Recommended for **middle school grades**

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STEM Coding Max

Hands-on approach to programming

Klett MEX

fischertechnik

STEM Coding Max

DETAILS

2-4 students

243 components incl. spare parts bag and simple re-sorting

11+4 models and **42+ lessons. Teaching material**

Incl. RX controller, 2 × motor, 4 × buttons, 3 × LED, color sensor, gesture sensor, proximity sensor, brightness sensor, reed switch, 9 V battery with USB-C charging port

More information, quick start guides, and video tutorials are available here:
→ www.fischertechnik.de/en/stem-coding-max

All tasks and building instructions are integrated into the **fischertechnik app "STEM Suite"**.
Just download the free app and get started.
The app is available for iOS, Android, Windows, and macOS.

LEGAL NOTICE

fischertechnik
→ www.fischertechnik.de/schools

Klett MEX
→ www.klett-mex.de

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CONTENTS

MEANING OF THE ICONS

Model level of difficulty:
- easy
- moderate
- difficult

Programming level of difficulty:
- easy
- moderate
- difficult

Lesson:
- with app
- without app

Tips
for teachers

STEM Coding Max

Hands-on and problem-oriented design and programming made easy for middle school students!

- **Complete everyday tasks in information technology and robotics**
- **Skill orientation based on the 4C model: Creativity, collaboration, communication, and critical thinking**
- **Scratch, Blockly, and Python programming with an easy-to-use controller**
- **243 components, incl. spare parts bag and simple re-sorting**

Teaching material
for over 42 lessons

Number of models
11+4

Number of students
2–4 per assembly kit

Learning objectives
- Learn the basics of information technology and robotics
- Understanding how actuators and sensors work

Time required
All tasks can be solved within 1–2 double lessons.

Age group
Middle school

LEARNING MATERIAL

Digital skills and an understanding of simple programming are now part of the basic education that must be included in middle school curriculum. STEM Coding Max helps students achieve this through motivating and instructive everyday examples.

Students begin with simple basic tasks and work independently following the app's instructions, gradually becoming familiar with more complex circuit challenges.

How do you learn to equip a simple microcontroller with sensors and actuators? How can this be programmed quickly and easily? How can you create a sensor-controlled, automatic door? How can you create a computer-controlled drawing plotter? What is the purpose of circuit diagrams? How do I calculate the circumference of a wheel? What is a flank?

PRODUCT DESCRIPTION

Using eleven common models and independently realizable tasks, students learn to implement exciting tasks from the field of information technology in problem-oriented short steps. With the help of an easy-to-use controller, a range of practical sensors and actuators, an intuitive app, and high-quality building blocks from fischertechnik, middle school students can solve tasks that they recognize from their daily lives. The hands-on and problem-based learning approach helps students develop subject-specific, methodological, personal, and social skills at different levels.

EDUCATION PLAN REFERENCES

The references to the educational plans/core curricula are based on the common reference framework for natural sciences, information technology, and technology (GeRRT). This forms the basis for cross-national comparability of technology skills and the development of corresponding curricula, the creation of textbooks, the design of school teaching materials, and the development of extracurricular teaching and learning concepts.

The common reference framework is divided into five skill areas. The projects are based on these areas:

Understanding technology:

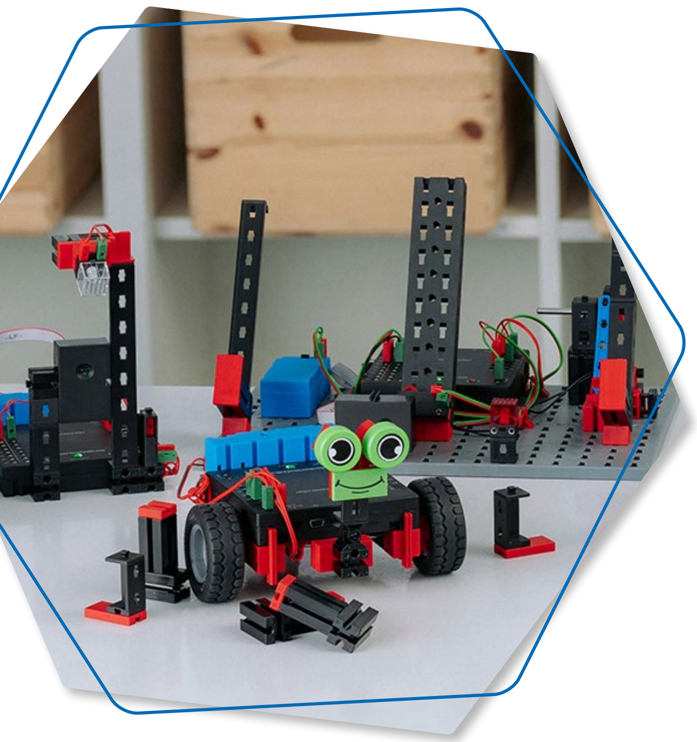
- Analyze and record a complex technical system functionally, hierarchically, and structurally.
- A simple example shows that every technological development and use of technology has consequences for society.

Using technology:

- Select a technical system typical for everyday use based on relevant technical criteria.
- If necessary, adequately analyze the malfunctioning of the technical system and identify and implement possible steps to solve the problem.

Developing technology:

- Break down a technical problem into sub-problems by analyzing requirements and the situation and assess the technical feasibility of solving the sub-problems.
- Develop or refine appropriate solutions for sub-problems, also based on existing solutions.
- Develop plans for partial solutions by adapting existing plans or developing your own partial solutions using digital tools.
- Use the partial solutions to develop the overall solution with the required (also digital) tools, devices, materials, and machines.



Evaluating technology:

- Evaluate a simple technical situation according based on individual criteria.

Communicating technology:

- Purposefully procure technical representations and evaluations for the technical system.
- Read and understand an existing technical description and instructions for the system in the appropriate language and/or images.
- Describe the technical system with standard technical diagrams as well as own technical solutions using technical language depending on the user.

LEARNING OBJECTIVES

The most important learning objectives:

- Achieve everyday tasks in information technology and robotics.
- Transfer model concepts to common applications.
- Practice and enhance project and group work in a team.
- Develop professional, methodological, personal, and social skills.
- Learn program sequences and simple computer structures.
- Learn Scratch, Blockly, or Python programming for an easy-to-use controller.
- Understand and apply the functionality and networking of actuators and sensors.
- Preprofessional orientation in mathematics, natural sciences, (information) technology.

INSTRUCTIONS FOR WORKING WITH THE MATERIALS

- The basic working and connection techniques of fischertechnik as well as the functionality and structure of a program are taught using four entry-level models that are divided into a total of eight introductory basic tasks.
- These basic examples can be used in the following help menu to clarify problems.
- 11 independently realizable projects (models) are available.
- The materials can also be used to create your own solutions to everyday issues.
- Information on implementation, media, organizational forms, or differentiation is provided for all models.
- The teacher materials are structured according to the following common grid:
  - key questions on the topic,
  - presentation of the teaching idea,
  - description of the task,
  - everyday relevance,
  - subject reference within the framework of the curriculum,
  - lesson plan,
  - methodological and instructional tips with differentiation options and motivational aspects,
  - programming skills,
  - notes on additional materials,
  - functional descriptions of the individual models, and
  - material lists.
- The students' tasks are also structured according to a recurring grid:
  - storytelling as an introduction,
  - introductory and in-depth tasks on the topic,
  - design and construction phase of the project,
  - instructions for transferring the program code,
  - commissioning of the model,
  - troubleshooting assistance,
  - differentiation options, and
  - a section with information on related topics or interesting facts at the end of the project.

More information, quick-start guides, and video tutorials are available here:
→ www.fischertechnik.de/en/stem-coding-max

INSTRUCTIONS FOR WORKING WITH THE APP

All tasks and building instructions are integrated into the fischertechnik "STEM Suite" app.

Just download the free app and get started. The app is available for iOS, Android, Windows, and macOS.

The students complete projects and tasks in the app independently in the order listed above.

The given order of the tasks and solutions enable all students to achieve a functioning result (model) and gain a sense of accomplishment.

Entry-level models

to become familiar with the components and programming

KEY QUESTIONS:

- What function can a switch perform? *(Communication)*
- What types of switches are there? *(Communication)*
- What examples from everyday life use a remote-controlled function or trigger a switching operation? *(Communication)*
- Which sensors can trigger actions? *(Creativity)*
- What function must a repetition loop and a time loop fulfill? *(Communication)*
- Which actuators can be triggered by a switching operation? *(Creativity)*

THE TEACHING CONCEPT AT A GLANCE

Grade level: 5–7

Time required: 1 hour each / possibly with differentiation groups

Degree of difficulty: Models
Programming

Models:

- Circuit with LED and button
- Circuit with LED and gesture sensor
- Motor with rotational movement
- Motor with vertical movement

MODEL DESCRIPTION / TASK

Eight simple basic tasks are designed to introduce students to work with the STEM Coding Max experiment box. First, the design of the RX controller, the controller configuration, and the structure of the programming interface are clearly described. For example, simple switching operations are triggered by a sensor. This processes information within a self-created program in the control system and, if necessary, switches on an actuator or performs a function.

SUBJECT REFERENCE

- **Information technology:** Programming basics
- **Physics:** Sensors, actuators
- **Technology:** Gear theory, basics of electr. circuit

LESSON PLAN

Introductory phase

Classroom discussion

- Clarify in the classroom discussion which basic circuits can occur (connection of sensors, actuators, repetition loops, time loops, if-then functions ...).
- Discuss what can be switched off and on (everyday examples).
- Name possible types of sensors: Sensors for brightness, movement, switching on, switching off, toggling ...
- Name possible programming loops: Switch-on delay, switch-off delay, time, repetition ...
- Name possible functions of actuators: turn, lift, illuminate, switch ...

Support, if necessary

- Show sensors, actuators and components from the assembly kit, use presentation media if necessary.

Planning Phase

Classroom discussion

- The basic structure of the app and its functions, e.g. help buttons, the function of the basic circuits, differentiation options ... are shown and explained.
- The progression of the work steps in the app when processing a project is shown.

Classroom discussion

Preparation of the work phase:

- The basic function of a switch (e.g., closed or open circuit), an LED (e.g., operating principle), a motor (e.g., operating principle), and their possible connection variants are discussed.
- The triggering of the switching process and the desired change to an actuator function within a program are discussed.
- The triggering of an actuator and its possible connection variants after the switching process are discussed.

Classroom discussion

- The distribution of work for the lesson is specified. The following eight basic tasks (circuits; increasing degree of difficulty) are implemented as an introduction:
  a) An LED switches on when the program starts.
  b) Pushing a button switches an LED on and off again.
  c) A button switches an LED on or off with a time delay.
  d) A button switches on the flashing function of an LED.
  e) An LED is manually switched on or off.
  f) An LED is automatically switched on when the brightness decreases.
  g) A motor performs a rotational movement.
  h) A gear motor performs a lifting movement.

Partner or individual work

- The students familiarize themselves with the app and download the corresponding task.

Construction Phase

Partner or individual work

- The students use the app to construct the tasks. The app guides them through the program in short steps.
- The circuits are wired. The app guides them through the program in short steps.

Programming Phase

Partner or group work

- The students write the program for the tasks. The app guides them through the program in short steps; the app provides assistance.
- The program is transferred to the RX controller after each programming step.

Experimentation and Test Phase

Partner or group work

- The circuits are put into operation and tested.
- Possible malfunctions in the functional sequence must be found and eliminated. The app offers assistance.
- Any optimizations to the hardware (e.g., loose wiring) and the programming of the sensor command output (e.g., time delay) are carried out.

Final Phase	
Presentation	• Procedure 1: A selected group of students present the circuits. • Procedure 2: The respective group of students present the circuits.
Discussion in plenary	• Discussion of the further procedure in up-coming lessons. • **Optional:** Presentation of a planned project for motivational purposes.

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options

Depending on previous knowledge within the respective groups, the groups can work independently on the eight introductory tasks in sequence at their own pace.

Differentiation tasks can be set for particularly fast groups.

Examples:

- Installation of a second LED in a different color that flashes alternately with the first LED.
- Programming task in which one LED lights when the motor is running clockwise and the other lights when it is running counterclockwise.

