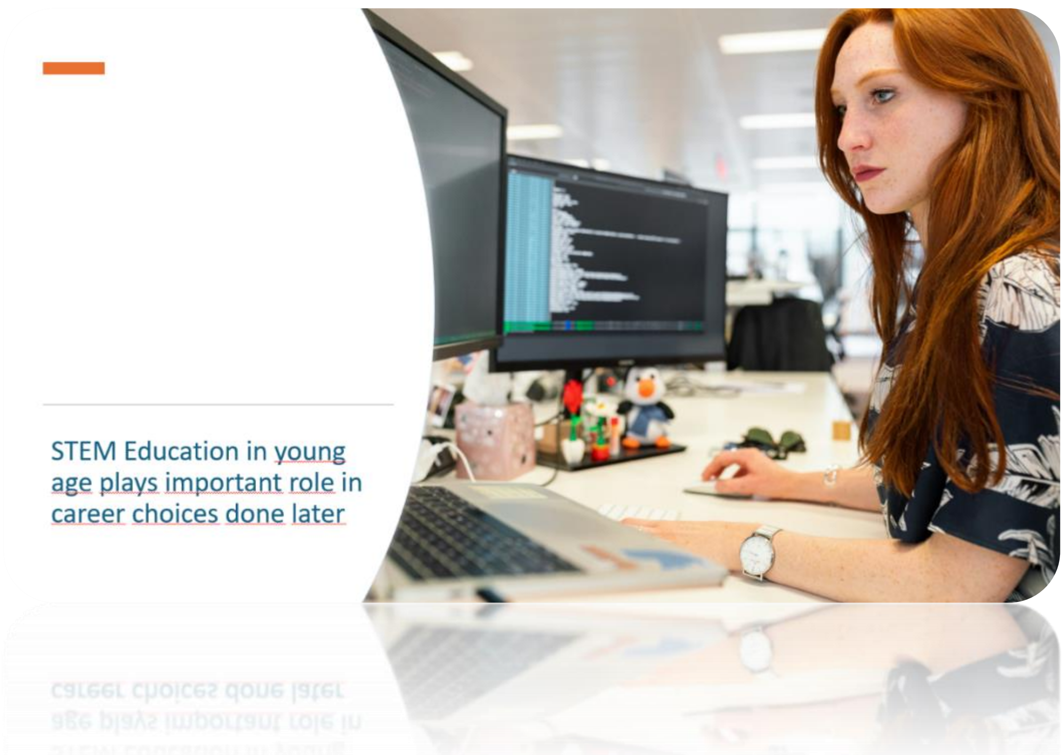
The objective of this document is to provide a step-by-step guide for organizing an engaging, fun, and educational robotics event aimed at increasing interest, motivation, and knowledge in STEM among young people. This document is intended for anyone working with youth in the field of STEM.

The importance of STEM subjects is essential for the future of every country. Encouraging more young people to pursue careers in technology presents a valuable opportunity to strengthen the future workforce and drive innovation [1]. The pace of technological advancement is rapidly increasing, yet the methods of teaching STEM subjects in schools are evolving slowly, making it challenging to keep up. Extracurricular initiatives, such as workshops and camps, play a vital role in raising awareness about STEM and the demand for engineers.

> ***“These events often provide young people with their first experience in coding or robotics, which is why careful planning and well-structured methodology are crucial.”***

Poorly organized event can discourage students and deter them from pursuing technology-related opportunities in the future.

The DIGIROBO camp is a three-day robotics and technology event designed for students aged 10–16. It offers hands-on activities with robots, where participants work in teams to solve challenges presented through a story-driven narrative. The event begins with an introduction to industrial revolutions, robotic manipulators, and coding. By the end of the camp, teams present their results and compete to determine the most effective solution. This camp was organized three times as part of the Erasmus+ DIGIROBO project—once in Estonia and twice in Malta. The number of participants per camp depends on the availability of teachers and equipment, though it is generally recommended to limit the group size to a maximum of 30 students to ensure an optimal learning environment. There was one experienced teacher per every 10 students. Throughout the project, feedback was collected and analyzed to improve the camp structure. This document outlines the overall concept of the camp and provides a step-by-step guide on how to set up the event, from recruiting participants to defining the rules of the game.



Event details

Agenda

Day 1
11:00 Arrival
11:00-11:15 Meet & greet
11:30-12:30 Introduction to summer camp (timetable, where it is etc)
12:30-13:30 Insights to industrial robot technologies
13:30-14:30 Lunch
14:30-18:15 Practicing and construction
18:15 End of first day
18:30 Free time (some activity from organizers)

Day 2
10-11:00 Meet & greet motivation building
11:15-14:00 Practicing and construction
14-15:00 Lunch
15-16:00 Industry robot experience
16-18:00 Practicing and construction
18:15 End of the second day
18:30 Free time (some activity from organizers)

Day 3
10-11:00 Meet & greet motivation building
11:15-13:15 Practicing and construction
13:00-14:30 Performing
14:30-15:30 Lunch
15:30-16:30 Finishing ceremony, end words, feedback

Rules of the event

The summer camp is structured around a central theme and problem statement, introduced to participants through the technique of storytelling. The defined scenario for the summer camp challenge is as follows:
In a dynamic manufacturing environment, rapid adaptation to shifting product demands is crucial. To address this, robots must be capable of swiftly taking on new tasks. In response to a pandemic, the factory must urgently pivot to producing a critical medical product. Due to the urgency, suppliers are unable to deliver materials to designated locations, instead placing them randomly in the storage area. As these materials are hazardous, human workers cannot handle them directly.
Your mission is to program mobile robots to autonomously locate and transport these materials to a robotic arm for assembly. The input materials are color-coded to aid identification, and the robot arm relies on precise placement in marked positions. Given the high demand for the new product, production time is strictly limited. The mobile robots must efficiently locate and transport materials within the given timeframe, while the robotic arm must complete the assembly process within its own restricted time window. Figure 1 provides a visual representation of this challenge.

