K20 L•E•A•R•N

Mind-Crafting Robotics Through LEGO® Mindstorms: An Introduction

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Time Frame 180-200 minutes

Essential Question(s)

How can the use of robotics in class help students begin to think like scientists and/or engineers?

Summary

This professional development session, built on theoretical constructs SAMR and Authentic Teaching and Learning, engages participants in an overview of LEGO Mindstorms and a model activity for Mindstorms EV3. Participants can expect to be engaged in a hands-on experience where they will apply research-based practices to support the use of robotics technology in the curriculum, explore the effects of robotics on student learning, and troubleshoot potential roadblocks for student learning with robotics technology.

Learning Goals

- Participants will apply research-based practices, like SAMR and Authenticity, to support the use of robotics technology in curricula.
- Through the lens of science and engineering practices, participants will connect the effects of classroom robotics technology to students' lives outside the classroom.
- Participants will troubleshoot potential difficulties for student-learning experiences (building and coding) with robotics technology using the LEGO Mindstorm platform.

Attachments

- 3-2-1—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.docx
- 3-2-1—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.pdf
- Drag and Drop Scavenger Hunt—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.docx
- Drag and Drop Scavenger Hunt—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.pdf
- EV3 Resources—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.docx
- EV3 Resources—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.pdf
- Presentation Slides—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.pptx
- Task Cards Template—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.docx
- Task Cards Template—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.pdf
- Task Cards—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.docx
- Task Cards—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.pdf
- Troubleshooting Reflection Sheet—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.docx
- Troubleshooting Reflection Sheet—Mind-Crafting Robotics Through LEGO Mindstorms An Introduction.pdf

Materials

- LEGO Mindstorms Kit
- LEGO Mindstorms EV3 Software
- Computer
- Presentation Slides (attached)
- 3-2-1 handout (attached; one per participant)
- Drag and Drop Scavenger Hunt handout (attached; one per participant)
- EV3 Resources handout (attached; one per participant)
- Task Cards (attached; one per participant)
- Task Cards Template (attached; one per participant; optional)
- Troubleshooting Reflection Sheet (attached; one per participant)
- Paper
- Pencil

Engage

To begin, display **slide 3** of the attached **Presentation Slides.**

Using the Bell Ringer strategy, activate prior knowledge of robotics from participants. These images can include real and fictional robots, but also red herrings, such as washing machines, to spur discussion of what is and isn't a robot.

> **Presenter's Note: Images**
>
> Links to the images for this Bell Ringer are included in the notes section of the presentation slides on slide 3.

Ask participants to work with a partner to determine if the contents within the image are robots or not, briefly discuss with their partners and come to an agreement.

Solicit a few responses from the group.

Move to **slide 4**. Use the following questions to engage participants in a whole-group discussion:

- What are the characteristics of a robot? (Sample discussion points may include that they are manufactured, they can sense their environment, they follow instructions, they move, etc.)
- What is an example of a robot, real or fictional, that you can share?
- How does your example of a robot match the characteristics we discussed a few moments ago?
- Why do we make robots? What do you think is the purpose of robotics?

Once you have finished, inform your audience of the goals and objectives for the PD using **slides 5–6**.

In this session, you will:

- Apply research-based practices to support the use of robotics technology in the curriculum.
- Through the lens of science and engineering practices, connect the impact of classroom robotics technology on students' lives outside of the classroom.
- Troubleshoot potential difficulties for the student learning experience (building and coding) with robotics technology using the Mindstorms platform.

Transition to **slide 7** and share with participants the quote about robotics in the classroom.

> **Presenter's Note: Purpose of Quote**
>
> The quote emphasizes the importance of practicality and clear instructions. You don't need to be an engineer or programmer to use robotics; just provide explicit instructions for the robot (and your students)!

Explore

The next slide, **slide 8**, contains a video that can help illustrate to participants how code must be explicit and proceed step-by-step.

Next, move to **slide 9** and introduce the next activity, a scavenger hunt. Move to **slide 10**, pass out a copy of the attached **Drag and Drop Scavenger Hunt** handout to each participant, and have participants open the LEGO Mindstorms program. Have participants explore the drag and drop coding features while completing the scavenger hunt as they examine the various functions, buttons, and icons. After participants have had time to explore the program and try a few lines of coding, model for participants the process of turning the robot on and having it run the created code.

Give participants a simple instruction, such as make the robot move and turn and allow time (10–15 minutes) for them to work on their task.

Afterward, have participants share out. Move to **slide 11** and ask the questions on the slide:

- What did you get your robot to do?
- What did you notice about programming your robot?
- How can you relate to the kid's experience in the PB&J video after working on your robot?

Optional Math Connection

How could you calculate how far the robot is going to go (in radians)?

Explain

Navigate to **slide 12**. Pass out a card from the attached **Task Cards** to each participant. Differentiate cards for each participant based on each person's knowledge and level of understanding. Cards feature open-ended tasks such as:

- Program your robot to drive forward, turn left 90 degrees and continue driving.
- Program your robot to drive forward, turn right 90 degrees and continue driving.
- Program your robot to drive forward and make 90 degree turns around an obstacle.