Motivational aspects

Building the basic circuits, which can be programmed using a “mini-computer”, has a motivating effect on many students. It is important to ensure that concerns about the system or the possibly unfamiliar methods are reduced or do not arise in the first place. Working independently with the support of an app is also becoming increasingly popular. The groups determine the working rhythm and speed themselves.

An additional motivating factor is that more complex construction tasksrelated to every-day life can be realized.

Optional download:

- Circuit diagram
- Building instructions

ADDITIONAL MATERIALS

- If necessary, use drawing media (paper, whiteboard, or projection screen) to intro-duce the topic.

FUNCTIONS OF ENTRY-LEVEL MODELS AND THEIR TECHNICAL SOLUTIONS

Function of the sensors/actuators	Technical solution
a) Switch an LED on and off.	Displaying a signal with an LED
b) Switch an LED on and off with a button.	Evaluate a button signal and activate an LED
c) Switch an LED on and off with a time delay using a button.	Evaluate a button signal and activate an LED after a time delay using a time loop
d) Allow LED to flash after pressing the button.	Evaluate a button signal and modulated control of an LED
e) Manually switch an LED on and off.	Evaluate the signal from a gesture sensor and activate an LED
f) Automatically switch an LED on and off in the dark.	Evaluate the signal from a brightness sensor and control of an LED
g) Turn a motor left and right.	Evaluate a button signal and motor control
h) Raise and lower a motor slightly.	Evaluate a button signal and motor control with independent return

MATERIAL LIST

Entry-level model 1 (circuit with LED and button) – Basic tasks a) to d)

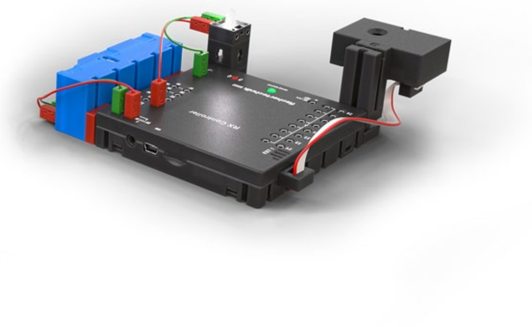
Sensors	Function
1 button	Trigger the switching signal

Actuators	Function
1 LED, white	Lighting

Entry-level model 2 (circuit with LED and gesture sensor) – Basic tasks e) to f)

Sensors	Function
1 RGB gesture sensor	Trigger the switching signal

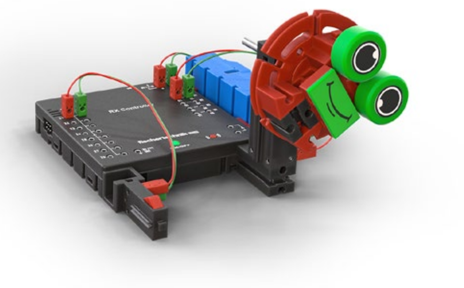
Actuators	Function
1 LED, white	Lighting



Entry-level model 3 (motor with rotational movement) – Basic task g)

Sensors	Function
1 button	Trigger the switching signal

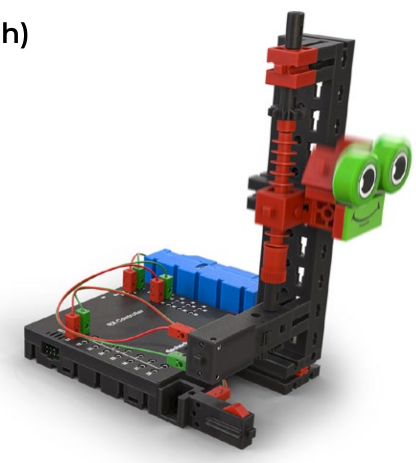
Actuators	Function
1 motor	Rotary movement



Entry-level model 4 (motor with vertical movement) – Basic task h)

Sensors	Function
1 button	Trigger the switching signal

Actuators	Function
1 motor	Linear movement



Differentiation

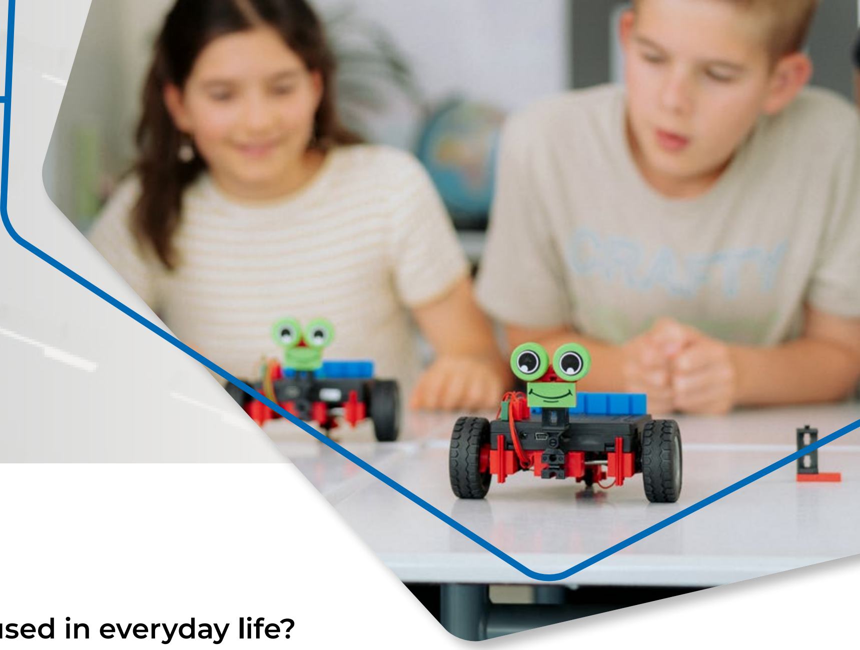
Sensors	Function
1 button	Trigger the switching signal

Actuators	Function
1 motor 1 LED red 1 LED green	Linear movement Lighting Lighting

MODEL 1

RoXy

Keeps the track



KEY QUESTIONS:

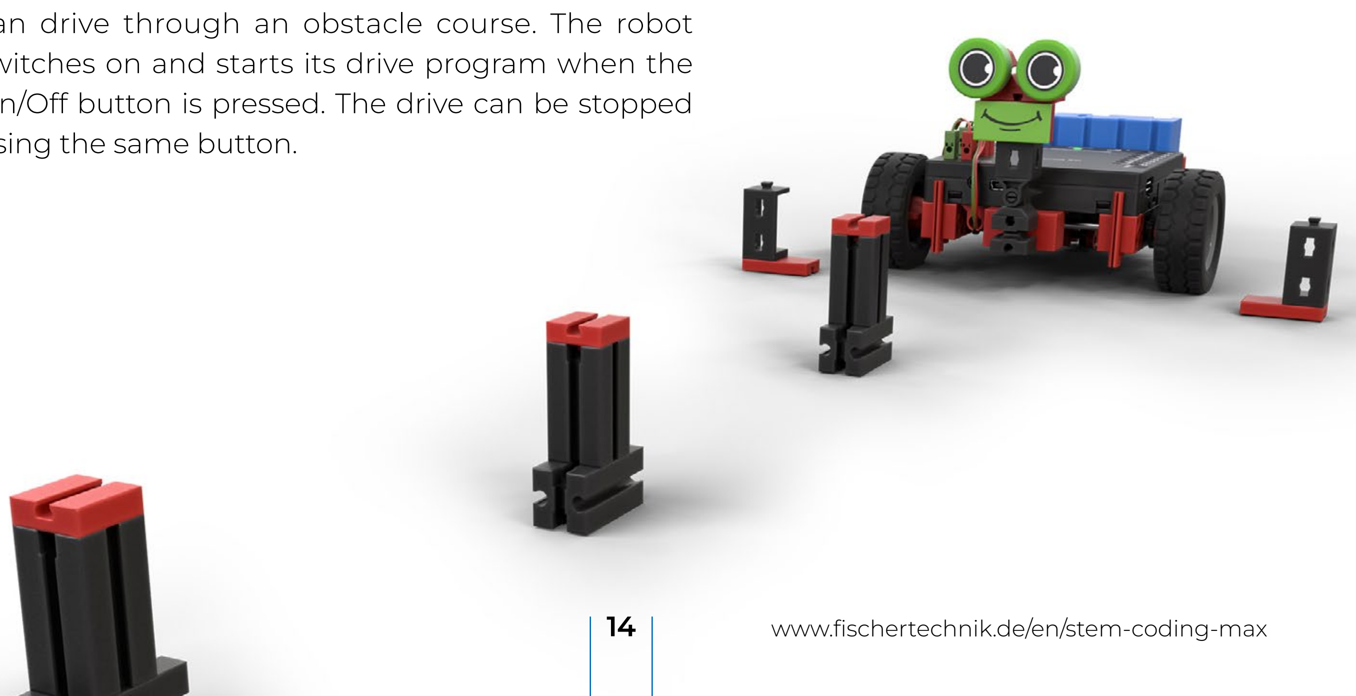
- **Where can a self-propelled robot be used in everyday life? *(Communication)***
- **What functions must the robot fulfill? *(Collaboration)***
- **Under what conditions should the system switch on or off? *(Critical thinking)***
- **What needs to be considered so that the robot can be used at different locations and the system functions as robustly as possible? *(Creativity)***

THE TEACHING CONCEPT AT A GLANCE

Grade level:	5-7
Time required:	1 double lesson (extendable up to 8 DL)
Degree of difficulty:	Model
	Programming up to
Model type:	mobile device, can be positioned individually and used for transportation/movement

MODEL DESCRIPTION / TASK

The students plan and realize a driving robot that can drive through an obstacle course. The robot switches on and starts its drive program when the On/Off button is pressed. The drive can be stopped using the same button.



EVERYDAY RELEVANCE

The automatic triggering of a process and the self-propelled driving of a robot have a strong motivational effect on students. The topic can be individualized with up to four additions to the basic task.

The topic could be integrated into prepro-fessional orientation with regard to IT-related occupational fields. Automated switching by recording physical variables is used here in many fields. In particular, the automated movement of objects is becoming increas-ingly important in home automation (robot vacuum cleaners, robot lawnmowers) and in automotive engineering.

SUBJECT REFERENCE

- **Information technology:** Programming basics, time loops
- **Physics:** Change of movement
- **Technology:** stable building, construction technology
- **Mathematics:** Circumference, units of length, angles
- **Biology:** Movement of individuals

LESSON PLAN

Introductory phase		
	Classroom discussion	• Announcement of the topic, if applicable Show “Robots from film and television”. • Inquire about what makes these robots tick, automation vs. life. • Inquire about scenarios in which self-propelled robot systemsare used (vacuum cleaners, lawn mowers, cars). • Discuss possible applications of the collected scenarios (e.g., robot vacuum cleaner, lawnmower and/or car). • Determine the requirements for the chassis. • Discuss the advantages and disadvantages of different types of drive (chain/wheels). • Justify the need for an emergency stop switch.
	Support, if necessary	• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.
Planning Phase		
	Classroom discussion	• The procedure for building the model and the target function are developed jointly. • Sequence steps of the app are specified or discussed.

Partner or individual work	• The students familiarize themselves with the app and download the corresponding task. • Students define the useful functions of a self-propelling robot. • Students use the app to create the list of requirements for building the robot.
Optional: Partner or group work	• Optionally, the students sketch the potential robots. • The students discuss the results in the group and choose a design.
Construction Phase	
Partner or individual work	• The students use the app to build the driving robot. The app guides them through the program in short steps.
Programming Phase	
Partner or group work	• Students write the program for the driving robot (2 × motor, on/off button). The app guides them through the program step by step. • The app offers assistance. • The program is transferred to the RX controller.
Experimentation and Test Phase	
Partner or group work	• The driving robot is put into operation. • The first drives are carried out with the robot. • Possible malfunctions in the functional sequence must be found and eliminated. • Suggestions in the app can be used for troubleshooting. • Possible optimizations can be made to the hardware (e.g., wheel mounting, rotary roller) and programming.
Final Phase	
Optional: Presentation and allocation of differentiations	• The teacher may approach students eligible for differentiation. The robot's optimization possibilities (cornering, tentacles) are explained. • The app offers concrete ideas for fast learners.
Discussion in plenary	• Project debriefing in class. • Clarification of future possible applications in everyday life (transfer of the topic to everyday life), e.g., vacuum cleaner robots, lawn mowing robots, cars, drones.