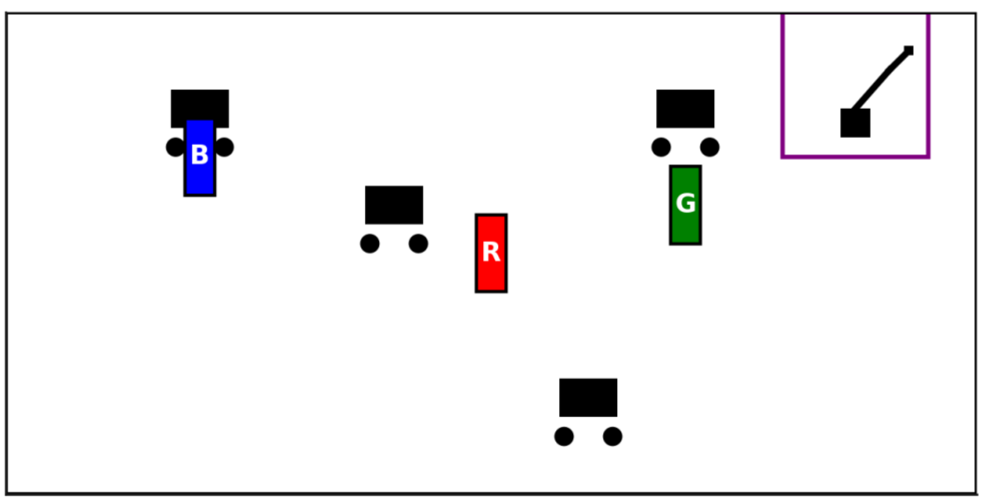


Figure 1: Sketch of the overall problem statement: mobile robots have to detect objects (highlighted in blue, red, green) and bring them to the robotic arm for assembly.

DIGIROBO Summer Camp Competition Rules and Guidelines

1. General Task Description

Participants must program mobile robots to locate objects on a defined field and transport them to designated assembly areas based on colour. A robotic arm must then be programmed to stack these objects on top of each other.

2. Field

2.1 Dimensions

Dimensions are shown below in Figure 2.

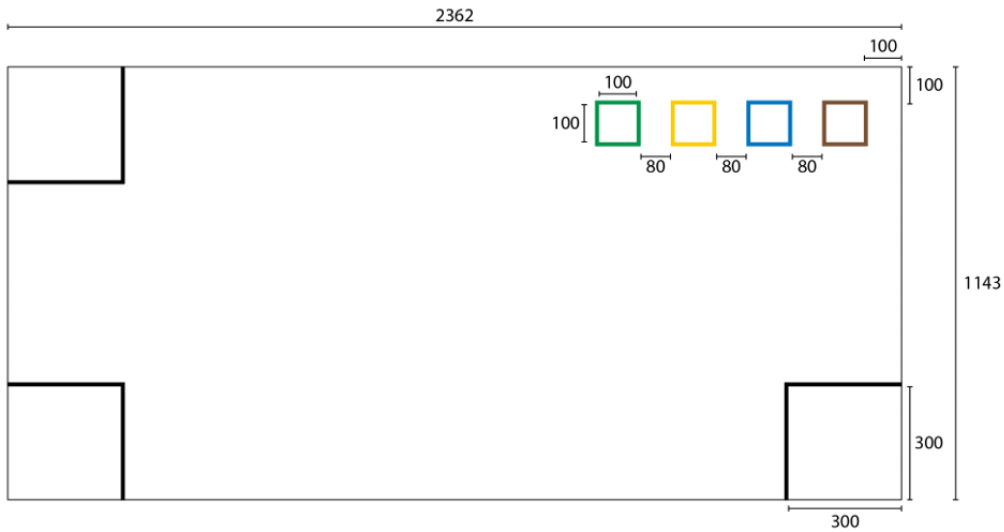


Figure 2: Dimensions of the field in mm

- Field size: 2362 x 1143 mm
- Three starting bases located in the top-left, bottom-left, and bottom-right corners.
    - Each base shares two sides with the field boundary.
    - Each base has inner dimensions of 300 x 300 mm.
    - Surrounding lines are 10 mm wide.
- Four coloured assembly areas in the top-right corner.
    - 80 mm of space between them.
    - Each box has inner dimensions of 100 x 100 mm.
    - Surrounding lines are 10 mm wide.

2.2 Objects

- Four objects will be scattered randomly on the field.
- Objects will not be placed too close to starting bases or walls.
- Objects are aluminium cans with a diameter of 63.1 mm, wrapped in coloured paper.
- Colours match the four collection boxes.
- Each object will be placed on a white disc with a matching coloured edge.
    - Disc diameter: 123.1 mm
    - Edge line width: 20 mm

3. Robots

3.1 Collection Robot

- Must be built using only the parts supplied by the organizers.
- Must fit inside a 300 x 300 x 300 mm box.
- Must not damage the field or harm players.

3.2 Robotic Arm

- Participants must complete safety training by the organizers before operating the robotic arm.

4. Event Rules

- Participants will build and program the collection robot only during the event.
- Each team will receive a playmat for practice and competition use.
- Teams may add markings to their playmat using tape to aid navigation for their robots.
- Participants must program the robotic arm only during the event.

