STEM TROOPERS

LEVEL 4

Student Book

STEM Advancement Inc.

Achievements
Educational Services

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TABLE OF CONTENTS

WHAT IS STEM?

S	Science is how we understand the world around us. Science is meant to be built, touched, and experienced. As you start the journey to learn and experience science, remember the scientists who came before you- they did not simply memorize or imagine unclear ideas- science was real to them and that is what allowed them to understand it. This course ensures that you get that chance to fully experience the science- with your mind and your hands.
T	Of course, we see how much technology is part of our lives. Work, medicine, transportation, play- is there an area where we don't see technology being used? If we want to understand the world around us, it is important that we understand how technology works- only then can we figure out new ways that technology can safely and usefully help our world. We do not want to be slaves to the technology other people design- we want to be able to utilize the power of technology for the good ideas that we have.
E	What does it mean to be an engineer? Simply put, engineering is problem-solving. The ability to judge a situation, weigh the good and bad, figure out how to use your resources, and search for an original solution is something that helps you for your whole life. The critical thinking and problem-solving skills you get from this course will be with you throughout life, and you will confidently come to rely on them as you face life's challenges. Never underestimate your ability to solve a problem- any problem.
M	Talking about math with students is always scary - nobody wants to admit how important the numbers really are. But they are important. You want to build a bridge? Angles matter. You want to figure out how fast the roller coaster can go without flying off the track? Math again. Instead of seeing math as the enemy, a difficult set of rules for how numbers should and should not be combined, this course will teach you simple understandable ways to use math.

THE ENGINEERING DESIGN PROCESS

Throughout this book you will come across some open-ended STEM CHALLENGES which allow you to problem-solve and find solutions to real world problems using your science, math, engineering, and technology skills. The engineering design process shown below has 5 steps which will help guide your thinking and ability to experiment.

 **ASK**	**IN THIS STEP, YOU WILL BE PRESENTED WITH A REAL-WORLD CHALLENGE**
 **IMAGINE**	**IN THIS STEP, YOU WILL BRAINSTORM AND THINK OF MANY DIFFERENT POSSIBLE SOLUTIONS.**
 **PLAN**	**IN THIS STEP, YOU WILL DRAW A SKETCH OR DRAFT OF THE IDEA YOU PLAN TO CREATE.**
 **CREATE**	**IN THIS STEP, YOU WILL GATHER MATERIALS FROM YOUR TEACHER AND TRY TO BUILD YOUR OWN SOLUTION.**
 **IMPROVE**	**IN THIS STEP, YOU WILL IMPROVE YOUR PRODUCT, AND POSSIBLY EVEN START OVER WITH A NEW PLAN IF YOUR FIRST ATTEMPT DID NOT WORK. ENGINEERS DO NOT GIVE UP!**

HOW TO USE THIS BOOK

This book is divided into 26 lessons. Each lesson has 2 sessions.

Session 1:

- **Reading**- students will read about a new topic and highlight key terms or main ideas.
- **Group Worksheet**-students will answer questions based on the reading in preparation for the lab activity in session 2.

Session 2:

- **Lab activity** -students will collect materials from their teacher and complete a lab activity. Students will fill in the worksheet as they go along and record their results.

The symbols on the bottom of the pages will tell you when a session continues and when a session ends.

	The green arrow means keep working and go to the next page.
	The red stop sign means stop working and do not move on to the next page.