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options

Depending on the duration of the lesson series and the strengths of the students, the following are possible:

- specification of the position of the obstacle blocks including the travel routes,
- student measurement of the position of the obstacle blocks,
- the route program blocks are specified,
- self-measurement of the routes,
- self-programming of the routes,
- manual collection of obstacles.

Motivational aspects

All students are familiar with the topic of self-propelled robots from everyday life. In many households, robot vacuum cleaners and lawn mowers have long been part of everyday life as well as many other smart applications. Semi-autonomous cars are becoming increasingly common on the roads.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **repeat until**
- Loop **wait**
- Use of variables and their change
- Working with subprograms

ADDITIONAL MATERIALS

Optional download:

- Circuit diagram
- Building instructions

- If available, a robot from film and television (BB8, R2D2, Wall-E), a robot vacuum cleaner, or another real object from the field of robotics/forklift trucks can be used for the introductory phase of the topic.
- Drawing media (paper, whiteboard, or projection screen).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the sensors/actuators	Technical solution
Performing straight movement	Uniform and simultaneous control of the two drive motors
Performing a turn-left movement	Control of one of the two drive motors
Performing a turn-right movement	Control of one of the two drive motors
Start of a robot drive	Signal input on the On/Off button of the controller
End/emergency stop of a robot drive	Signal input on the On/Off button of the controller
Differentiation: quick turning on the spot (left/right)	Uniform and simultaneous control of the two drive motors in different directions

MATERIAL LIST

Sensors	Function
1 On/Off button on the controller	1. Switching on the robot 2. Emergency stop of the robot

Actuators	Function
2 motors	Movement

MODEL 2

Action timer

Time is always frustrating!

KEY QUESTIONS:

- **What function must a timer fulfill? *(Communication)***
- **Which steps must be taken into account when controlling time loops? *(Critical thinking and collaboration)***
- **How could the timer be optimized in terms of material savings and effectiveness? *(Creativity)***

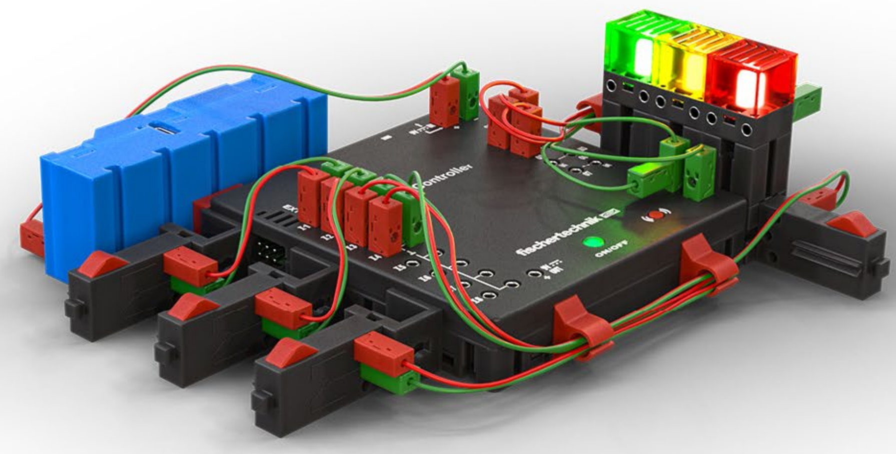
THE TEACHING CONCEPT AT A GLANCE

Grade level:	5–7
Time required:	1 double lesson
Degree of difficulty:	Model
	Programming
Model type:	Desktop device as a timer for time games or measurements

MODEL DESCRIPTION / TASK

Students plan and implement a timer for all types of games where time is of the essence. Three different countdown times can be set using three buttons. The selected time is confirmed when an LED lights up briefly. The countdown then starts via a different button. The remaining running time is indicated by the flashing of the respective LED. Shortly before the time expires, all three LEDs flash quickly and then go out.

The action timer can now be restarted for the next game round.



EVERYDAY RELEVANCE

Variable time loops (hard, medium, and soft for egg timers, or sound sequences for a distance warning device, or running times and acoustic output for sonar devices …) as well as simple options for outputting recorded processes have a strong everyday relevance for the students.

The topic could be integrated into preprofessional orientation with regard to IT-related occupational fields. Time loops and the synchronization of times are required in almost all apps or types of software.

SUBJECT REFERENCE

- **Information technology:** Programming basics, time loops
- **Physics:** Recording and displaying times
- **Sports:** Measurement of reaction times
- **Technology:** develop constructive solutions for technical problems, manufacture and optimize an object

LESSON PLAN

Introductory phase		
Classroom discussion	• Inquire about scenarios in which a timer is used. • Collect different timers from the students' everyday lives (optionally as realia or on text cards). • Presentation of the task. • Discussion about possible/useful time intervals depending on the area of application. Reference to useful times: e.g., egg timer 5/7/10 minutes, chess 1/2/5 minutes, activity 20/30/40 seconds.	
Support, if necessary	• Show sensors and actuators from the assembly kit or timers from everyday life (egg timer, stopwatch); use presentation media if necessary.	
Planning Phase		
Classroom discussion	• The teacher specifies the procedure using the work steps in the app.	

Partner or individual work	• The students familiarize themselves with the app and download the corresponding task. • Students complete the first task in the app.
Optional: Partner or group work	• The students sketch a possible system. • The students discuss the results and agree on a design.
Construction Phase	
Partner or individual work	• Students use the app to build the action timer. The app guides them through the program in short steps.
Programming Phase	
Partner or group work	• Students write the program for the action timer. The app guides them through the program in short steps. • The app offers assistance. • The program is transferred to the RX controller.
Experimentation and Test Phase	
Partner or group work	• The action timer is put into operation and tested. • Possible malfunctions in the functional sequence must be found and eliminated. The app offers assistance. • Any optimizations can be made to button positioning, the wiring, or the programming.
Final Phase	
Discussion in plenary	• Project debriefing in class. • The strengths and weaknesses of the solutions are discussed. • Theoretical optimization options for various application scenarios in everyday life are discussed.
Optional: Presentation and allocation of differentia-tions	• The app offers a differentiation option for fast learners.
Competition	• The use of the individual timers in a practical application, e.g., in an action game, can take the form of a small competition.

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options

Depending on the desired application, the three usable **running times** for the Action Timer can be adapted to individual requirements, e.g., use as an egg timer (hard, medium, soft) or adapted playing times (e.g., for timed games, brain teasers, and guessing games). The running times can be reprogrammed for this purpose.

Motivational Aspects

Students are familiar with the problem of timing and possible resulting disputes in the course of a board game, as well as other possible uses of time measurements and their functions in everyday life. As a rule, the students know that clear rules for time schedules have a positive effect on social interaction.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **if – then**
- Loop **wait**
- Loop **repeat – x times** (variable-dependent)
- Integration of variables
- Change of variables

ADDITIONAL MATERIALS

Optional download:
- Circuit diagram
- Building instructions

- If necessary, use a realia in the form of an egg timer or a stopwatch to introduce the topic.
- Optional drawing media (paper, white-board, or projection screen).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the timer	Technical solution
Select the desired running time (1, 2, or 3)	Press one of the three buttons for the respective time loop
Confirmation of the selection made	Flashing of one of the three associated LEDs
Starting a timing process	Pressing the start button
Output of the countdown function	Flashing of the associated LED (every second)
shortly before the set time expires	Rapid flashing of all three LEDs (every half second)
Expiry of the entered time	All three LEDs go out
Differentiation: Adaptation of the time loops to specific areas of application (e.g., egg timer)	Changing the time loop

MATERIAL LIST

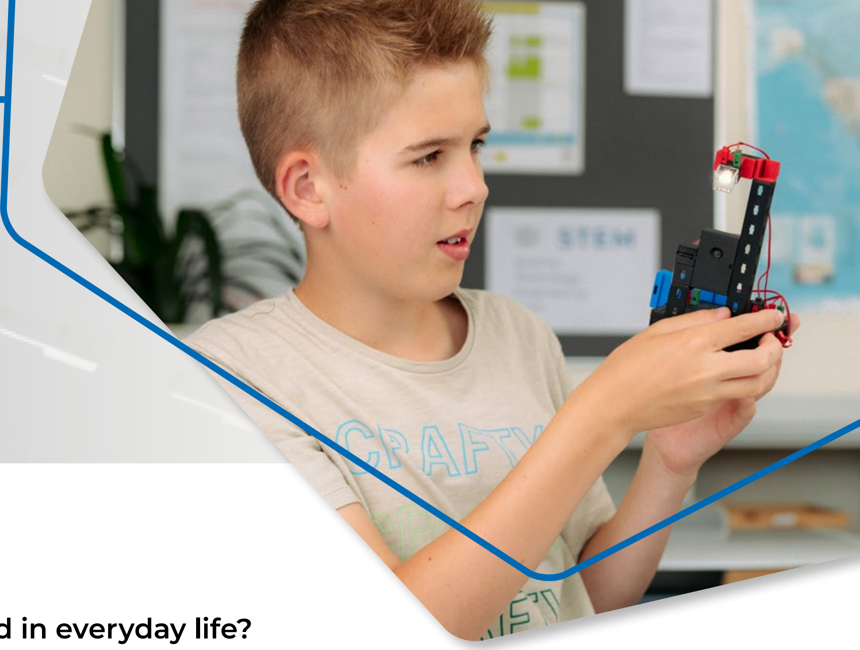
Sensors	Function
4 buttons	Input

Actuators	Function
3 LEDs, yellow, green, red	Display
1 motor	Alarm transmitter

MODEL 3

Outdoor light

Brightness for dark corners



KEY QUESTIONS:

- Where can automatic lighting be used in everyday life? *(Communication)*
- What functions does the system need to fulfill? *(Collaboration)*
- Under what conditions should the system switch on or off? *(Critical thinking)*
- What needs to be considered so that the system can be used at different locations and be as robust as possible? *(Creativity)*

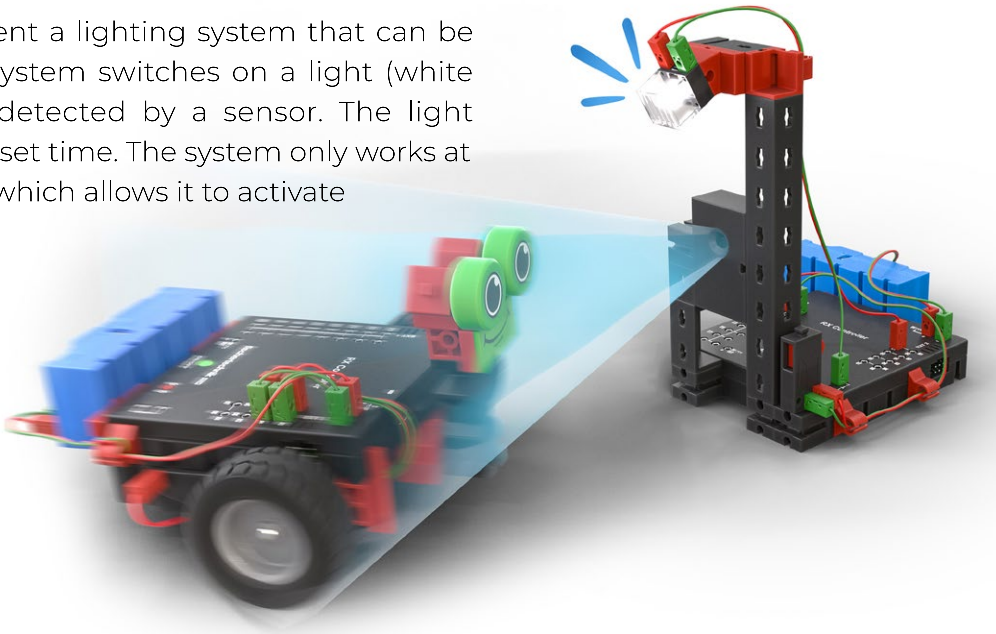
THE TEACHING CONCEPT AT A GLANCE

Grade level:	5–7
Time required:	1–2 double lessons
Degree of difficulty:	Model
	Programming
Model type:	mobile device, can be positioned individually and used for lighting

MODEL DESCRIPTION / TASK

Students plan and implement a lighting system that can be positioned anywhere. The system switches on a light (white LED) when movement is detected by a sensor. The light switches off again after a preset time. The system only works at a certain level of brightness which allows it to activate itself in the dark.

