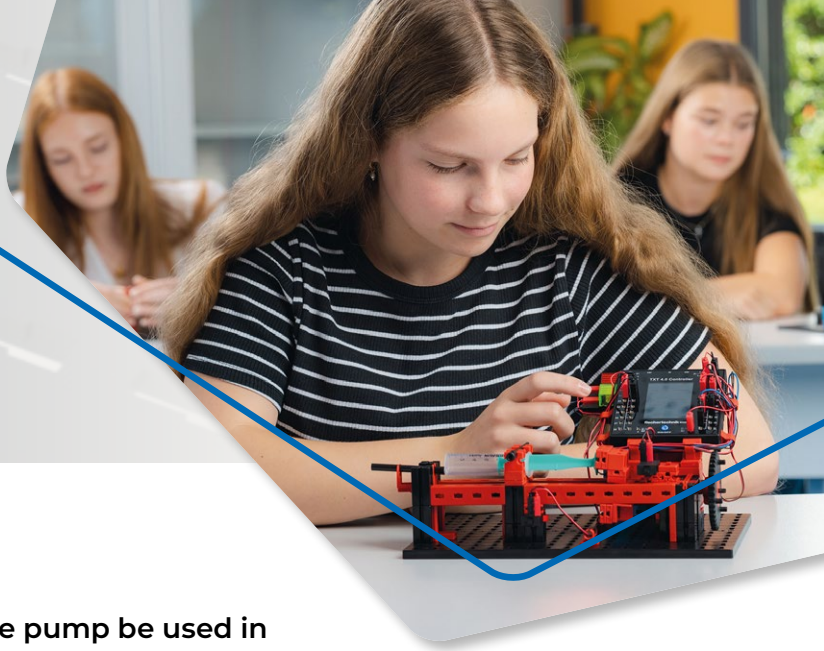
MODEL 2

Syringe pump

It’s all about the dose!



KEY QUESTIONS:

- **Where can an automatic medical syringe pump be used in everyday life? *(Communication)***
- **Which functions must the syringe pump control reasonably fulfill? *(Collaboration)***
- **Under what conditions should the system move the syringe? *(Critical thinking)***
- **What must be considered so that the control can be used at different locations and the system functions as robustly as possible? *(Creativity)***

THE TEACHING CONCEPT AT A GLANCE

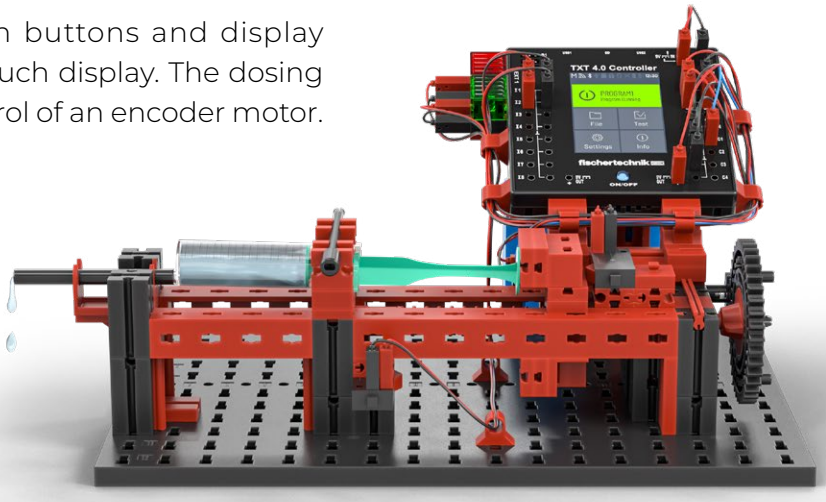
Grade level:	11–13
Time required:	3 double lessons (expandable up to 6 DL)
Degree of difficulty:	Model
	Programming
Model type:	Tabletop model for syringe pumps

MODEL DESCRIPTION / TASK

The students plan and implement a medical syringe pump for the fine dosing of medication.

Control elements such as selection buttons and display elements are programmed on the touch display. The dosing is precisely achieved by stepwise control of an encoder motor.

Two LEDs provide light signals during dosing operation (green) or in the end position and if the fluid volume is insufficient for a dose (red). Via touch buttons, various functions such as *Start*, *Reverse*, *Dose preselection*, and *Injection time* are implemented step by step. From the number of



Syringe pump

motor revolutions, the currently injected dose as well as the remaining quantity of medication in the syringe are determined and displayed. If the remaining quantity is insufficient for a pre-selected dose, the start is blocked. Likewise, the motor stops when the syringe is fully pushed in. In both cases, the red LED blinks.