5. Competition Guidelines

- Three rounds will be played.
- Playing order will be announced at the event.
- At the start of each round, object locations will be determined.

- Object locations remain the same for all teams during that round.
- Teams will set up their playmat before competition begins.
- Objects and coloured discs will be placed on the playmat.
    - Objects may cover player-added markings.
- The competition consists of two phases: Collection Phase and Building Phase

5.1 Collection Phase

- The collection robot has 4 minutes to pick up and transport objects to their corresponding assembly area.
- The robot can only start after the referee gives a signal.
- Only the collection robot may move and interact with objects during this phase.
    - Players may not touch objects unless an emergency occurs.
    - If a player touches an object, they will be quarantined and unable to assist their team.
- The robot can only carry one object at a time.
- Once moved, objects' discs remain on the field.
- The robot may start from any starting base.
- Players may pick up the robot when it is at least partially inside a starting base.
- If the robot gets stuck (e.g., no movement, against a wall), players may rescue it:
    - A referee must approve the rescue.
    - Rescue may not be used strategically (e.g., avoiding an obstacle).
    - If a player rescues a robot carrying an object, they will be quarantined.
- When the 4-minute timer ends, a player or referee will turn off the robot.

5.2 Building Phase

- The robotic arm has 2 minutes to stack objects in a specific order determined by the organizers.
- The robotic arm can only start after the referee gives a signal.
- During this phase, only the robotic arm may handle objects for safety reasons.

- Once the 2-minute timer ends, a player or referee will turn off the robotic arm.

6. Organizing

- Any questions or disputes during the event will be resolved by referees or organizers.
- Organizers reserve the right to adjust the rules if necessary.

Learning outcomes

- Students will be able to collaboratively design, build, and program a basic robotic system to solve a defined real-world challenge.
- Students will demonstrate an understanding of how automation and robotics are used in modern manufacturing and will explain the basic functions of a collaborative robot (cobot).
- Students will reflect on their personal experience in the camp to identify which areas of robotics, coding, or teamwork they would like to explore further.

Preparation

Summer/winter camphool is an event for students in ages 10-16. They should be targeted through teachers by sharing the invitation of the event in relevant channels. It might depend on how educational system is built, organizers possibilities etc. For the demo event, mostly e-mail lists were used to share information about DigiRobo event.

Next step is to set up registration. Most easy is to do it through online forms available. Sample registration questions are below:

1. Participant's First and Last Name *
2. Participant's Age *
3. Participant's Phone Number
4. Participant's Place of Residence (County, Town/Village) *
5. Participant's School
6. Participant's Experience in Robotics, including FLL Program Participation
    - Beginner
    - 1 year
    - 2 years
    - 3 years
    - 4 years
    - 4+ years
    - Other (please specify)
7. Does the participant have any dietary requirements? (Please specify)
    - *Note: The organizers will do their best to accommodate dietary needs but cannot guarantee all requests.*
8. Do you need accommodation if available? *
    - *Accommodation may be in 2- or 3-person rooms. Depending on the number of requests, participants may need to cover part of the accommodation costs themselves.*
    - Yes
    - No
    - Other (please specify)

Parent/Guardian Information

9. Parent/Guardian's First and Last Name *
10. Parent/Guardian's Email *
11. Parent/Guardian's Phone Number *

According to laws and regulations, parents need to sign release and consent form to allow their children to take part of the DigiRobo event. Organizers should understand and follow the local regulations. Sample consent form is available in Annex 1.

Facilities

Selecting the right venue is crucial to ensuring a smooth and efficient event. Several factors must be considered, including the size of the competition fields, number of participants, availability of electricity, and overall layout of the space.

For participants, it is most convenient if all activities take place in a single room. If this is not possible, any additional rooms should be located as close together as possible to minimize disruptions. Each team typically requires a table and chairs, ensuring a comfortable workspace.

Since participants will be working with a robotic arm, they must first complete a safety training session. The specific requirements for safety training may vary depending on the host's guidelines. For example, safety area that cobot UR5 requires is shown on Fig 3.