To expand the system, differentiation can be integrated as an additional switch. This makes it possible to manually switch the light on and off as permanent lighting.



EVERYDAY RELEVANCE

The automatic triggering of a process has a strong motivational effect on students. The triggering of the physical quantity "light" is quick and easy for everyone to understand. Supplementary options for the basic task allow the topic to be individualized.

The topic could be integrated into preprofessional orientation with regard to IT-related occupational fields. Automated switching by recording physical variables is used here in many fields. The detection of movements in particular is becoming increasingly important in many areas of information technology, e.g., gesture control.

SUBJECT REFERENCE

- **Information technology:** Programming basics, time loops
- **Physics:** Light, change in movement
- **Technology:** stable building, construction technology
- **Mathematics:** Beam set
- **Biology:** Light colors for plant growth

LESSON PLAN

Introductory phase	
Classroom discussion	• Inquire about scenarios: Where and how are automatic lighting systems used? (outdoor light, night light, alarm system ...) • Discuss possible applications of the collected scenarios - e.g., outdoor light – function: Switch on (sensor motion detection) only at dusk, switch off after 30 sec–60 sec. - e.g., night light – function: Switches on (motion detection sensor) only when dark, switches off when brightness increases - e.g., alarm system – function: time-delayed switching on (motion detection sensor) in the dark, switching off the flashing light after 30–60 sec. • Collect desirable properties of outdoor lights (different switch on and off times, time delays ...). • **Note:** a 5-second switch-on time is initially used for programming to avoid extending the experiment time for too long.
Support, if necessary	• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.

Planning Phase		
✓	Classroom discussion	• The teacher specifies the procedure using the work steps in the app.
✓	Partner or individual work	• The students familiarize themselves with the app and download the corresponding task. • The students work on the tasks.
✗	**Optional:** Partner or group work	• The students sketch a possible system. • The students discuss the results and agree on a design.
Construction Phase		
✓	Partner or individual work	• The students use the app to build the outdoor light. The app guides them through the program in short steps.
Programming Phase		
✓	Partner or group work	• The students write the program for the outdoor light. The app guides them through the program in short steps; the app provides assistance. • The program is transferred to the RX controller.
Experimentation and Test Phase		
✓	Partner or group work	• The outdoor light is put into operation and tested. It may only react to movements in front of the sensor that are detected in the dark. • Possible malfunctions in the functional sequence must be found and eliminated. The app offers assistance. • Possible optimizations to the hardware (e.g., changing the height of the sensor) and programming the sensor sensitivity (movement and brightness).
Final Phase		
✓	**Optional:** Presentation and allocation of differentia-tions	• The app offers a differentiation option for fast learners. • An additional button can be added to the system so that it can also be used as a table lamp or room lamp. • The additional procedure is realized via the app.
✗	Discussion in plenary	• Project debriefing in class. • The strengths and weaknesses of the individual solutions and differentiations are discussed.

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options
The system can be extended so that the light can also be operated manually.

Motivational Aspects
All students are familiar with the topic of lighting from everyday life. Automatic status detection has also long been part of everyday life in many smart applications. Students thus know and use automatic brightness adjustments for smart devices or motion-controlled lighting.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **repeat until**
- Loop **if – then**
- Waiting block

ADDITIONAL MATERIALS

Optional download:
- Circuit diagram
- Building instructions

- If necessary, use realia from the lighting field to introduce the topic (cupboard light, night light, etc.)
- Drawing media (paper, whiteboard, or projection screen).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the sensors	Technical solution
Detecting a movement	Evaluating the signals on the gesture sensor
Light output	Lighting the white LED
Differentiation: Initiating a manual lighting process	Signal input on a button

MATERIAL LIST

Sensors	Function
1 RGB gesture sensor	1. Only switch on the system in the dark 2. Triggering the switching operation with movement
1 button	Manual switching on in the dark
Differentiation: 1 button	Manual switching on in continuous operation

Actuators	Function
1 LED, white	Lighting

MODEL 4

Distance measurer

Measuring and surveying

KEY QUESTIONS:

- **What are everyday life examples for the use of rangefinders? *(Communication)***
- **How or with what simple technical means can a route be recorded? *(Communication)***
- **What problems can occur during use? *(Critical thinking)***
- **How must the distance measurer be designed with regard to the housing and the associated programming (distance to the measuring device) in order to record exact measuring points? *(Creativity and collaboration)***

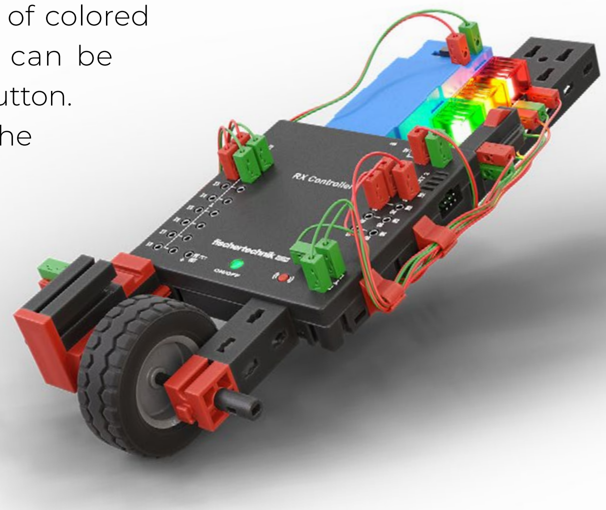
THE TEACHING CONCEPT AT A GLANCE

Grade level:	5–7
Time required:	2–4 double lessons
Degree of difficulty:	Model
	Programming up to
Model type:	mobile device for rangefinder for near and far targets

MODEL DESCRIPTION / TASK

The students plan and realize a portable rangefinder. The device can be used for short and medium distances. The measured distance of the device is displayed via three colored LEDs in the form of colored pulses (units, tens, and hundreds). The information can be displayed again after the counting process via another button. The user adds the displayed values to a total distance. The device resets itself when a new measurement is taken. A simple redesign or reprogramming can also record shorter or longer distances.

As a challenging differentiation task, the students can work on reading in, temporarily storing, and redisplaying the measurement results activated by pressing a button.



EVERYDAY RELEVANCE

Recording and outputting distances is not an unfamiliar topic for the students, unlike counting with a pulse generator (this is usually familiar from a bicycle speedometer). The effect of the pulse generator can also be observed in toys for small children (e.g., a wobbling duck).

The topic is a good basis for preprofessional orientation in the field of coding. This is increasingly important in many modern (technical) professions.

SUBJECT REFERENCE

- **Information technology:** Programming basics, time loops
- **Physics:** Route, distances
- **Technology:** Construction technology, gear theory
- **Mathematics:** Conversion factors, conversion of numbers from different number systems

LESSON PLAN

Introductory phase		
	Classroom discussion	• Inquire about scenarios in which distance measurement is required. • Work out the precision of distance measurements (1 m, 10 m, 100 m [3.28 ft, 32.8 ft, 328 ft]) • Develop various possible sensors that can be used to detect distances (e.g., in everyday appliances). • Presentation of the task. • Work out the gear ratio required for the supplied wheel. For this purpose, the rolling circumference of the wheel is recorded and the pulse frequency of the clock generator is explained.
	Support, if necessary	• Show sensors, actuators, and components (wheel for measuring circumference) from the assembly kit, use presentation media if necessary.
Planning Phase		
	Classroom discussion	• The teacher specifies the procedure using the work steps in the app.
	Partner or individual work	• The students familiarize themselves with the app and download the corresponding task. • Students work on a task to set up the system and calculate the distance meter.

Optional: Partner or group work	• The students sketch a possible system. • The students discuss the results and agree on a design.

Construction Phase

Partner or individual work	• The students use the app to build the rangefinder. The app guides them through the program in short steps.

Programming Phase

Partner or group work	• The students write the program for the range finder. The app guides them through the program in short steps. • The app offers assistance. • The program is transferred to the RX controller.

Experimentation and Test Phase

Partner or group work	• The rangefinder is put into operation and tested. • Possible malfunctions in the functional sequence must be found and eliminated. The app offers assistance. • Any optimizations to the hardware and the programming of the sensor sensitivity are carried out.

Final Phase

Optional: Presentation and allocation of differentia-tions	• The app offers a differentiation option for fast learners: - **Differentiation 1:** The counting wheel can be marked so that the start position can be recognized. The LEDs can also be labeled (adhesive labels). This makes it easier to read the units. Relevant material must be provided. - **Differentiation 2:** The system can be programmed so that the shortest distance is reduced to 2 cm (halved) by tapping the edge change from positive to negative edge. - **Differentiation 3:** The system can be designed with a gearbox extension so that even greater distances (e.g., 2.1 km [1.3 mi]) can be determined. - **Differentiation 4:** The system can describe and show the previously saved measurement results with the three LEDs at the touch of a button. • The additional procedure is realized via the app.
Discussion in plenary	• Project debriefing in class. • The strengths and weaknesses of the individual group solutions or distance measuring meters for short or long distances are recognized and discussed.

METHODOLOGICAL AND INSTRUCTIVE TIPS

Instructive tip

Due to the complexity of the model, it is recommended that the distance measurer is only introduced and processed at the end of the respective learning unit. The programming skills required are quite complex, and the programming-based knowledge (see Programming Skills) should already have been learned and applied in other models. For this reason, step-by-step-programming instructions are not included in the student section.

The primary calculation of the measurement factors and the subsequent conversion of numbers from different number systems are relatively challenging for the students. This is why the student section focuses on the necessary conversions and pulse/edge control.

Differentiations

- The LEDs can have markings on labels for easier readability of the units. The starting position on the wheel can also be marked with a colored marker.
- If required, shorter or longer distances can be measured by changing the programming or hardware.
- The measurement results can be temporarily stored in a variable. Using a conversion algorithm, the measured values can then be recoded into multiples of 2, 10 and 100 by surveying the measured value and displayed by an LED after pressing the second button. This program is very complex due to the recoding, divisions with remainder, use of counting variables, and the necessary call up of a subprogram. It should only be given to advanced students as a differentiation task.

Competition

- The distance measurer with the greatest measuring accuracy should be determined in a practical application under competitiveconditions.
- Various measurements of known and standardized distances, e.g., 400-m race track [437.4 yards] on the sports field, can be carried out.