Along with the Task Cards, give each participant (or small group) a copy of the attached **Troubleshooting Reflection Sheet** to document their experiences. Provide guidance as necessary to keep participants on task, but allow them to self-direct a majority of the learning experience. Twenty to forty-five minutes, as time allows, should be sufficient.

Participants now reflect and share out their experiences in completing the Task Cards (**slide 13**).

- (Time allowing) Show us your robot's movements.
- What problems did you come across?
- How did you troubleshoot and fix the problem?

Extend

On **slide 14**, use the Agreement Circles strategy to gather a few quick responses from participants:

- Were the Task Cards fun?
- Were the Task Cards doable?
- Were the Task Cards practical?
- How do these robotics tasks prompt a student to think like a scientist or an engineer?
- How do these robotics tasks aid in the development of a student's critical thinking and problem-solving skills?

Transition to **slide 15,** and ask participants, "How would these robotic activities connect to the NSTA Science & Engineering Practices?" Follow the link on slide 15 to share with participants the NSTA Science and Engineering practices. Emphasize that beyond highlighting science and engineering practices, relevancy to the students' lives is an important piece of the equation.

Move to **slide 16.** Have participants vote using the Sticky Bar strategy to show which one of the practices they think students can most easily connect to their lives. Have participants write on a post-it their practice of choice, and construct a bar graph showing the distribution of opinions.

Move to **slide 17.** Have participants take a moment (ten to fifteen minutes) to explore more LEGO Mindstorms resources. Pass out a copy of the attached **EV3 Resources** handout to each participant. Using the resources provided, have participants begin identifying lessons or activities that could foster the development of skills and knowledge needed in their content area.

Presenter's Note: Goals

The goal here is to get participants to see how robotics can enhance the teaching and learning environment to create authentic learning experiences. "As a teacher in the classroom, how am I going to integrate LEGO Mindstorms into my practice?"

Evaluate

Finally, participants will complete a 3-2-1 strategy. Move to **slide 18,** pass out a copy of the attached **3-2-1** handout to each participant, and present the following prompt:

- What are 3 activities with LEGO Mindstorms you could use in your classroom? (Circle one that you could implement in the next two weeks.)
- What are 2 different NSTA Science and Engineering Practices that would be supported by incorporating a Mindstorms lesson?
- What is 1 question or problem that students might have, and how do you plan to answer it (or support students' struggle to solve it themselves)?

Follow-up Activities

Some questions you may want to share at the end of the session to prepare for a follow-up with participants after they've implemented their created lesson or activity:

- What activity did you implement with students?
- How did students approach the task?
- What challenges did students experience?
- How did they problem solve or “troubleshoot” these challenges?
- How did the task promote students’ critical thinking?
- How did the learning experience support NSTA practices?

Research Rationale

The use of STEM-integrated technology in the classroom, such as LEGO Mindstorms, requires teacher preparation and intentional planning for student engagement. Teacher preparation must ensure that the collective total knowledge of all involved teachers is adequate, which can be accomplished through training and professional development that emphasizes “content knowledge, practices, implementation approaches, connection between and among STEM disciplinary knowledge and skills, and assessment of learning outcomes”(Ntemngwa, 2018). Authenticity is needed, as the relationship between engineering and technology is more easily understood by students if science and math classes are carried out in the context of everyday life (Erdem, 2019). In order for lessons using STEM-integrated technology to be successful, teachers must provide clear lab instructions with embedded resources, such as YouTube videos, and create reasonable activities that are practical, fun, and/or doable under time constraints (Bhounsule et al, 2018). Finally, teachers must cultivate an atmosphere where failure with problem-solving is acceptable. This can be accomplished using reflective self-assessment wherein students focus on themes such as group dynamics, problem scope, time management, and iteration/testing (Bitetti et al, 2018).

Resources

- Bhounsule, P.A. et al (2018). Control systems and robotics outreach to middle-school girls: Approach, results, and suggestions. Presented at 2018 ASEE Gulf-Southwest SectionAnnual Conference, Austin, 2018. Berlin: Research Gate.DOI: 10.1109/FIE.2018.8659344
- Bitetti, S. et al (2018). Examination of student self-assessed learning in a project-based freshman robotics course. Presented aat 2018 IEEE Frontiers in Education Conference(FIE), San Jose, CA, 2018.
- Erdem, A. (2019). Robotics training of science and arts center teachers: Suleymanpasa/Tekirdagcase. Journal of education and training studies, 7(7), 50-61. DOI:10.11114/jets.v7i7.3943
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- Ntemngwa, C. & Oliver, J.S. (2018). The Implementation of Integrated Science Technology, Engineering and Mathematics (STEM) Instruction using Robotics in the Middle SchoolScience Classroom. International Journal of Education in Mathematics, Science and Technology (IJEMST), 6(1), 12-40. DOI:10.18404/ijemst.380617