Co-funded by the Erasmus+ Programme of the European Union

Lesson Plan

Module:	Walking graphs			
Teaching Hours:	65-80 min			
Grade Level:	6-8			
Brief Description:	In this module, students investigate graphs of functional relationships in the context of movements of their own bodies. The physically experienced situation "Walking Graphs" describes the relationship between the distance to a fixed point/sensor and the time in which a movement is completed. Students experience this situation enactively through real walking in front of a sensor in the classroom as well as digitally with GeoGebra. The understanding of graphs is enhanced by the possibility to link a physical situation (motion) directly to the visually perceivable information in the graph (slope, y-axis intercept). The learning process is supported by embodiment, i.e. the interaction of perception and movement in the sensorimotor system of the human body.			
Design Principles:	**Inquiry**	■		
	Situatedness	■	■	■
	Digital tools	■	■	■
	Embodiment	■	■	
Functional Thinking:	**Input – Output**			
	Covariation	■	■	■
	Correspondence	■		
	Object	■	■	
Learning Goals:	- Enhancing the qualitative understanding of functional relationships - Students are able to find corresponding graphs for specific situations and vice versa. - Students know which graphs cannot be walked.			

Additional information:

QR-Code: by scanning the QR-code students are able to open the corresponding GeoGebra applet. The code is available in the presentation and the student handout.

The research results handout can be clued to the bottom of the first page of the student handout.

Sensor:

- For the introduction, a sensor and the corresponding program Logger Lite (https://t1p.de/1za8h) are needed. With the help of the sensor it is possible to record and analyse graphs.
- When working with the sensor, malfunction can be reduced by paying attention to the direct surroundings of the sensor.
- For the alternative introduction, the website by Tim Lutz can be used. Link: https://t1p.de/qx3ci. It is recommended to gain experience with this tool before using it in class.

Activities

Introduction

Teacher introduces todays topic: *Today, we're exploring how to create a graph with movements of our body.*

Teacher explains the set up of the experiment (sensor, line on the floor with distances marked) and introduces the following tasks:

1. *We observe what happens when (student name) moves in front of the sensor.* Teacher asks one student to come to the front, to stand and/ or perform movements (walking forward/ backward, just standing in one position, …) on the line on the floor. The movement is recorded with help of a sensor and displayed on the board.
   How did the student move to create this graph? → other students are asked to describe the student's movement and how it shows in the graph.

   Optional:
   Use of the question: *Can you create a certain pattern with your movement?*
   Use of cards with descriptions of different movements (movement cards). Students are asked to find the matching card.

2. Teacher shows a graph to the students. *How does (student name) has to move to create this graph?* → students describe the corresponding movements and a student tries to create this graph as good as possible.

During the discussion, it is important to highlight the different movements, the descriptions of the graph, and slope. If needed, the most important findings can be recorded on the black board. This is especially helpful for low achieving classes.

Suggested tools/materials/:

- Tablet/ Computer
- Sensor
- tape

Estimated duration: 10-20 minutes

Comment:

- First exploration and confrontation with the phenomenon "creating graphs with movement"
- Motivation through real experiment - physical experience of walking graphs. Students experience the effects of certain movements and their changes (covariation) on the course of the graph. Students can experience basic ideas ("start at a distance of 1 m" (correspondence); "get faster" (covariation); "walk evenly" (function as an object)) with multiple senses of their own body.
- If no sensor is available, online sensor can be used. With the online sensor it is not possible to show graphs which can be created by students online.

Exploration and research assignments

Teacher explains: *Now, we are investigating which effects moving a finger has on the course of a graph.*

Teacher uses the GeoGebra applet and explains different functions and buttons. Teacher explains that the position of the small figure is indicated by a point left of the y-axis.

Students work on research assignments in groups of 2 for about 30 minutes.

Suggested tools/materials/:

- Tablets
- GeoGebra
- Research booklet (student handout)
- PPP slides 2-3

Estimated duration: introduction of material/GeoGebra: 5-10 min, working phase: 30 minutes

Comment:

- The different research assignments support the situational construction and interpretation of graphs.
- Optional: If the possibility of walking a graph should be provided to all students, students can walk graphs in this part of the lesson.