Motivational Aspects

Students are highly motivated by the acquisition of analog data, its conversion into digital data, and the output of the results. Converting one size into another presents a certain challenge. The subject provides a good basis for coding, which is becoming increasingly important in many professions.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **if – then**
- Loop **repeat until**
- Loop **repeat – x times**
- Loop **wait**
- Integration of variables
- Manipulation of variables (addition, multiplication, division [also with remainder])
- Call up subprograms
- Output of results

Optional download:
- Circuit diagram
- Building instructions

ADDITIONAL MATERIALS

If necessary, use realia to introduce the topic:
- Visual aids in the form of simple rollers or wheels to show the distance covered in one rotation.
- If necessary, various commercially available rangefinders that can be triggered manually, e.g., bicycle speedometer with Hall sensor.
- Optional: Drawing media (paper, whiteboard, or projection screen).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the distance measurer	Technical solution
Start of the measuring process	Traveling the distance to be measured
Recording a route/path	Pulse generator on the counter wheel outputs data
Output of the recorded distance of “4 cm” [1.57 in]	Color output of the green LED
Output of the recorded distance of “16 cm” [6.3 in]	Color output of the yellow LED
Output of the recorded distance of “64 cm” [25.2 in]	Color output of the red LED
Output result	LED output by pressing the button
New measurement	Restart the system

MATERIAL LIST

Sensors	Function
1 wheel on a shaft	Recording the distance
1 button	Pulse counter
Differentiation 4: 1 button	Intermediate storage and later retrieval of the measurement results by 2nd button

Actuators	Function
1 LED, green	Output for units of 2^2, e.g., 4 cm [1.57 in] or multiples thereof **Differentiation 2:** Units of 2, e.g., 2 cm or multiples thereof **Differentiation 3:** Display of the measurement result for multiples of 2 cm
1 LED, yellow	Output for units of 2^4, e.g., 16 cm [6.3 in] or multiples thereof **Differentiation 2:** Units of 10, e.g. 10 cm [3.9 in] or multiples thereof **Differentiation 3:** Display of the measurement result for multiples of 10 cm [3.9 in]
1 LED, red	Output for units of 2^6, e.g., 64 cm [25.2 in] or multiples thereof **Differentiation 2:** Units of 100, e.g., 100 cm [39.4 in] or multiples **Differentiation 3:** Display of the measurement result for multiples of 100 cm [39.4 in]
Differentiation 3: Gearbox on the shaft	Extension of the possible measurement paths/measurement results

MODEL 5

Tabletholder

Secured valuables

KEY QUESTIONS:

- How can a flat object be positioned so that its surface is clearly visible and not concealed? *(Communication)*
- Where and how are important objects staged and what advantages and disadvantages does this entail? *(Collaboration, critical thinking)*
- What types of alarm signals are suitable and how can corresponding physical values be created? *(Critical thinking)*
- What aspects of the design need to be taken into account to ensure that the system stands securely and the objects do not fall over or get damaged? *(Creativity, critical thinking)*

THE TEACHING CONCEPT AT A GLANCE

Grade level:	5–7
Time required:	2 double lessons
Degree of difficulty:	Model
	Programming
Model type:	stationary device as a support for pictures, books, or smart devices with an optical alarm function when approaching or optical and acoustic alarm function when removing the placed object.

MODEL DESCRIPTION / TASK

The students plan and realize a holder for the presentation of flat objects (pictures, books, smart devices, etc.). The objects on display are secured. A proximity sensor for the "pre-alarm" (LED flashes) indicates that the distance to the viewer is too short. When the presented objects are removed, an optical and acoustic signal triggers an alarm.

A magnetic switch can be integrated as a main switch for differentiation.

EVERYDAY RELEVANCE

Students are familiar with protecting and securing objects.
Security systems such as a Kensingtonlock, a cell phone lock in a sales exhibition, a bicycle or ski repair kit next to cycle paths/slopes etc., can be shown in the original or as pictures.
Securing mechanical items poses a particular challenge.

SUBJECT REFERENCE

- **Physics:** Recording physical quantities (shape, movement)
- **Information technology:** Basics of programming, switches, sensors, time loops
- **Economics:** Sales strategies
- **Technology:** stable building, construction technology

LESSON PLAN

Introductory phase	
Classroom discussion	• Inquire about scenarios and everyday applications, how objects that need to be secured are presented. • Collect safety options and preventive warning options and discuss their advantages and disadvantages. • Collect and discuss alarm output options. • Collect desirable functions relating to alarm triggering (time delays, safety shutdown, shutdown function of a triggered system ...).
Support, if necessary	• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.
Planning Phase	
Classroom discussion	• Announcing the topic. • Name the sensors and actuators used in the project. • Discuss the functional principle of the sensors and actuators used. • The teacher specifies the procedure using the work steps in the app.

Partner or individual work	• The students familiarize themselves with the app and download the corresponding task. • Students sort the important and less important features of an automatic safety system. • The students prepare the list of requirements for the system to be built.
Optional: Partner or group work	• The students sketch a possible system. • The students discuss the results and agree on a design.
Construction Phase	
Partner or individual work	• The students use the app to build the automatic safety system. The app guides them through the building instructions step by step.
Programming Phase	
Partner or group work	• Students write the program for the automatic safety system. The app guides them through the program in short steps; the app provides assistance. • The program is transferred to the RX controller.
Experimentation and Test Phase	
Partner or group work	• The safety system is put into operation and tested. • Possible malfunctions in the function sequence (approach, noise output of the actuator, safe position …) must be detected and eliminated. • Any optimizations must be made in the programming. • Follow the app suggestions to carry out troubleshooting.
Final Phase	
Optional: Presentation and allocation of differentia-tions	• The app offers a differentiation option for fast learners: - A main switch can be added using a reed switch. This can be used to activate the system or switch it to stand-by. • The app helps realize the further procedure.
Discussion in plenary	• Project debriefing in class. • If applicable. Presentation of the differentiated solutions.
Competition	• A sound measurement of the different solutions can be carried out as acompetition (the loudest system wins).

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options
An additional sensor can be installed in the system for differentiation. This enables the system to be disarmed or armed by triggering a reed switch. This should be attached to the side of the system.

The reed switch could also be visually improved in the form of a flat magnet that is glued to an access card.

Motivational Aspects
Students are familiar with securing objects from everyday life; it provides intrinsic motivation. The independent realization of an actuator can lead to very creative solutions.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **repeat until**
- Loop **if – then**
- Programming and calling up subprograms
- Waiting block

ADDITIONAL MATERIALS

Optional download:
- Circuit diagram
- Building instructions

- In the introductory phase, you can use locks you have brought with you (bicycle, Kensington etc.).
- Objects to be secured must be available (e.g. tablet, book).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the sensors/actuators	Technical solution
Capturing an object to be secured	Triggering a button (permanent contact)
Falling below a safety distance	Record with the gesture sensor
Output of the “Safety distance” warning function	The red LED flashes
Output of the “Alarm” warning function	Rotational movement of a motor with sound transmission
Differentiation: Arming or disarming the system	Contact via the reed switch

MATERIAL LIST

Sensors	Function
1 RGB gesture sensor	Motion sensor on approach
1 button	Switching contact when removing the exhibit
Differentiation: 1 reed switch	Arming or disarming the system

Actuators	Function
1 LED, red	Visual warning function
1 gear motor	Acoustic warning function

MODEL 6

Automatic door

Out of the way!

KEY QUESTIONS:

- Where are automatic doors installed in everyday life? *(Communication)*
- What triggering options are there for operating the door? *(Communication)*
- How can a rotational movement be converted into a linear movement? *(Creativity)*
- Which time loops are useful when operating? *(Critical thinking, collaboration)*

THE TEACHING CONCEPT AT A GLANCE

Grade level:	6–8
Time required:	2 double lessons
Degree of difficulty:	Model
	Programming
Model type:	Table model for industrial automatic doors

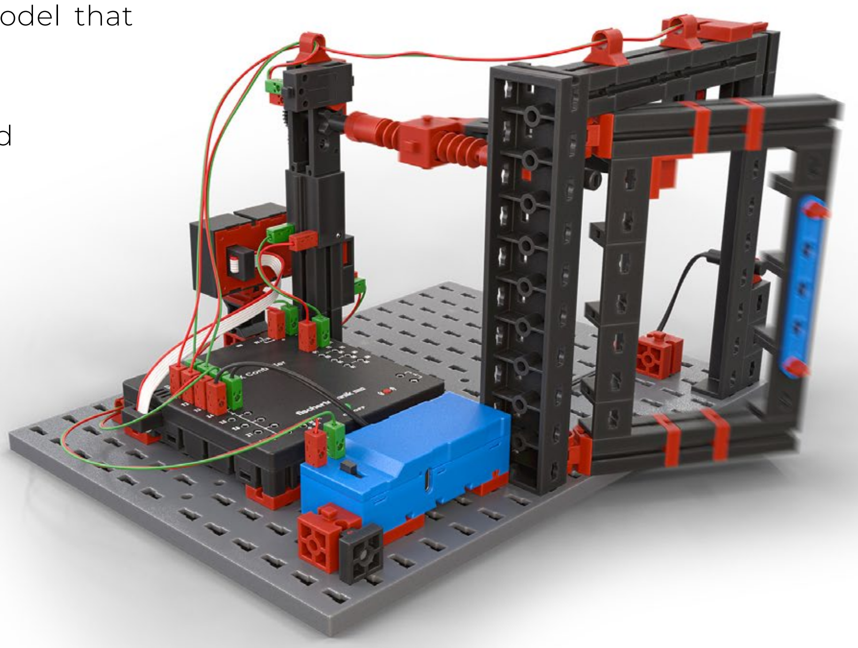
MODEL DESCRIPTION / TASK

Students plan and realize a door model that opens and closes automatically.

The automatic system can be triggered via various sensors depending on the differentiation requirements:

- Manual switch (basic circuit),
- Magnetic access card (differentiation 1) or
- Motion detection (differentiation 2).

The closing time can be set variably via the programming.



EVERYDAY RELEVANCE

The function of an automatically triggered mechanical movement initiated by a sensor is becoming increasingly present in the everyday lives of students (car doors, tailgates in vehicles, elevator doors, automatic faucet ...).

Triggering an automated function (e.g. through switches, changes in brightness, movement or gesture control) has always been highly motivating, as well as the combination of mechanical movements with modern controls.

Preprofessional orientation also plays an important role with regard to using, understanding, developing, and optimizing a corresponding system.

SUBJECT REFERENCE

- **Information technology:** Programming basics of various sensors, time loops
- **Physics:** Mechanical and kinematic aspects of movements
- **Technology:** Gear theory, manufacture and optimize an object

LESSON PLAN

Introductory phase		
Classroom discussion		• Inquire about scenarios in which automatically triggered mechanical processes make life easier. • Collect different possible systems from the everyday lives of students. • Presentation of the task. • Discussion of possible sensors and definition of the solution(s) to be implemented. • Discussion of reasonable time intervals (delays) and definition of time loops. • Discussion about the realization of possible kinematic solutions (rotation/translation) and determination of the kinematic realizations of the drive.
Support, if necessary		• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.
Planning Phase		
Classroom discussion		• The teacher specifies the procedure using the work steps in the app.

Partner or group work	• The students familiarize themselves with the app and download the corresponding task. • Students complete the first task in the app. • In the app, they create requirement lists for mechanical parts and sensors that are necessary for the automatic opening and closing of the door.
Classroom discussion	• Addresses possible sensors to be used (differentiation). The minimum requirement of the task is defined: 1 sensor for opening the door. • The procedure for further differentiation is discussed.
Optional: Partner or group work	• Students sketch the possible system and its mechanical drive. • The students discuss the results and agree on a design.
Construction Phase	
Partner or individual work	• The students build the automatic door using the app. The app guides them through the program in short steps.
Programming Phase	
Partner or group work	• The students write the program for the door control (button as sensor). The app guides them through the program in short steps. • The app offers assistance. • The program is transferred to the RX controller.
Experimentation and Test Phase	
Partner or group work	• The door control unit is put into operation and tested. • Possible malfunctions in the functional sequence must be found and eliminated. The app offers assistance. • Any optimizations to the hardware and the time loop programming are carried out.
Final Phase	
Optional: Presentation and allocation of differentia-tions	• The app offers a differentiation option for fast learners: - **Differentiation 1:** Additional control via a magnetic switch - **Differentiation 2:** Additional control through gesture control • The teacher approaches eligible students. The app realizes the further procedure..

	Discussion in plenary	• Project debriefing in class. • If necessary, the differentiation results are discussed. The use of the various other sensor controls is demonstrated. • Strengths and weaknesses of the solutions are recognized and discussed. • Outlook on optimization possibilities/needs in everyday solutions (transfer of the topic to everyday life) are identified and discussed (e.g. light barrier, warning light ...).

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options

The model (basic task button on the inside) is particularly suitable for differentiation. Depending on the time available, the system can be easily supplemented with a magnetically triggered switch on the front of the door (reed switch) and/or a motion sensor (RGB gesture sensor) on the inside of the door. Programming by means of additional loops produces a great effect through further triggering options for opening the door.

Motivational Aspects

The desire to have a system that can be controlled in as many ways as possiblethrough the use of a wide variety of sensors is great. The familiarity with various everyday solutions also means that there is likely to be interest in adding further useful components to the system (e.g. visual status display of the system, warning function before the door closes, ...).