CURRICULUM OVERVIEW

Lesson	Concept	Activity	Standard*
1	Automation	Learn to use Mini Bots to see how robots follow commands	**3-5-ETS1-1 Engineering Design** **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.** **3-5-ETS1-2 Engineering Design** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. **3-5-ETS1-3 Engineering Design** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
2	Sequencing	Have the Mini Bot turn colors in the order you choose. Students will draw on a traffic map and have the bot turn red at intersections and green on highways.	
3	Decoding	Students will reverse-engineer to determine what 3 color codes represent.	
4	Coding/Crack the code	Students will learn and practice using simple codes for the bit bot/ identify which code will make it jump, spin, etc.	
5	Programming	Students will create a simple program that has an ambulance bot racing through a map of a park to get to an injured bike rider.	
6	Loops	Students will learn how to program the robot do the same process over and over again.	
7	Final project	Students will design their own game using the coding processes they have learned.	
8	Button battery bots with a larger brush and multiple batteries	Students will see the motor turns faster and the bot goes faster when it is provided with more energy. Students will have the bot knock over cups and see which bot has more energy to do so.	**4-PS3-1 Energy** Use evidence to construct an explanation relating the speed of an object to the energy of that object. Performance Expectation **4-PS3-2 Energy** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. **4-PS3-3 Energy**
9	Button battery bots collision course	Students will add small devices to their button bots in order to make them stronger. Students will place their own versions of the bots into an arena and watch to observe which bot is the last left standing.	

			Ask questions and predict outcomes about the changes in energy that occur when objects collide. **4-PS3-4 Energy** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*
10	Color filter glasses	Students will use different colored cellophane to make writing in different crayons "disappear".	**4-PS4-2 Waves and Their Applications in Technologies for Information Transfer** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
11	Waves in a bottle	Students will use oil, water, and food coloring to model the movement of ocean waves, and make observations.	**4-PS4-1 Waves and Their Applications in Technologies for Information Transfer** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
12	Morse code	Students will develop a means of communicating using only light. Students will use lights to send messages to each other using Morse code.	**4-PS4-3 Waves and Their Applications in Technologies for Information Transfer** Generate and compare multiple solutions that use patterns to transfer information.*
13	Intro to Cells	Students will make a model of the 4 basic parts of a cell.	**4-LS1-1 From Molecules to Organisms: Structures and Processes** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
14	Plant vs. Animal Cells	Students will use a microscope to identify key differences between plants and animal cells.	**4-LS1-1 From Molecules to Organisms: Structures and Processes** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

15	Protective Cells	Students will study several protective cells and choose one to draw and write about.	**4-LS1-1 From Molecules to Organisms: Structures and Processes** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
16	Hand washing and the growth of bacteria	Students will observe how effective washing hands is when it comes to stopping bacterial growth.	**4-LS1-1 From Molecules to Organisms: Structures and Processes** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
17	How plants protect themselves	Students will soak and dissect a seed and identify the small plant inside the seed casing.	**4-LS1-1 From Molecules to Organisms: Structures and Processes** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
18	Learned Behaviors vs. Inborn Behaviors	Students will perform reflex tests and learn about inborn and learned behaviors.	4-LS1-2 From Molecules to Organisms: Structures and Processes Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
19	Rocks and rock forming minerals	Students will compare and contrast different rocks and minerals.	4-ESS1-1 Earth's Place in the Universe Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.
20	Pollution	Students will quantify air pollution in certain areas.	4-ESS3-1 Earth and Human Activity Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. 4-ESS3-2 Earth and Human Activity

			Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*
21	Pollution	Air purifying plants	4-ESS3-1 Earth and Human Activity Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. 4-ESS3-2 Earth and Human Activity Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*
22	Pollution	Students will be challenged to design a toy completely out of recycled materials.	4-ESS3-1 Earth and Human Activity Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. 4-ESS3-2 Earth and Human Activity Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*
23	Erosion	Students will use sugar cubes and gravel to determine how mechanical erosion affects rocks of different hardness's.	4-ESS2-1 Earth's Systems Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
24	Erosion	Students will use vinegar and chalk to model the effects of acid rain on limestone, chemical erosion.	4-ESS2-1 Earth's Systems Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
25	Relief Maps	Students will use color to show elevation on a map	4-ESS2-2 Earth's Systems Analyze and interpret data from maps to describe patterns of Earth's features.
26	Climate zones	Students will use study climate zones and latitude associations.	4-ESS2-2 Earth's Systems Analyze and interpret data from maps to describe patterns of Earth's features.