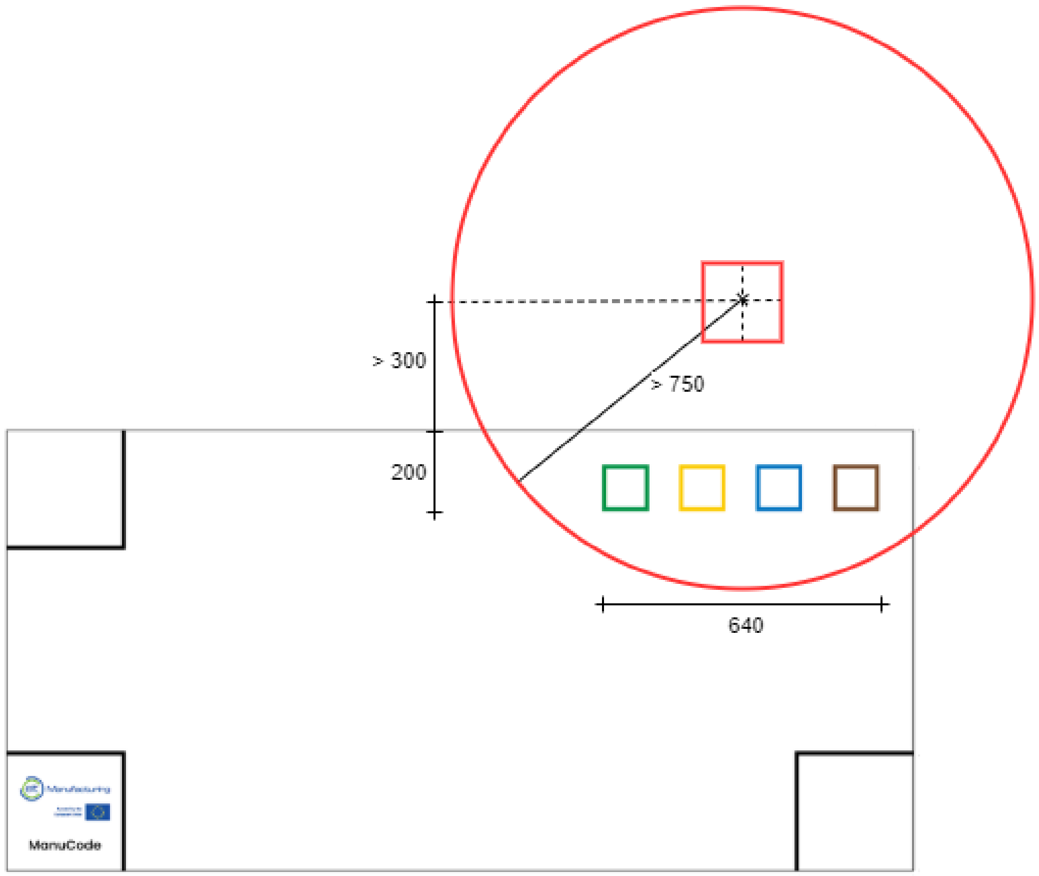


Figure 3: Place of the robotic arm and its working space

To facilitate testing, there should be at least one testing field available for every six teams. This will ensure that teams do not have wait too much for their turn to test the robot. Additional testing fields without a robotic arm may be set up, as this aspect of the activity is highly specialized and requires less time compared to the collection tasks.
To prevent damage to robots and laptops, catering should be provided in a separate area, away from the main activity space. This will help avoid potential risks from spilled liquids or food.

Equipment

To ensure a smooth learning experience, the following equipment is required:

- UR5 robotic arm (CB3 or eSeries)
- UR-compatible gripper with URCap (e.g., Robotiq Hand-E)
- Additional emergency stop (E-Stop) and necessary cabling
- LEGO Mindstorms EV3 robots/Spike Prime or equivalent
- Competition field (printed mat)
- Table(FIRST LEGO League game table – optional but useful for navigation using walls)

- Laptops for programming LEGO robots
- Empty metal cans for transportation(e.g., Red Bull 0.33 L, covered with paper)
    - It is recommended to use cans from a single manufacturer to avoid slight shape variations that may affect stacking.

Equipment Variations & Recommendations

Standardized equipment is recommended as the learning materials were developed specifically for this type and version of robots.

If alternative hardware is used instead of the UR5 robotic arm, it must be capable of performing the same tasks.

Most of the UR5 training was conducted on-site, as not all learning materials were ready before the event.

UR5 learning modules are designed to work with the UR5 simulator.

- If a simulator is unavailable, on-site training is the best approach.
- In such cases, the specific robotic arm used is less critical, as hands-on teaching will be required.

Challenges & Considerations

- Only one UR5 robotic arm was available during the summer camp, meaning teams had to take turns instead of having full-time access.
- Although alternative robotic arms (e.g., XArms at the University of Tartu) were available, the university chose to use the UR5 to test the learning materials in a controlled setting.

Team Formation Guidelines for Future Summer Camps

To ensure a productive and inclusive learning environment, it is recommended to use a structured approach when forming teams. While some participants may register as a group and prefer to work together, mixing participants into diverse teams on the first day is encouraged. This helps foster collaboration, exposes students to new ideas, and prevents pre-formed group dynamics from affecting the learning experience.

Recommended Team Size & Structure

- The optimal team size is three to four participants to ensure balanced engagement.
- Tasks can be divided as follows:
    - Two students work with the LEGO Mindstorms EV3 robot to locate and collect materials.
    - Two students operate the robotic arm for product assembly.

- Additional tasks, such as presentation preparation, documentation, and logistics management, can be assigned based on team strengths.

Suggested Methods for Team Assignment

1. Randomized Team Assignment (Recommended)

- A fair and effective method is to have participants draw random numbers, with each number corresponding to a team.
- This eliminates bias and ensures a diverse mix of students, preventing any perception that team assignments influence performance.

2. Self-Selected Teams with Constraints

- As an alternative, participants can be given the opportunity to form their own teams after an introductory session.
- To maintain diversity and balance, consider setting the following constraints:
    - Teachers and adults should not all be in the same team.
    - Teams should have a maximum of five members.
- If teams cannot be formed independently within a set time (e.g., 20 minutes), organizers should be prepared to assign teams randomly as a backup.

Example of Balanced Team Composition

- Team 1: 4 students + 1 university student (all female)
- Team 2: 2 teachers + 2 students (all male)
- Team 3: 3 students + 1 adult (all male)
- Team 4: International team – 2 teachers + 1 student

By following these guidelines, organizers can create fair, balanced, and effective teams that enhance the learning experience for all participants. Ensuring a structured approach to team formation helps minimize conflicts, encourages equal participation, and promotes teamwork in a diverse setting.