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **if – then**
- Loop **repeat until**
- Loop **wait**
- Loop **repeat – x times** (variable-dependent)
- Integration of variables
- Change of variables
- Working with subprograms

ADDITIONAL MATERIALS

- Optional: Drawing media (paper, white-board, or projection screen)

Optional download:

- Circuit diagram
- Building instructions

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the system	Technical solution
Triggering the door opening (seen from the inside)	Pressing a button
End position for open door	Pulse counter
End switch for closed door	Triggering the end switch (button)
Opening the door	Opening the door using a motor and worm gear
Closing the door	Closing the door using a motor and worm gear
Differentiation 1: Triggering the door opening (seen from the outside)	Triggering a reed switch using a magnet
Differentiation 2: automatic triggering of the door opening (seen from the inside)	Triggering the RGB gesture sensor

MATERIAL LIST

Sensors	Function
1 button	Triggering the door opening process
1 button	Switching off the motor when the door is closed
1 button	Defining the end position of the open door (pulse counter)
Differentiation 1: 1 reed switch	Triggering the door opening process
Differentiation 2: 1 RGB gesture sensor	Triggering the door opening process

Actuators	Function
1 motor, incl. gearbox	Opening/closing the door

MODEL 7

Cleaning robot

The crumb-collecting robot

KEY QUESTIONS:

- **What functions does a self-propelled robot need to fulfill? *(Communication, Collaboration)***
- **What problems can arise when using an autonomous vehicle? *(critical thinking)***
- **What design aspects need to be taken into account to ensure smooth operation? *(Creativity)***

THE TEACHING CONCEPT AT A GLANCE

Grade level:	5–7
Time required:	2 double lessons
Degree of difficulty:	Model
	Programming
Model type:	mobile robot / vehicle

MODEL DESCRIPTION / TASK

Students plan and implement an autonomous cleaning robot for a surface. Two sensors on the left and right bumper prevent the robot from moving objects or getting stuck. A signal from these sensors causes the robot to reverse, change direction, and then continue moving.

For differentiation, an RGB gesture sensor can be installed as crashprotection. This means that the device can also clean tables without falling.

EVERYDAY RELEVANCE

The automation of processes and the use of robotic systems is increasingly playing an important role in the everyday lives of students. In addition to existing lawn mower and vacuum cleaner robots, other personal assistants and support vehicles will certainly be added to our lives in the future.

Due to its increasing relevance in everyday life, the topic is suitable for preprofessional orientation. It arouses students' curiosity about the relevant everyday technology and professional aspects of autonomous driving.

SUBJECT REFERENCE

- **Information technology:** Programming basics of various sensors
- **Physics:** Friction and contact pressure
- **Technology:** Gear theory, vehicle stability, steering systems, manufacturing and optimizing an object, autonomous driving, traffic

LESSON PLAN

Introductory phase

Classroom discussion	• Collect various possible autonomous vehicles from the students' everyday lives. • Develop the basic technical functions of an autonomous vehicle. • Presentation of the task. • Discussion of possible/useful sensors and definition of the sensor solution to be implemented and the angle to be used to avoid obstacles. • Discussion of possible ways of attaching and proofing the wiping unit.
Support, if necessary	• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.

Planning Phase

Classroom discussion	• The procedure for building the model and the target function are developed jointly. • Sequence steps of the app are specified or discussed.

Partner or group work	• The students familiarize themselves with the app and download the corresponding task. • Students prioritize the functions of the system to be built. • Students use the app to create a list of requirements for the mechanical parts and sensors of the automatic table wiper.
Classroom discussion	• The structure of the robot is discussed. • Possible materials for the wiping media are discussed, and a short test experiment is explained.
Partner or group work	• Students test different wiping media (sponge, handkerchief, cloth, paper towel) and make a statement about the usefulness of each based on this.
Optional: Partner or group work	• Optionally, the students sketch the possible system. • The students discuss the results in the group and choose a design.
Construction Phase	
Partner or individual work	• The students use the app to build the robot. The app guides them through the program in short steps.
Programming Phase	
Partner or group work	• The students write the program for the wiping robot (two buttons as sensors for obstacle detection). The app guides them through the program in short steps. • The app offers assistance. • The program is transferred to the RX controller.
Experimentation and Test Phase	
Partner or group work	• The wiping robot is put into operation, placed on a flat surface, and tested. • Possible malfunctions in the functional sequence must be found and eliminated. The app offers assistance. • Any optimizations to the hardware (e.g., contact pressure of wiping cloth) and the programming of the travel distance (reversetravel and change of travel angle) are carried out.
Final Phase	
Optional: Presentation and allocation of differentia-tions	• Quick students are offered the possibility of differentiation. The teacher approaches eligible students. • The additional procedure is realized via the app.

	Discussion in plenary	• Project debriefing in class. • If applicable. Discuss the differentiation results: The use of fall protection and its function is demonstrated. • Clarification of how appropriate safety measures can be achieved for commercial cleaning robots or autonomous vehicles. • Clarification of future needs in everyday solutions (transfer of the topic to everyday life).

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options
The model is particularly suitable for systematically setting up and experimenting with different driving modes by changing the correction angle while driving.
By differentiating, the vehicle can easily be extended with an additional sensor (RGB gesture sensor) to increase the degree of autonomy.

Motivational Aspects
The desire to build a vehicle that controls itself as autonomously as possible by using several different sensors is great. There may also be interest in adding further useful components to the system (e.g., main switch, rear switch, optimization of the wiping function by integrating a drip tank ...). This can be addressed in the classroom discussion.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **if – then**
- Loop **wait**
- Loop **repeat – x times** (variable-dependent)
- Integration of variables
- Change of variables
- **Random numbers**
- Command **print**

ADDITIONAL MATERIALS

Optional download:
- Circuit diagram
- Building instructions

- if available, a vacuum cleaner robot, otherwise pictures if necessary
- Drawing media (paper, whiteboard, projection screen)
- Various wiping media (handkerchief, paper towel, sponge ...)

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the system	Technical solution
Triggering the cleaning run	Press the start button on the RX controller
frontal cleaning run	Activating both motors
Impact with an obstacle	Triggering one of the buttons, stopping the motors
Correction of the direction of travel due to an obstacle detected on the right	Reset the vehicle, turn approx. 20° (4 pulses) to the left, continue driving
Correction of the direction of travel due to an obstacle detected on the left	Reset the vehicle, turn approx. 20° (4 pulses) to the right, continue driving
Renewed frontal cleaning run	Activating both motors
Differentiation: Triggering the fall protection at the edge of the table	Stopping the motors, reversing the motors and counting the pulses, changing the direction of travel, moving on
Replacing the wiper medium	Open the clamping device for a wiper at the rear of the vehicle
Adjustment of the wiper medium	Adjusting the wiper mounting joint

MATERIAL LIST

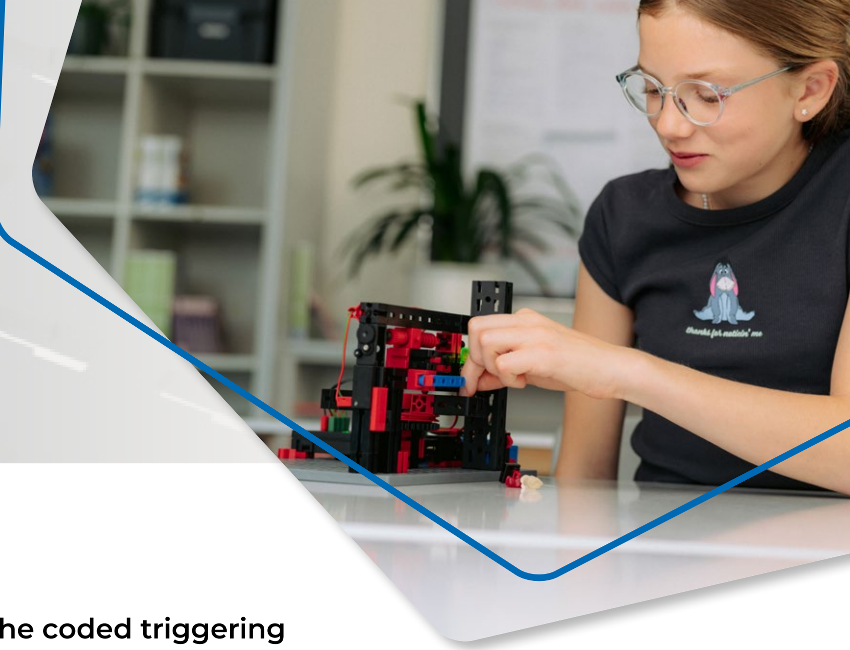
Sensors	Function
2 buttons	Obstacle detection
2 buttons	Pulse counting of the motors
Differentiation: 1 RGB gesture sensor	Prevents falling from an elevated position

Actuators	Function
2 motors	each for one axis

MODEL 8

Candy machine

Give me candy!



KEY QUESTIONS:

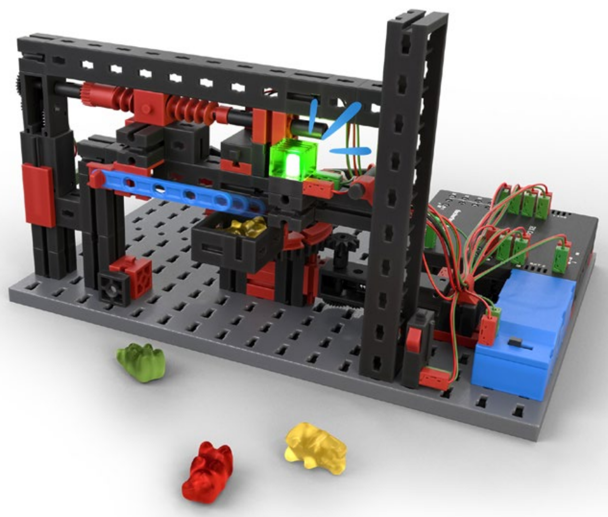
- **Which functions must be fulfilled for the coded triggering of a process? *(Communication, Collaboration)***
- **How can the user select the goods contained in the vending machine? *(Communication, Collaboration)***
- **How can the goods in the system be protected against access or how can access be granted? *(Creativity, Critical Thinking)***
- **What aspects of the design need to be considered to ensure that the system is protected against manipulation and is as robust as possible? *(Creativity, Critical Thinking)***

THE TEACHING CONCEPT AT A GLANCE

Grade level:	6–8
Time required:	2 double lessons
Degree of difficulty:	Model
	Programming
Model type:	a stationary dispenser, individually fillable for dispensing various small items (sweets, tablets, food supplements, ...)

MODEL DESCRIPTION / TASK

Students plan and implement a vending machine for the stocking and targeted distribution of small items, e.g., sweets. The desired product is selected on a motorized turntable using a button. The product is recognizable, but not yet removable. The product can then only be removed via an access system using a magnetic switch (reed switch). A motorized access guard opens for this purpose.



To extend the system, a warning light (LED) can be integrated to indicate when the product can be safely removed. This light flashes as a warning before the safety is locked.

EVERYDAY RELEVANCE

The automatic operation of a machine and the dispensing of an (edible) item have a strong motivational effect on the students. Many comparable solutions are known from everyday life (gumball machine, drinks machine, car scooter ...).

However, the incentive to manipulate a professional investment in your own favor is also well-known. This gives rise to considerations about making your own solution transparent while also being as tamper-proof as possible.

SUBJECT REFERENCE

- **Physics:** Detection of physical variables (rotation angle, end stop)
- **Information technology:** Basics of programming, switches, sensors, time loops
- **Economics:** Sales strategies
- **Mathematics:** Circular angle

LESSON PLAN

Introductory phase	
Classroom discussion	• Inquire about everyday applications in which processes are set in motion by coding-controlled systems. • Discuss the possibilities of manipulating such systems and protection against manipulation. • Discuss the advantages and disadvantages of various tamper protection options. • Specify which sensors and actuators should be used. The functional principle of the sensors and the actuator is discussed. • If necessary, offer the prospect of initial differentiation options. • The teacher specifies the basic function of the system to be achieved, and this is discussed together.
Support, if necessary	• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.