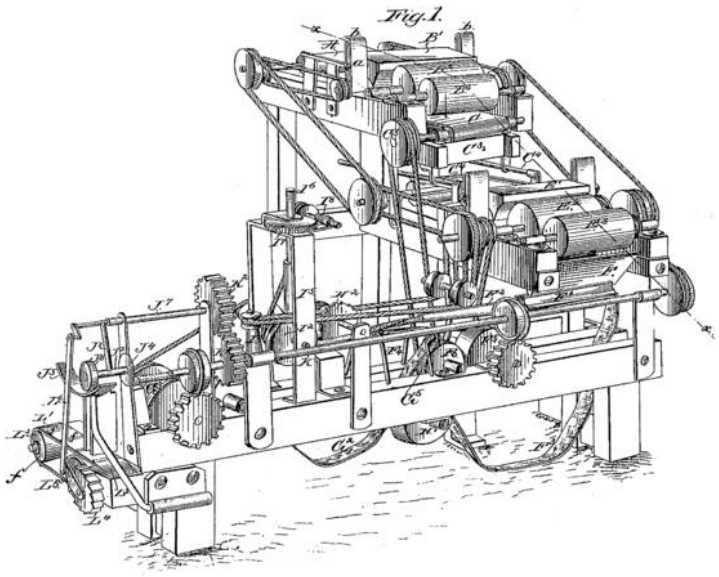
LESSON 1: SESSION 1 INTRODUCTION TO AUTOMATION

Objectives:

Understand that machines can be automated.

Understand that automated Machines can only perform actions they are programmed to follow.

Understand that machines use sensors to detect changes in their environment.



Key Terms:

Automated machines
Sensor
Code
Program
Coders
Programmers

Machines

Machines are things that help us by making work easier. Machines can be simple, like a shovel or a screw, or they can be complicated like a computer or a windmill. Some machines are automated. **Automated machines** are machines that, once they are turned on, can work by themselves. You may have seen a robot-vacuum that moves around the floor by itself. Once you turn it on, this is an automated machine. It does not need a human to push it around the floor, it is able to move around by itself. The robot uses **sensors** to detect when there is an object in the way, and it moves to avoid it.

Programming

Machines, especially automated machines, have no natural intelligence. Machines cannot make decisions about what to do by themselves. Instead, computer engineers create code. Each piece of **code** is a different instruction that tells the robot what to do. A bunch of code together that instructs the robot to complete an entire task is called a **program**. Computer engineers who write code are often called **coders** or **programmers**.

LESSON 1: SESSION 1 — GROUP WORKSHEET

Introduction to Automation

M **Machines such as computers or robots will follow instructions automatically.**

Circle the machines that are **automated**

Remember an automated machine will work according to whatever instructions it was programmed to do. Once it is turned on, an automated machine does not need a human to give it information, it works automatically.

1. Vacuum	2. Car	3.Roller Coaster Ride
4. Air Conditioner	5. DVD player	6. Bicycle
7. Robot	8. Thermostat	9. Factory Equipment

True or False:

1. An automated machine can turn on by itself (without instructions) _____
2. An automated machine can turn off by itself (without instructions) _____
3. Automated machines can only follow the instructions they are given _____

Imagine

Can you design an automatic machine that takes raw potatoes and turns them into bags of potato chips? Draw it below and label the different parts.

DRAW A PATH FOR YOUR MINI ROBOT

The Situation:

Your new Mini Robot can automatically follow thick dark black lines using special light sensors that allow it to tell the difference between black and white.. However, your lines must be drawn carefully in order to instruct the Mini Robot to follow them carefully. The lines represent your “code”. You must be carefully when you program your “code” so that the mini robot does exactly what you want.

Practice calibrating the mini robot and draw a path for it to follow.

The materials:

Mini Robot

White Paper

Coding Markers

Which kind of lines worked just right?