Feedback and post event activities

Collecting feedback is essential for improving the setup, materials, and logistics of the event. It is recommended to gather feedback at different stages, including both the preparation phase and after the event. During preparation, participants can provide input on learning modules, allowing organizers to refine and adjust materials before the event begins. Using digital forms for this process ensures efficiency and easy data collection. Post-event feedback is equally important, as it helps evaluate the overall organization, content, and logistics, providing valuable insights for future improvements. By

implementing a structured approach to feedback collection, organizers can continuously enhance the learning experience and optimize future events.
After the event, it is important to follow up with participants by sending thank-you emails or greetings and, if possible, sharing highlights and memorable moments on social media. However, any social media posts featuring participants should only be shared if parental consent has been given. If consent is not available, posts can still be made, but in compliance with GDPR 2021, individuals should not be recognizable. Organizers should also hold a debrief meeting to reflect on challenges, discuss possible improvements, and share memorable moments in a relaxed setting with drinks and snacks. Additionally, if certificates of participation were not distributed at the end of the event, they should be sent to participants afterward.

DIGIROBO Summer Camp Feedback example

Please provide feedback on the DIGIROBO summer camp that took place this summer. Your feedback will help us improve similar events in the future.
Thank you for completing this survey.
A PRIZE DRAW WILL BE HELD AMONG ALL RESPONDENTS TO WIN AN EDUCATIONAL LEGO SET!
Feedback Questions

1. How old are you? (Open-ended)
2. What is your gender?
    - Male
    - Female
    - Prefer not to say
3. Where do you live?
    - Country (please specify)
4. How did you hear about this summer camp?
    - From school
    - Social media
    - From a friend
    - Other (please specify)
5. Had you encountered robotics and coding before the summer camp?
    - Yes

- No
- Maybe

6. Which of the following do you use in your daily life? (Select all that apply)
    - Sending emails
    - Using Word, Excel, and PowerPoint
    - Browsing the web
    - Using social media (Facebook, Instagram, YouTube, TikTok)
    - Other (please specify)
7. What were you most interested in doing at the camp? (Select all that apply)
    - Hands-on activities
    - Seeing a university learning environment
    - Exploring different technical solutions offered by the university
    - I am simply interested in technology and engineering
    - Other (please specify)
8. How satisfied were you with the camp overall? (Scale 1-5)
    - 1 = Did not enjoy it at all
    - 5 = Very satisfied
9. How interesting were the topics, technologies, and activities covered in the camp? (Scale 1-5)
    - 1 = Not interesting at all
    - 5 = Very interesting
10. Did participating in the camp motivate you to explore robotics and coding further?
    - No, not really
    - Yes, definitely
11. Would you like to learn more about robotics and coding now?
    - No, not really
    - Yes, definitely
12. How was communication and teamwork within your team? (Scale 1-5)

- 1 = Poor
- 5 = Very good

13. Would you like to participate in similar camps in the future?
    - Definitely not
    - Definitely yes
14. What did you enjoy most about the camp? (Open-ended)
15. How could the camp be improved? (Select all that apply)
    - More theoretical content on robotics
    - Less theoretical content, more practical activities
    - Increase the amount of hands-on activities
    - Make the camp longer
    - Make the camp shorter
    - The camp should include overnight stays
    - The camp should remain a day camp (no overnight stays)
    - Other (please specify)
16. Would you like to add anything else? (Open-ended)
17. If you want to participate in the prize draw, please provide your email.
18. If you win the prize draw, which LEGO set would you prefer?
    - Duplo bricks
    - Standard LEGO bricks
    - LEGO Technic bricks

Analysis of the DIGIROBO summer camps

Estonia

The DIGIROBO Summer Camp brought together 16 participants of different ages, the youngest being 10 years old and the oldest 44 (teacher). Most of them, 10 out of 16, first heard about the camp through their schools, while others got the information from friends or social media. Although 12 participants had previous experience with robotics and coding, they were eager to learn more, and the camp promised to provide just that.

From the start, expectations were high—14 out of 16 wanted to engage in hands-on activities, whether it was assembling robots, programming them, or simply getting a feel for real-world technology. Some also looked forward to technical tours and structured training sessions to deepen their understanding. Once the camp began, it didn't disappoint. 10 out of 16 participants described the experience as very interesting, rating it 5 out of 5. The topics, technologies, and activities covered were also well-received, with another 10 participants rating them highly. Many mentioned that the opportunity to work with real robotics equipment and collaborate with others made the learning process more enjoyable.

Despite the positive experience, participants had a few suggestions for improvement. The most common request, mentioned by 7 attendees, was to increase the number of hands-on activities while reducing the amount of theoretical discussion. Others suggested that the camp could be longer, allowing more time to experiment with robotics. A few participants wanted deeper dives into specific technical aspects, such as robotic mechanics and automation.

One of the most promising outcomes of the camp was its impact on participants' interest in robotics. 13 out of 16 stated that they now wanted to learn even more about robotics and coding, proving that the experience had sparked their curiosity. Additionally, 15 participants said they would love to attend similar camps in the future, reinforcing the camp's success in making technology engaging and accessible.

In the end, the DIGIROBO Summer Camp wasn't just about learning—it was about creating, experimenting, and inspiring. Whether it was through building robots, working in teams, or simply discovering new technologies, it was clear that for most participants, this was only the beginning of their journey in the world of digital manufacturing and robotics.

Malta

The DIGIROBO Summer Camp in Malta welcomed 61 participants, primarily between the ages of 9 and 14. The majority of attendees were female, though male participants were also present. Most participants discovered the camp through school, while others learned about it through friends or social media.

Prior Knowledge & Expectations

All 61 participants had some level of prior experience with robotics or coding, making the camp an opportunity to build upon existing knowledge. The primary expectations for the camp included hands-on activities, learning about robots and coding, and seeing robots in action.