Planning Phase

Classroom discussion	• The teacher specifies the procedure using the work steps in the app.
Partner or individual work	• The students familiarize themselves with the app and download the corresponding task. • Students complete the tasks for planning the system in the app.
Optional: Partner or group work	• The students sketch a possible system, discuss the, and agree on a design.

Construction Phase

Partner or individual work	• Students use the app to build the dispenser machine. The app guides them through the program in short steps.

Programming Phase

Partner or group work	• Students write the program for the dispenser machine. The app guides them through the program in short steps; the app provides assistance. • The program is transferred to the RX controller.

Experimentation and Test Phase

Partner or group work	• The machine is put into operation and tested. • Possible malfunctions in the functional sequence must be recognized and eliminated. The app offers assistance. • Any optimizations in the programming (time loops for closing the removal) must be carried out. • The protection of the system against manipulation is tested if necessary.

Final Phase

Optional: Presentation and allocation of differentia-tions	• The teacher may approach students eligible for differentiation. The optimization possibilities of the system (optical display) are clarified. • The app guides the quick students through the necessary steps.
Discussion in plenary	• Project debriefing in class. • The strengths and weaknesses of the solutions are recognized and transferred to everyday machines.

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options

A green LED can be added to the system and programmed so that the system issues a visual approval (green LED) when the goods can be removed.

A flashing function can also be programmed to indicate when the removal safety device is locked.

Motivational Aspects

Sweets alone have a certain effect on the students. But the automated output of tangible things (as opposed to just information) also has an appeal. The students are familiar with the associated topic of manipulating information (in this case input information) which is relevant in many other areas of life. Both factors enable the promotion of intrinsic motivation.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **repeat until**
- Loop **if – then**
- Loop **wait until**
- Use of variables and their change
- Working with subprograms
- Working with complex programs

ADDITIONAL MATERIALS

Optional download:
- Circuit diagram
- Building instructions

- **Optional:** Drawing media (paper, whiteboard, or projection screen)

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the sensors/actuators	Technical solution
Detection of a signal to rotate the storehouse	Evaluating the input button signal
Rotation of the storehouse	Control of the rotary carousel motor
Stop position of the storehouse	Evaluating the cam-controlled signal of the position sensor
Recording the legitimacy of the issue	Triggering the reed switch
Opening the access guard	Control of the barrier motor via a time loop
Waiting time for the motor control unit to remove the goods	Time loop
Closing the access protection	Control of the barrier motor
Switching off the motor of the access guard	Evaluating the signal from the end switch
Differentiation 1: visual output that goods can be removed	Green LED lights up
Differentiation 2: visual output that access guard closes immediately	Green LED flashes

MATERIAL LIST

Sensors	Function
1 button	Signal for gear motor 1
1 button	End switch for gear motor 1
1 button	End switch for gear motor 2
1 reed switch	Signal for gear motor 2

Actuators	Function
1 gear motor 1	Turning the storehouse
1 gear motor 2	Opening the access guard
Differentiation: 1 LED, green	Optical indicator light

MODEL 9

Claw machine

I’m going to get you!

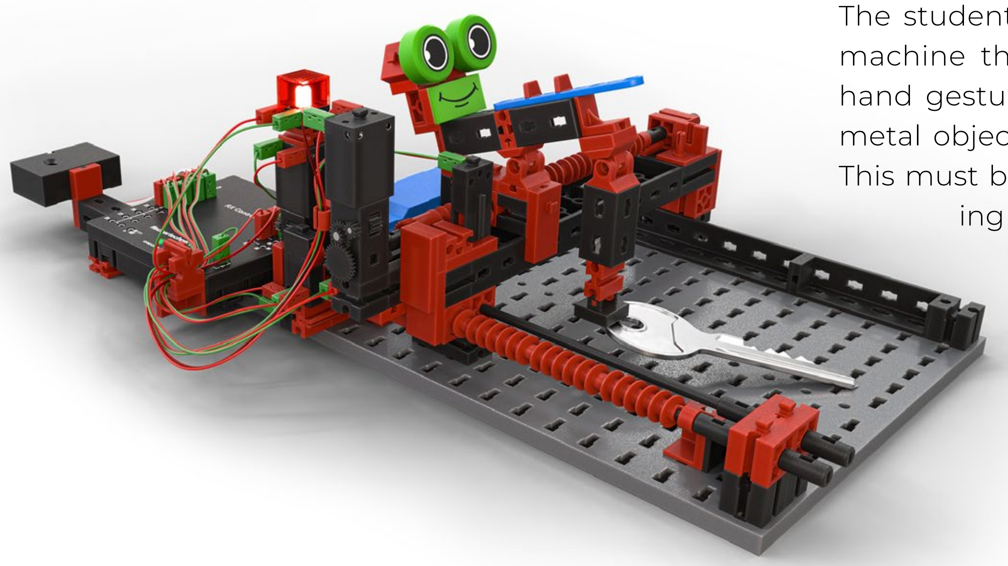
KEY QUESTIONS:

- **Where can a claw machine be used in everyday life? *(Communication)***
- **What functions does the system need to fulfill? *(Collaboration)***
- **Under what conditions should the system enable gaming? *(Critical thinking)***
- **What needs to be considered so that the system can be used at different locations and be as robust as possible? *(Creativity)***

THE TEACHING CONCEPT AT A GLANCE

Grade level:	7–10
Time required:	3 double lessons
Degree of difficulty:	Model ■■■
	Programming ■■■
Model type:	Mobile device, can be positioned individually and used flexibly

MODEL DESCRIPTION / TASK



The students plan and realize a claw machine that moves two axes via a hand gesture control and picks up a metal object with an affixed magnet. This must be transported to the starting position after the playing time has expired.

The playing time can be changed as a differentiation.

EVERYDAY RELEVANCE

The automatic triggering of a process has a strong motivational effect on students. Recording the physical quantity "movement" is quick and easy for everyone to understand.

The topic could be integrated into preprofessional orientation with regard to IT-related occupational fields. Automated switching by recording physical variables is used here in many fields. The detection of movements in particular is becoming increasingly important in many areas of information technology (e.g. gesture control).

SUBJECT REFERENCE

- **Information technology:** Programming basics, time loops
- **Physics:** Strength, movement
- **Technology:** stable construction, construction technology, component arrangement

LESSON PLAN

Introductory phase	
Classroom discussion	• Announcing the topic. • Inquire about scenarios in which automatic claw machines are used (fairgrounds, retail stores, waiting areas, etc.) and which objects can be grabbed. • Basic functional options, e.g., switching on when a coin is inserted, game time limit ... Objects: e.g., candy, plush toys, surprise eggs
Support, if necessary	• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.
Planning Phase	
Classroom discussion	• The procedure for building the model and the target function are developed jointly. • Follow-up steps of the app are announced or discussed.

	Partner or group work	• The students familiarize themselves with the app and download the corresponding task. • Students sort these into useful and less useful functions of a claw machine. • The students prepare the list of requirements for the system to be built.
	Optional: Partner or group work	• The students sketch the possible system. • The students discuss the results in the group and choose a design.
Construction Phase		
	Partner or individual work	• The students use the app to build the claw machine. The app guides them through the program in short steps.
Programming Phase		
	Partner or group work	• The students write the program for the gesture control of the motors. The app guides them through the program step by step. • Individual intermediate steps are transmitted to the RX controller and tested. • The app offers assistance. • The complete program is transmitted to the RX controller.
Experimentation and Test Phase		
	Partner or group work	• The claw machine is put into operation and tested. It is only allowed to react to the gestures in front of the sensor. • Possible malfunctions in the functional sequence must be found and eliminated. • Suggestions in the app can be used for troubleshooting.
Final Phase		
	Optional: Presentation and allocation of differentia-tions	• Quick students are offered the possibility of differentiation. The teacher approaches eligible students. • The additional procedure is realized via the app.
	Discussion in plenary	• Project debriefing in class. • Clarification of future application possibilities in everyday life (transfer of the topic to everyday life), recourse to the discussion in the introductory phase – e.g., locations such as fairgrounds and waiting areas as well as objects to be grabbed such as candy and plush toys.

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options
Quicker pupils can be given the task ofextending or shortening the playing time.

Motivational Aspects
Students are familiar with claw machines from everyday life at various locations. Perhaps they have once used a claw machine. Being on the "production side" instead of the "operator side" may now fill them with pride.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **if – then**
- Loop **repeat until**
- Loop **wait**
- Loop **repeat – x times** (variable-dependent)
- Integration of variables
- Change of variables
- Working with subprograms
- Subprograms with transfer variables
- Dealing with time functions

Optional download:
- Circuit diagram
- Building instructions

ADDITIONAL MATERIALS

- If available, pictures of claw machines can be presented in the introductory phase of the topic.
- If applicable. Drawing media (paper, whiteboard, or projection screen).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the sensors/actuators	Technical solution
Capturing gestures	Evaluating the signals on the gesture sensor
Light output	The red LED lights up

MATERIAL LIST

Sensors	Function
1 RGB gesture sensor	Gesture recognition right/left and forward/backward
2 buttons	End switches x- and y-axes
2 pulse buttons	Rotation counter per axis (x/y) in 90° steps

Actuators	Function
1 motor x-axis	Forward/reverse travel
1 motor y-axis	Forward/reverse travel
1 LED	End of playing time display

MODEL 10

Plotter

I write and paint your idea!

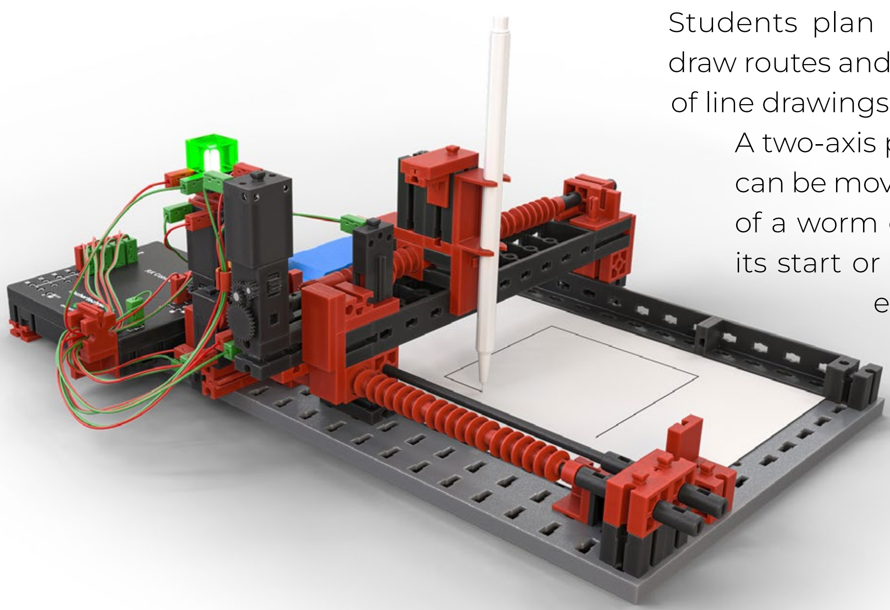
KEY QUESTIONS:

- Where can automatic drawing or cutting be used in everyday life? *(Communication)*
- What functions does the system need to fulfill? *(Collaboration)*
- Under what conditions should the system switch on or off? *(Critical thinking)*
- What needs to be considered to ensure that the system can be used with different media (paper, film) and that the system functions as robustly and reliably as possible? *(Creativity)*

THE TEACHING CONCEPT AT A GLANCE

Grade level:	5–7
Time required:	2 (up to 8) double lessons
Degree of difficulty:	Model up to
	Programming up to
Model type:	mobile device, can be positioned and used individually

MODEL DESCRIPTION / TASK



Students plan and implement a plotter that can draw routes and thus enable the automated creation of line drawings.

A two-axis plotter is built for this purpose, which can be moved in the x and y directions by means of a worm drive. The plotter can safely move to its start or end position using a end switch for each axis. The travel paths are measured using pulse wheels with 4 pulses per revolution so that the plotter can be positioned precisely at ¼ revolutions.