Structuring & securing research results

Back in a whole class setting, the teacher uses the research results to talk about the different sections of the graph with the students. Missing parts are added.

Suggested tools/materials/:

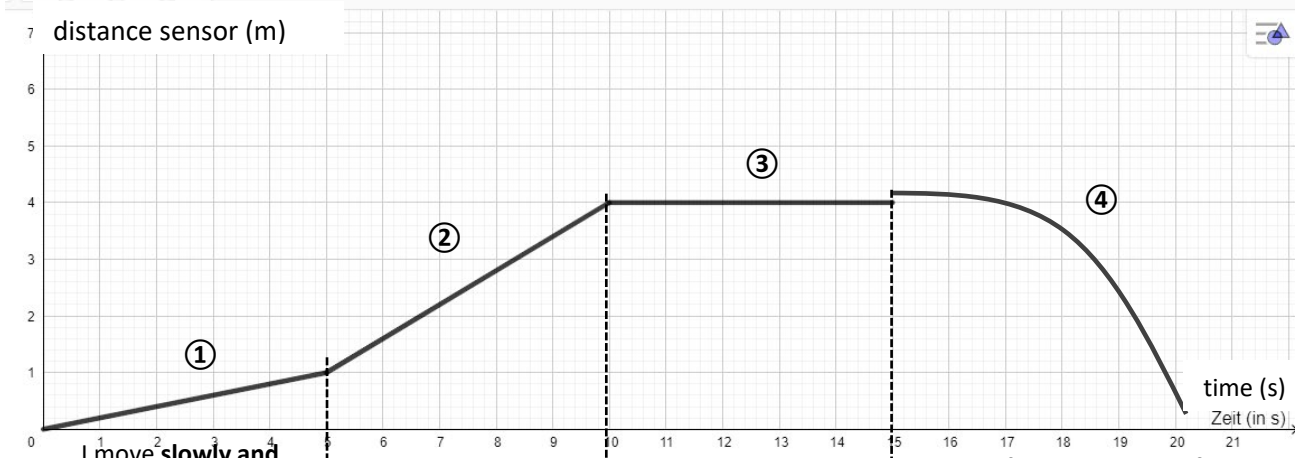
- PPP slides 4-5
- Research booklet (Student handout)
- Research result handout

Estimated duration: 10 min

Student handout:

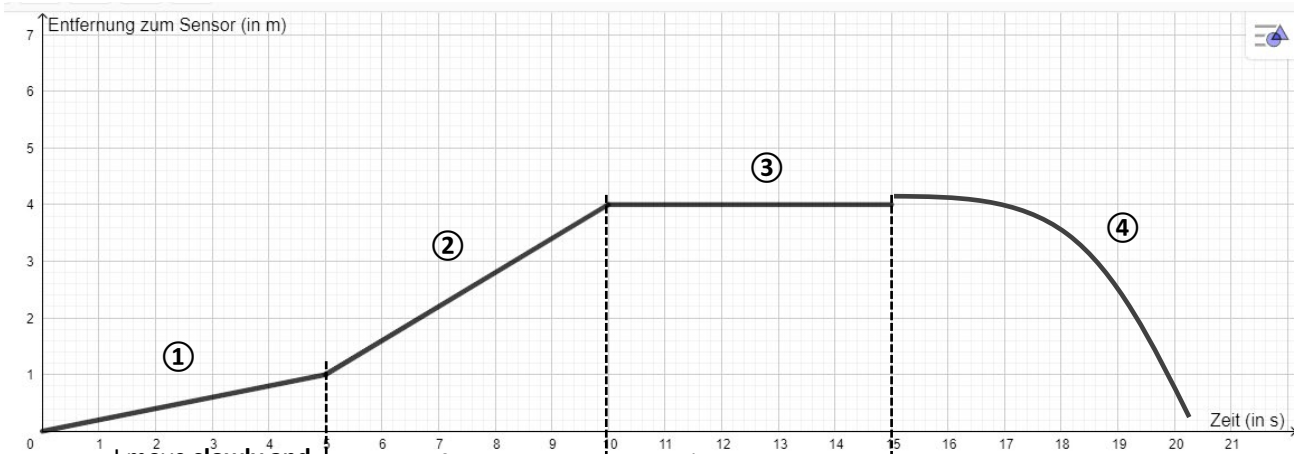
Research results „walking graphs“

The movement in front of a sensor is shown here as a graph. You can interpret the graph by describing the **movement**, the course of the **graph** and the **slope** of the graph.