Experience & Learning

The camp received an impressive average rating of 4.8/5, reflecting a high level of satisfaction among participants. Interest in the topics covered was rated even higher at 4.9/5, with an overwhelming majority expressing a strong desire to continue learning. Specifically, all 61 participants indicated that they wanted to learn a lot more about coding and further explore robotics.

Teamwork was also well-received, with an average rating of 4.8/5, indicating effective collaboration and group engagement.

Favourite Aspects & Suggestions

Participants highlighted the following as their favourite parts of the camp:

- Trying out technical equipment
- Learning new coding skills
- Competing with their creations

When asked how the camp could be improved, the most common suggestions included:

- Organizing more team challenges
- Extending the duration of the camp
- No changes needed – everything was great

Future Participation

Interest in attending similar events in the future was overwhelmingly positive, with all 61 participants eager to return for another DIGIROBO camp.

The feedback highlights the success of the DIGIROBO camp in sparking enthusiasm for robotics and coding. The strong engagement, high satisfaction ratings, and eagerness to learn more confirm that the camp was both enjoyable and educational. By incorporating participant suggestions, such as expanding team-based challenges and extending the duration of activities, future events can be even more impactful.

Background

Introduction to industrial revolutions

First industrial revolution was in late 18th century and early 19th century, where the keywords were mechanization and steam power (see Fig 4). Factories were formed near coal mines and waterfalls to use the source of energy for production. Revolution intransportation – steam engine trains and ships.
Second industrial revolution was in late of 19th century and early 20th century where the keywords were electricity, mass production, assembly line and combustion engines that revolutionized transportation.

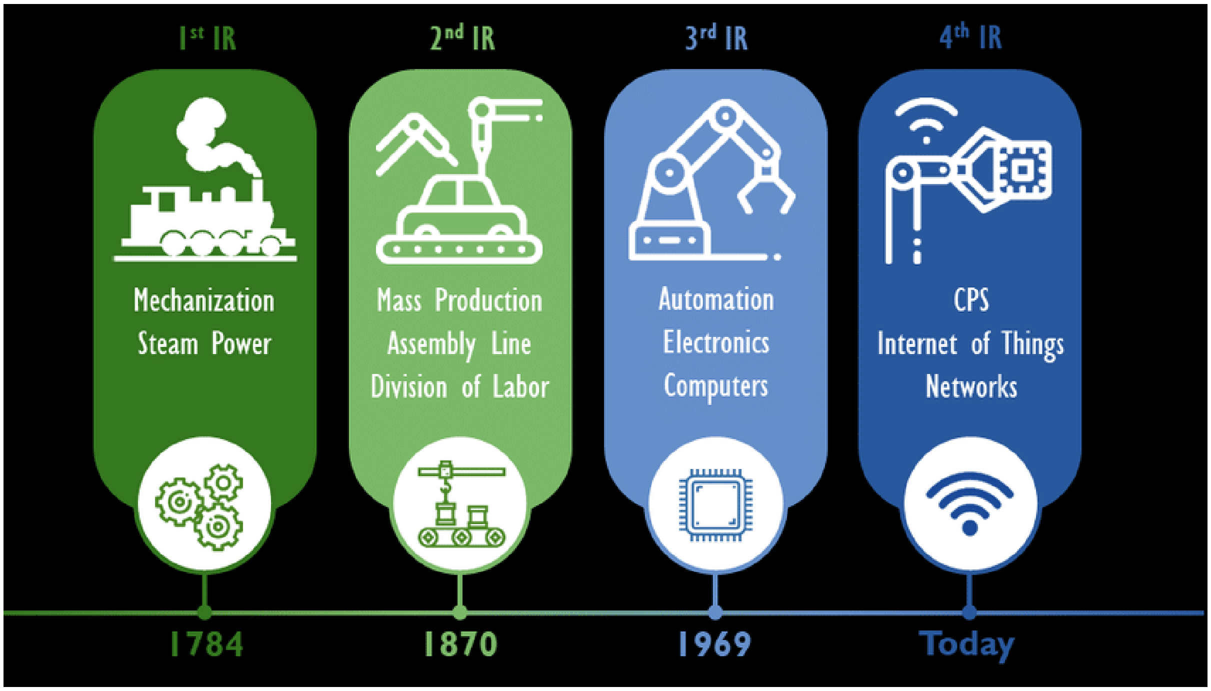


Figure 4: Industrial revolutions timeframe

Third industrial revolution was in 20th century with keywords of automation, electronics, computers and beginning of robotics. Factories started to use digital technologies and robotics to automate the production.
Fourth industrial revolution started in 21st century and is ongoing. The keywords there are Smart Technologies, Internet of Things, Automation and Robotics, Artificial Intelligence etc [2][3].
Video of fourth industrial revolution - https://www.youtube.com/watch?v=b9mJrzdlfR8

Introduction to robotics

Robotics is a branch of engineering and computer science that involves the conception, design, manufacture and operation of robots. Simply designing, building and testing the robots.

Key components of robots:

1. Sensors – devices that help robot to gather information from environment. Sensors can detect light, sound, motion, heat etc.
2. Controller or control unit – so called "brain" of the robot that processes the information gathered by sensors and making actions accordingly with actuators.
3. Actuators – devices that allow robots to move or make actions, like play sound, blink light or show something on screen.
4. * Software – programs and algorithms that says how the robot behaves, like pathfinding, object recognition, decision-making etc.
5. * Battery of any other power source that helps the robot to be autonomous and mobile.