EVERYDAY RELEVANCE

The automatic triggering of a process has a strong motivational effect on students. The automatic creation of line drawings is quick and easy to understand for everyone. Two additional options to the basic task allow the topic to be individualized.

The topic could be integrated into preprofessional orientation with regard to information technology or design professions.

Automated printing or drawing (plotting) is used here in many fields. In particular, the sensor-based detection of movements is becoming increasingly important in many areas of production technology, e.g. laser cutting or 3D printing.

The two-axis plotter is therefore a very good introduction to automated 3-axis production.

SUBJECT REFERENCE

- **Information technology:** Programming basics, time loops, saving variables, comparisons, loops, travel paths
- **Physics:** Electric motor, change in motion, linear motion
- **Technology:** stable construction, construction technology, gears, conversion of rotation into linear motion
- **Mathematics:** Coordinate system, coordinate geometry, linear functions

LESSON PLAN

Introductory phase	
Classroom discussion	• Announce the topic; if necessary, use "3D printer in action" or show the shutter/screen control in the classroom. • Inquire about what constitutes this control, automation vs. manual control. • Inquire about scenarios in which technical systems that move automatically in a linear motion are used (roller shutters, yard gates, 3D printers, CNC milling machines, cutting plotters ...). • Discuss possible applications of the collected scenarios. • Determine the requirements for a two-axis plotter. • Discuss the advantages and disadvantages of different types of drives (chain/wheels/worm). • Justify the need for an end switch, a path or time control, and an emergency stop switch.
Support, if necessary	• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.

Planning Phase

Classroom discussion	• The procedure for building the model and the target function are developed jointly. • Sequence steps of the app are specified or discussed.
Partner or group work	• The students familiarize themselves with the app and download the corresponding task. • Students recognize the useful functions of a plotter. • Students draw up the list of requirements for the device.
Optional: Partner or group work	• Optionally, the students sketch possible two-axis plotters. • The students discuss their results in the group and decide on a design.

Construction Phase

Partner or individual work	• The students use the app to build the plotter. The app guides them through the program in short steps.

Programming Phase

Partner or group work	• The students write the program for the two-axis plotter (2 motors/4 buttons). The app guides them through the program step by step. The app offers assistance. • The program is transferred in the RX controller.

Experimentation and Test Phase

Partner or group work	• The plotter is put into operation and tested. • Pressing the On/Off button on the controller starts or ends the program. • Possible malfunctions in the functional sequence must be found and eliminated. • Suggestions in the app can help with possible troubleshooting. • Possible hardware optimizations (e.g., second linear guide, second end switch, optimization of the pen holder) and programming.

Final Phase

Optional: Presentation and allocation of differentiations	• Quick students are offered the possibility of differentiation. The teacher approaches eligible students. • The additional procedure is realized via the app.
Discussion in plenary	• Project debriefing in class. • Clarification of future application possibilities in everyday life (transfer of the topic to everyday life), e.g., plotter, printer, CNC milling, automated production.

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options

Depending on the duration of the lesson series and the strengths of the students, the following are possible:

- the length of the travel path per 90° rotation is specified,
- the length of the travel path per 90° turn is measured by the students,
- the route program blocks are specified,
- self-measurement of the routes,
- self-programming of the routes,
- the plotter is equipped with end switches in the other end positions,
- the students retrofitted a second linear guide on the bridge for stability reasons,
- the students can retrofit a third axis for raising and lowering the pen.

Motivational Aspects

All students are familiar with 3D printing and plotting from everyday life. The automatic detection of a status has long been part of everyday life in many smart applications. For example, students are familiar with corresponding circuits from an automatic roller shutter control system or from an automatically closing yard or garage door or elevator doors.

These linear movements in onedirection are now supplemented by a second direction in this project. All students are familiar with the planar x-y coordinate system from their math lessons.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **if – then**
- Loop **repeat until**
- Loop **wait**
- Loop **repeat – x times** (variable-dependent)
- Integration of variables
- Change of variables
- Working with subprograms
- Subprograms with transfer variables

ADDITIONAL MATERIALS

Optional download:

- Circuit diagram
- Building instructions

- If available, a roller shutter control system, a 3D printer, a 2D Styrofoam cutter, or other real objects from the field of automated control/manufacturing can be used for the introductory phase of the topic.
- Drawing media (paper, whiteboard, or projection screen).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the sensors/actuators	Technical solution
Executing a movement in the x-direction	Control of the x-axis motor
Executing a movement in the y-direction	Control of the y-axis motor
Stopping the movement in the x-direction	Evaluating the signals at the end switch
Stopping the movement in the y-direction	Evaluating the signals at the end switch
Control the movement in the x-direction	Evaluating the signals on the rotation counter/button
Controlling the movement in the y-direction	Evaluating the signals on the rotation counter/button
Start a drawing	Signal input on the On/Off button of the controller
End/emergency stop	Signal input on the On/Off button of the controller

MATERIAL LIST

Sensors	Function
1 On/Off button on the controller	1. Switching on the plotter 2. Emergency stop of the plotter
2 buttons	End switches on the x- and y-axis
2 buttons	Rotation counter per axis in 90° steps

Actuators	Function
2 motors	Movement
1 LED	Status display of pen holder

MODEL 11

Ticket control

I need music!
Let me in!

KEY QUESTIONS:

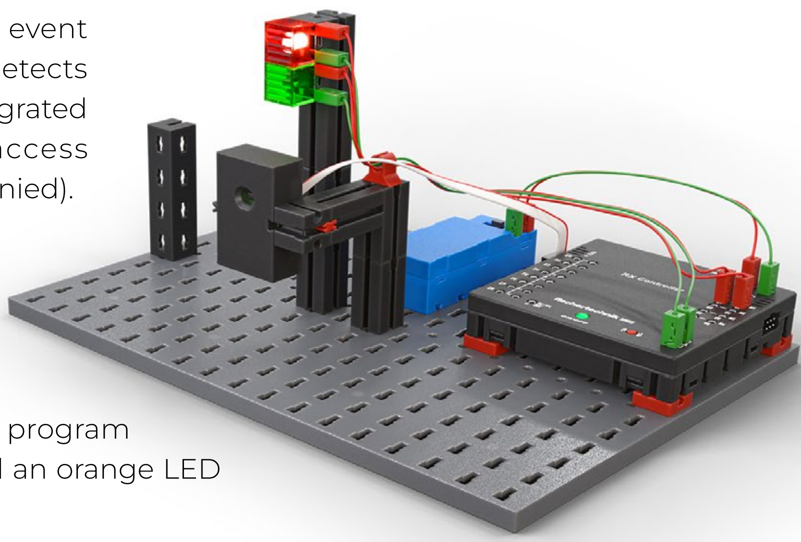
- **Where can automatic ticket inspection be used in everyday life? *(Communication)***
- **What functions does the system need to fulfill? *(Collaboration)***
- **Under what conditions should the system allow or deny access? *(Critical thinking)***
- **What needs to be considered so that the system can be used at different locations and be as robust as possible? *(Creativity)***

THE TEACHING CONCEPT AT A GLANCE

Grade level:	7–10
Time required:	2 double lessons
Degree of difficulty:	Model
	Programming
Model type:	mobile device, can be positioned individually and used flexibly for ticket inspections

MODEL DESCRIPTION / TASK

Students plan and implement a ticket control system that regulates access to a music event using colored tickets. When the system detects the colors blue, yellow or green, per an integrated sensor, a green LED is switches on (access permission) or a red LED flashes (access denied).



The green LED switches off again after a preset time; then the red LED displays a continuous light.

Differentiation options: either modify the program so that only two colors allow access, or add an orange LED (ready for operation) to the model.

EVERYDAY RELEVANCE

The automatic triggering of a process has a strong motivational effect on students. Recording the physical quantity "color" is quick and easy for everyone to understand. Two additional options to the basic task allow the topic to be individualized.

The topic could be integrated into preprofessional orientation with regard to IT-related occupational fields. Automated switching by recording physical variables is used here in many fields. Motion detection in particular is becoming increasingly important in many areas of information technology, e.g., gesture control.

SUBJECT REFERENCE

- **Information technology:** Programming basics, time loops, RGB color model
- **Physics:** Light, color
- **Technology:** stable construction, construction technology, component arrangement
- **Biology:** Light colors for plant growth

LESSON PLAN

Introductory phase	
Classroom discussion	• Announcing the topic. • Inquire about scenarios in which automatic ticket controls are used (train stations, means of transportation, package pick-up stations, time recording, alarm system, etc.). • Discuss possible applications of the collected scenarios - e.g., ticket control function: Switches on at the right color, switches off after a set time - e.g., train stations function: Release rotating grid with correct card - e.g., alarm system function: time-delayed activation to leave the house, deactivation of the alarm system with the correct card
Support, if necessary	• Show sensors, actuators and components from the assembly kit, use presentation media if necessary.
Planning Phase	
Classroom discussion	• The procedure for building the model and the function to be achieved are worked out together. • Sequence steps of the app are specified or discussed.

✓	Partner or group work	• The students familiarize themselves with the app and download the corresponding task. • Students evaluate various functions of an automatic ticket control system. • They compose the list of requirements for the system to be built.
✗	**Optional:** Partner or group work	• Optionally, the students sketch the possible system. • The students discuss the results in the group and choose a design.
Construction Phase		
✓	Partner or individual work	• The students use the app to build the ticket control. The app guides them through the program in short steps.
Programming Phase		
✓	Partner or group work	• The students write the program for the color recognition of the tickets (1 RGB gesture sensor / 2 LEDs). The app guides them through the program step by step. • Individual intermediate steps are transmitted to the RX controller and tested. • The app offers assistance. • The program is transferred to the RX controller.
Experimentation and Test Phase		
✓	Partner or group work	• The ticket control system is put into operation and tested. It is only permitted to react to the color cards in front of the sensor. • Possible malfunctions in the functional sequence must be found and eliminated. The app offers assistance.
Final Phase		
✗	**Optional:** Presentation and allocation of differentia-tions	• Differentiation options can be discussed with the students if additional teaching time is available.
✗	Discussion in plenary	• Project debriefing in class. • Clarification of future application possibilities in everyday life (transfer of the topic to everyday life), recourse to the discussion in the introductory phase (e.g. train stations, means of transport, package pick-up stations, time recording, alarm system).

METHODOLOGICAL AND INSTRUCTIVE TIPS

Differentiation options

The following differentiations are possible with additional teaching time. These promote 4C skills, but are not included in the instructions of the app:

1) Modification of the program so that only two colors allow access. For this, the students need to independently reorganize the existing program, developed in short steps, in a relatively more demanding approach. They can also decide which colors allow and block access.

2) Extension of the model with an additional LED. In this extension, the students should independently integrate an additional LED and modify the programming so that the orange LED indicates operational readiness, the green LED lights up when access is granted, and the red LED lights up when access is denied.

Motivational Aspects

All students are familiar with the topic of ticket control and corresponding applications from everyday life.

PROGRAMMING SKILLS

- Program start
- Continuous loop
- Integration of sensors
- Integration of actuators
- Loop **if – then**
- Loop **repeat until**
- Loop **wait**
- Loop **repeat – x times** (variable-dependent)
- Integration of variables
- Change of variables
- Working with subprograms
- Handling lists

Optional download:
- Circuit diagram
- Building instructions

ADDITIONAL MATERIALS

- If available, pictures of ticketinspection machines can be presented for the introduction to the topic.
- Drawing media (paper, whiteboard, or projection screen).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the sensors/actuators	Technical solution
Recording a color	Evaluating the signals on the gesture sensor
Light output	Green and red LEDs light up
Differentiation 1	Reprogramming the system
Differentiation 2: additional display	Installation and configuration of an additional LED

MATERIAL LIST

Sensors	Function
1 RGB gesture sensor	1. Color recognition of blue, yellow, green, red 2. Triggering the switching operation
1 button	End switch for gear motor 1
1 button	End switch for gear motor 2
1 reed switch	Signal for gear motor 2

Actuators	Function
1 LED, green	Display for access allowed
1 LED, red	1. Ready for operation (continuous light) 2. Display for access denied (flashing)
Differentiation 2: 1 LED, orange	Operational readiness