Programming a CNC machine: drawing a rectangle in concrete measurements / Mathematics - v1:

MaFEA – Making Future Education Accessible
PR3 - EDUCATIONAL LEARNING PATHS

Technology tools:	LEGO Spike Prime
Tool version:	29
Requirements: What do you need? (Think hardware, skills, knowledge.)	• Computers or tablets • Stable internet connection • Basic robotics and programming knowledge for teacher
Optional technologies:	
Date:	10.01.2024
College:	VOCO, Estonia
Author (optional):	Getter Hiis-Hommuk
Topics of the lesson(s):	Robotics and mathematics
Estimate time	2x 90 min

Funded by the European Union

Lesson title/subject: Programming CNC machine: drawing a rectangle in concrete measurements/Mathematics

Intention: What do you wish for or hope to happen? (Intentions are often not measurable or tangible, but help you in developing the design process.)

1. Students collaborate with each other both in assembling the robot and in writing the code.
2. Students stay on task and don't get distracted.
3. Students are careful with the tools.
4. Students see how mathematics works in real world.

Desired Outcomes: One or more measurable and tangible goals the teacher aims for with this lesson/these lessons.

1. Pairs of students assemble a LEGO robot.
2. Students brainstorm and come up with solutions to fix the broken robot.
3. Students program in pairs.
4. Students correct and complete their code.
5. Students use and activate knowledge about measuring and geometry.
6. Students reflect on how they did and what they learned.

Agenda: HOW are you going to reach the goals? Description of the lesson plan / educational activities / working methods.

In class, students will assemble a LEGO robot “CNC machine” and program it to draw a rectangle with given size. At first, they try to let the robot draw a random rectangle. After that, teacher gives them a paper with a rectangle and a ruler. They have to figure out, how to make the rectangle with their robot.

The lesson is about learning by doing. Pupils try to come up with a solution on their own and the teacher gives only minimal guidance. There is always the possibility for students to ask for help, in which case the teacher will guide them towards the correct solution/answer.

Roles: Who facilitates what? Who participates? What do we expect of the students?

1. Teacher -> guides, guides the progress of the lesson, helps when needed, guides students to better cooperation.
2. Students -> take part in the lesson, hold tools well, work in pairs.

Rules: Rules or principles are about how you want to learn and work together.

1. We look after the school's assets. We are careful not to break or lose anything.
2. We help each other. If necessary, classmates can be helped by pointing them in the right direction.

3. Let's work together. While only one student can program at a time, another can help to think and guide. It is also important that both pairs understand the code that is being generated.

Time: Describe the time path: What time do we start / finish / break? When is the time for reflection? What happens between contact times?

1. (5 min) The teacher explains the purpose of the lesson and briefly explains what is going to happen.
2. (2 min) The teacher divides the pupils into pairs (groups of three if necessary) and gives each pair a LEGO Spike set.
3. (3 min) At the same time, the teacher asks the students to go to https://spike.legoeducation.com/ and choose LEGO Spike Prime → Build → CNC machine.
4. (40 min) The teacher explains that one student in the pair will build the top of the machine and the other will assemble the bottom part of the machine. Finally, they combine both parts into one. The teacher now asks the students to start assembling their robots. She will go around the class and help if needed.
   Last part of the assembly is adding a pen or pencil (their own) to the robot.
5. (20 min) Is it working? Students figure out that some of the parts of the machine are missing. They fix the problematic parts of the machine. If needed, they make adjustments later on (in between writing the code).
6. (3 min) When the robot is ready, the teacher asks you to go to Home → New Project → Word Blocks. The teacher explains that you need to start writing code there.
7. (50 min) Students are instructed to draw a rectangle with the robot that they just made. Students need to test different blocks and try to understand how they work. Then they can start making a rectangle. If needed, teacher helps by pointing them to the right direction.
8. (5 min) Students present what they have made to the teacher. Teacher checks if their code is really doing a rectangle. If it is working as needed, the teacher gives them a new exercise. If it is not working, teacher points out the problem and they have to make it work properly.
9. (35 min) The teacher gives the students a rectangle and says that they have to make a program which cuts out this rectangle. (No cutting will actually happen; they will have to draw it with their machine.) They have to modify the code that they made before.
   Students present the code they have made to the teacher. Teacher checks the code and how it works. If needed, teacher asks the students to fix some parts of the code.

10. (10 min) Teacher discusses with students. What went well? What were the hardest parts? What new did you learn? Exchange of experiences and discussion. If necessary, the teacher will discuss key points.
11. (7 min) The teacher asks everyone to dismantle their robots and put all the pieces back in their correct places.

☐ Approximately +- 2 x 90 min.