Fun and simple game to illustrate robotic system

All the students act like robots, they have sensors (eyes), control unit (brain) and actuators (hands and legs). Teacher is the changing environment that the robots have to detect.

Robots have to follow the code:

```
Loop FOREVER
    If teacher hands are NOT up:
        Robots just stand
    If teacher raises RIGHT hand:
        Robots have to crouch
    If teacher raises LEFT hand:
        Robots rotate 1 full turn
    If teacher raises BOTH hands:
        Robots jump 5 times and PROGRAM ENDS
    Repeat:
```

Robot classification

Robots can be classified by different ways, by generations, by types of mobility, by use of sector or function etc [4].

There are five generations of robots (by chronology):

1. **First generation** – robot manipulators that can pick up and move things but lack of mobility. Mostly controlled by humans and calibrated by humans.
2. **Second generation** – learning robots that learn from environment and gather information. Sensors help to calibrate the movement and tasks controlled by external control unit.

3. **Third generation** – reprogrammable autonomous robots that use sensors to interact with environment and act accordingly. They have their own control unit.
4. **Fourth generation** – intelligent robots capable of interpreting the environment in real time appear.
5. **Fifth generation** – robots with artificial intelligence to mimic human beings.

Robots can be classified by their mobility also:

1. **Robotic arms** – good in moving objects and doing tasks repeatedly, good in speed and accuracy.
2. **Automated Guided Vehicles** (AGV-s) – robots that move along on pre-defined tracks
3. **Autonomous Mobile Robots** (AMR-s) – can move and make decisions on their own, using sensors and on-board control unit.
4. **Humanoids** – AMR-s that look like humans and do tasks like humans.
5. **Cobots** – or collaborative robots are robots that can work alongside with humans, keeping in mind the safety

And robots can be classified also by their function in sector [5], one of the biggest are:

1. **Industrial robots** – these robots are used in production line and they often carry out a routine tasks. Robotic arms, robot couriers etc.
2. **Domestic robots** – these robots are used in everyday life and often at homes. Security cameras, smoke detectors, vacuum cleaners, lawn mowers etc.
3. **Educational robots** – these robots are used for educational purposes. These can be LEGO robots, drones and other robotic kits. These can be pre-built robots, programmable robots and modular robots like LEGO Mindstorms etc.
4. **Military robots** – these robots are used for military purposes, such as supporting armies, carrying payloads or wounded, surveillance or to detect explosives. Can be UGV (Unmanned Ground Vehicles), UAV (Unmanned Aerial Vehicles) or others.
5. **Medical robots** – these robots are used for health care, like surgery, transportation, communication, examination etc.

Introduction to robotic arm – UR5

The UR5e is a collaborative robot, or "cobot," developed by Universal Robots (see Fig 5). Designed to work safely alongside humans, it assists in various tasks within factories. Weighing approximately 18.4 kg and with a reach of 850 mm, the UR5e can handle payloads up to 5 kg [7].

How the UR5e Cobot Works in Factories:

- Assembly: The UR5e can precisely put together products by assembling components, ensuring consistency and reducing errors.

- Machine Tending: It assists in operating machinery by loading and unloading parts, which enhances efficiency and allows human workers to focus on more complex tasks.

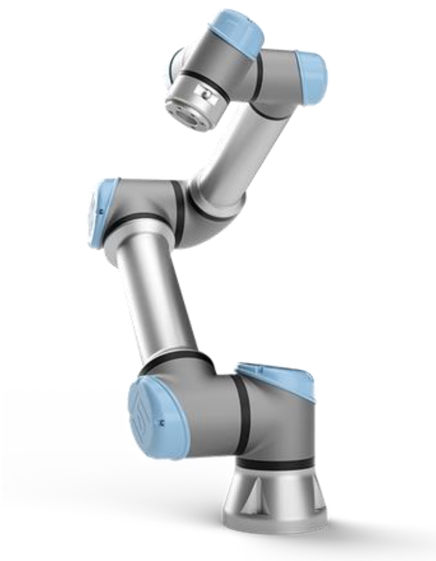


Figure 5: UR5 cobot

- Material Handling: The cobot moves materials within the factory, streamlining workflows and reducing the physical strain on human workers.
- Quality Inspection: Equipped with sensors, the UR5e can perform detailed inspections to ensure products meet quality standards, identifying defects that might be missed by the human eye.

Benefits of Using the UR5e Cobot:

- Safety: Designed to work alongside humans without the need for safety cages, the UR5e enhances workplace safety.
- Flexibility: Its lightweight and adaptable design allow it to be easily integrated into various production lines, making it suitable for different tasks.
- Efficiency: By taking over repetitive tasks, the cobot increases productivity and allows human workers to engage in more complex activities.

In summary, the UR5e cobot is a versatile and efficient tool that enhances factory operations by collaborating with human workers, improving safety, and boosting productivity. For these reasons, it is a great tool to use in education since it is more safe than other robotic manipulators without counter-force detection.

Introduction to LEGO Education SPIKE Prime

The LEGO® Education SPIKE™ Prime Set (see Fig 6) is an innovative educational tool designed to engage students in hands-on STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning [6]. Combining colourful LEGO building elements, easy-to-use hardware, and an intuitive drag-and-drop coding language based on Scratch, SPIKE Prime encourages students to think critically and solve complex problems, regardless of their learning level.

In the context of summer camps, especially those focused on robotics and technology for students aged 10-14, SPIKE Prime offers several advantages:

Figure 6: Spike Prime robot

1. Hands-On Learning: Participants can build and program their own robots, vehicles, and interactive machines, fostering creativity and problem-solving skills.