When prompted to change the syringe and automatically at program start, the syringe drive returns to the start position and stops automatically.

EVERYDAY RELEVANCE

Medical syringe pumps are precision dosing devices that administer medications or fluids in precisely controlled amounts over a specific period of time. Significantly, they are frequently used in medicine, for example in anesthesia, intensive care, or pain therapy.

In addition, syringe pumps can be used for precise dosing in biological or chemical experiments and manufacturing processes.

SUBJECT REFERENCE

Information technology:	Advanced programming, conditional loops, functions
Physics:	Change of movement
Technology:	Stable construction, construction technology
Mathematics:	Conditional counting, volume and time calculation
Biology, Chemistry:	Experiments with dosing tasks: In chemical and biological experiments, the syringe pump can be used across subjects to perform precise dosing.

LESSON PLAN

Introductory phase

Classroom discussion	• Announce the topic. • Ask about the essential features of the syringe pump.
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. • The work steps in the app are specified or discussed.
Partner or individual work	• The students familiarize themselves with the app and load the corresponding task. • The students define meaningful functions of an automatic syringe pump. • The students use the app to create the requirements list for the syringe pump to be built.
Optional: Partner or group work	• Optionally, the students sketch possible setups of the syringe pump with additional sensors (end switch) and actuators (LED). • 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 syringe pump. The app guides them through the program in short steps.
Programming Phase	
Partner or group work	• The students write the program for the syringe pump. The app guides them step by step with open questions through the programming task. • The app offers assistance. • The program is transferred to the TXT 4.0 controller after each differentiation step.
Experimentation and Test Phase	
Partner or group work	• The syringe pump is put into operation. • Possible malfunctions in the functional sequence must be found and eliminated. • Potential troubleshooting is possible based on suggestions in the app. • Possible optimizations of the hardware and the programming can be carried out.
Final Phase	
Discussion in plenary	• Project debriefing in class. • Clarification of future possible applications in everyday life

METHODOLOGICAL AND INSTRUCTIVE TIPS

Technical explanation
In medical practice, professional syringe pumps work with highly precise step dosing. Instead of allowing a liquid to flow continuously, the desired volume flow is achieved by repeatedly delivering the smallest individual doses (e.g. 0.01 ml or even 0.001 ml). This principle ensures maximum accuracy and safety, especially with potent medications in intensive care or emergency medicine.

Didactic advantages
In the model, a microdose of 0.1 ml is preset. Dosing in such discrete steps can be implemented particularly clearly in programming terms, as it can be easily translated into loops or time-controlled routines. The dosing speed can be easily adjusted by changing either the number or the frequency of microdoses – such considerations encourage an active understanding of regulation and control. In addition, the procedure is intuitively understandable for the students: It is more tangible to consider how many individual steps are needed to dispense, for example, 1 ml of liquid than to imagine a continuous flow abstractly.

Differentiation options
Depending on the working speed of the individual students, variations in the minimum dose and the injection speed can be programmed (Differentiation option 1). Furthermore, the touch display can be expanded with a slider that allows the injection time to be set continuously (Differentiation option 2).

Motivational aspects
Working with syringe pumps connects technology with meaningful application – it is not just about motors and sensors, but about how technology can save lives. For boys, but especially for girls, this medical technology context can be particularly motivating because it shows that programming and building are not abstract, but meaningful and socially relevant. Those who tinker here are working on solutions that help people – this makes technology tangible, exciting, and valuable.

PROGRAMMING SKILLS

- Program start
- Infinite loop **repeat forever**
- Integration of sensors and actuators
- Programming of the display on the TXT 4.0 controller
- Integration of buttons on the touch display
- Loop **repeat n times**
- Command **wait**
- Use of variables and their change
- Working with subprograms
- Working with threads
- Working with events

Optional download:
- Circuit diagram
- Building instructions

ADDITIONAL MATERIALS

- Drawing media (paper, whiteboard, or projection screen).

FUNCTIONS OF THE MODEL AND THEIR TECHNICAL SOLUTIONS

Function of the sensors/actuators	Technical solution
Execution of a rotation of an encoder motor	Controlling the drive motor for a rotation with a fixed step size
Light signals red/green LED	Controlling the LED for operation and error messages
Calculation and display of information on the touch display	Programming and evaluation of amounts and times

MATERIAL LIST

Sensors	Function
1 On/Off push button on the TXT 4.0 controller	1. Switching on the syringe pump 2. Emergency stop of the syringe pump
2 mini push buttons	Detect the start and end positions

Actuators	Function
1 encoder motor	Movement
2 LEDs (1 × red, 1 × green)	Status display