	①	②	③	④
movement	I move **slowly and evenly** away from the sensor.			I move first **slowly**, then **faster and faster** towards the sensor
graph	The graph **rises/increases** steadily, **fairly flat.**		The graph runs **parallel** to the **x-axis.**	The graph does not **decrease** as a straight line.
slope	**positive**			

Completed handout:



	①	②	③	④
movement	I move **slowly and evenly** away from the sensor.	I move **fast and evenly** away from the sensor.	I don’t move.	I move first **slowly**, then **faster and faster** towards the sensor.
graph	The graph **rises/increases** steadily, **fairly flat.**	The graph **rises/increases** steadily, **fairly steep.**	The graph runs **parallel** to the **x-axis.**	The graph does not **decrease** as a straight line.
slope	**positive**	**positive**	**0**	**negative**

Checking

Teacher presents four items and asks students to interpret the graphs and to provide reasons for their answers.

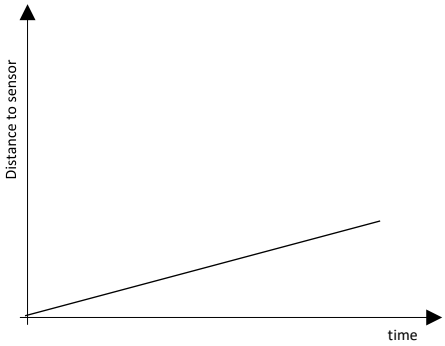
Suggested tools/materials/:

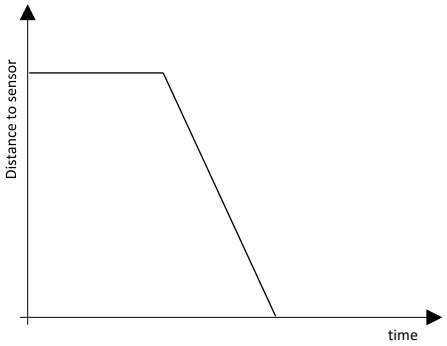
- PPP slides 6-9

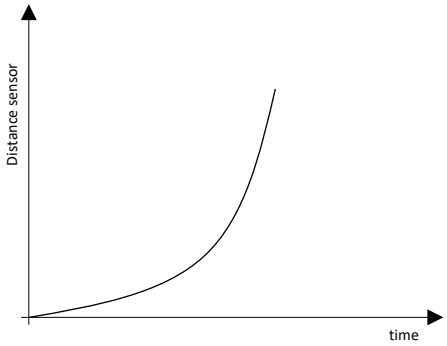
Estimated duration: 5-10 min

Optional Material:

Blackboard (introduction):







Bewegung	I start at the sensor and slowly move away from the sensor.	I start at a certain distance to the sensor. At first, I don't move. Then, I move fast and evenly towards the sensor.	I start at the sensor and move away from the sensor. At first, I move slowly getting faster and faster.
Verlauf des Graphen	The graph increases steadily, fairly flat.	The graph runs parallel to the x-axis and then decreases fast.	The graph does not increase as a straight line.

Movement cards:

The cards describe different movements in front of a sensor. Which card did your classmate chose? What graph was created by the movement?

Movement card 1 I start in front of the sensor. I move away from the sensor. I move faster and faster.	**Movement card 2** I start in front of the sensor. I move slowly and evenly away from the sensor.	**Movement card 3** I start far away from the sensor. I move slowly and evenly towards the sensor.
Movement card 4 I start in front of the sensor. I first move away from the sensor. Then, I walk towards the sensor again.	**Movement card 5** I stand in 1m distance from the sensor for the entire time.	**Movement card 6** I start far away from the sensor. I move towards the sensor. I stop moving when I am 1m away from the sensor.
Movement card 7 I stand in front of the sensor for 3 seconds. Then, I move evenly away from the sensor.	**Movement card 8**	**Movement card 9**