2. Progressive Skill Development: The system supports learning progression from elementary to middle school, ensuring that activities can be tailored to various skill levels.

3. Comprehensive Resources: With over 40 guided lessons and step-by-step building and coding instructions, camp facilitators have access to a wealth of materials to structure their programs effectively.

4. Team Collaboration: The platform encourages teamwork, as students often work in groups to build and program their creations, enhancing communication and collaboration skills.

By integrating SPIKE Prime into summer camps, organizers can provide an engaging and educational experience that not only introduces participants to robotics and coding but also cultivates essential 21st-century skills in a fun and supportive environment.

You will find extras together with this document that are downloaded from LEGO Education Spike Prime lessons. These PDF files include:

1. Annex 2 - Training Camp 1: Driving Around - Build a Practice Driving Base and make precise and controlled movements
2. Annex 3 - Training Camp 2: Playing with Objects - Use sensors to control motors and interact with objects on the competition field
3. Annex 4 - Training Camp 3: Reacting to Lines - Write programs using the Colour Sensor to make the Driving Base autonomous

Practicing and tasks

Summer camp activities are chosen in a way that there is a learning flow – tasks are fun, engaging and getting a bit harder and harder.

Day 1 – getting to know LEGO robotics

1. Help – fun and easy build for detecting colours and storytelling (engaging activity, talking about your pets etc) (Light sensor, colours, sound)
2. Break dance – fun activity (Motors, Sound, Music)
3. Super Cleanup – manufacturing a robotic hand to

Day 2 – getting more serious with tasks toward manufacturing

1. Pass the brick – challenge to bond more
2. Driving base – start building a manufacturing robot (Driving + sensors)
    a. Driving – start coding, drive a square
    b. Avoiding walls – touch sensor to avoid walls – robot vacuum as an example
    c. Avoiding obstacles – ultrasonic sensor to avoid obstacles
    d. Grabber – pick-up obstacles and third motor + ultrasonic

Day 3 – challenge day to combine what we have learned and to complete a challenge

1. Place your order – detects objects by colour and moves accordingly – in industry, raw materials can be taken automatically to and out of warehouse. Colour might be used as characteristic in quality control.
2. Challenge – in group of 6 (2 teams together) make a robot that transports a larger brick from one position to another. In the end mark there is a robot waiting for the object (brick) and a) plays a sound if the brick is in certain colour b) plays a sound and moves the brick further somewhere. Custom built for transport robot and detection robot.

Methodology for Using Robots in Summer Camps

Summer camps provide an exciting environment to introduce students to STEM through robotics. To make the experience meaningful and motivating, educators should apply teaching methods that promote creativity, collaboration, and real-world problem-solving. The following approaches have proven especially effective in short-term, hands-on learning contexts like robotics camps [8].

Project-Based Learning (PBL)

In PBL, students work in small teams to complete open-ended tasks or solve real-world challenges using robots. This method emphasizes planning, design, testing, and iteration. Teachers act as facilitators—guiding students as they build, program, and refine their robotic solutions. PBL promotes autonomy, critical thinking, and the integration of STEM knowledge with practical action.

Problem-Solving Approach

Robotics naturally introduces problems: things don't always work on the first try. Whether it's a motor that won't run or a robot that turns the wrong way, students are constantly challenged to diagnose issues and develop solutions. This method strengthens logical thinking and perseverance, while offering immediate, visible results that reinforce learning.

Collaborative Learning

Working in pairs or small groups allows students to share knowledge, divide responsibilities, and support each other. Roles can rotate between building, coding, documenting, and presenting. Collaborative learning enhances communication skills and helps students learn from diverse perspectives. It also aligns well with real-world robotics projects, which are rarely solved alone.

Competition-Based Learning

Friendly competition—such as timed challenges or robot races—can boost motivation and engagement. However, it is important to keep the focus on improvement and learning rather than simply winning. When designed well, competitions offer students a fun goal that drives them to refine their robot's performance through multiple iterations.

Use a blend of methods to meet varied learner needs and keep activities dynamic. Keep group sizes small (max 4 participants) to ensure every student can be hands-on. Encourage reflection and discussion after each activity to reinforce learning. Select tools and challenges that are age-appropriate and scale in difficulty. Create an environment where mistakes are seen as learning opportunities.

By applying these active, student-centered approaches, teachers can make robotics summer camps not only fun and exciting—but also deeply educational. These methods help build technical competence, teamwork, and a lasting interest in STEM fields.

Summary

This handbook provides a comprehensive, step-by-step guide for organizing the DIGIROBO Summer Camp—an engaging, educational, and hands-on robotics event aimed at increasing interest in STEM among students aged 10–16. The camp combines storytelling, teamwork, and practical problem-solving to simulate real-world industrial robotics scenarios using mobile robots and a robotic arm.

The document includes guidance on preparing the event (recruitment, registration, facilities, and equipment), structuring the agenda over three days, setting up the competition field, and ensuring safety. It offers detailed competition rules and outlines tasks for participants, ranging from simple sensor-based builds to full robot challenges.

Emphasis is placed on the educational impact, with defined learning outcomes that focus on teamwork, coding, and an understanding of modern manufacturing processes. The handbook also provides tips for forming balanced teams, collecting feedback, and evaluating success post-event. Examples from camps held in Estonia and Malta are included to showcase real-world application and participant experiences.

Supporting materials such as LEGO SPIKE Prime learning modules and consent form templates are included in the annexes to assist educators and organizers in replicating or adapting the camp independently. The DIGIROBO Summer Camp is a scalable and tested model for inspiring the next generation of roboticists and engineers.

References

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