

Lesson Plan

Module:	Function Machines		
Teaching Hours:	3 x 40 min		
Grade Level/Age Range:	Grades 5-6 (10-12 years old)		
Brief Description:	The module engages students with the function machines, the graphical representation of the relationship between input and output values, and in finding the rule that correspond the input with the output values.		
Design Principles:	Inquiry		
	Situatedness		
	Digital tools		
	Embodiment		
	<ul style="list-style-type: none"> • Meaningful: Build on students' intuitive knowledge and daily life experiences in real-life scenarios • Embodiment: Perceptual-motor (action-perception) experiences in noticing the correspondence between input and output values, grounding the understanding of the relation between the involved quantities with concrete actions • Inquiry based learning: explore qualitative and quantitative relations (additive, multiplicative, linear) • Digital: tablet devices equipped with appropriate apps • Didactical phenomenology / situatedness: the correspondence of values from data sets (input-output) is recorded, tabularized and mathematized 		
Functional Thinking:	Input – Output		
	Covariation		
	Correspondence		
	Object		
Learning Goals:	<ul style="list-style-type: none"> ✓ Conceptualize arithmetic operations as functions in an implicit way ✓ Conceptualize functions as an input-output process ✓ Notice, generalize and express additive, multiplicative and linear relations ✓ Use functional expressions to model real-life scenarios 		

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Activities

Exploration

"Guess my Birthday"

Students follow a set of instructions (as shown below). The output number represents the date and the month of their birthday. After that the teacher figures out the date of birth of each student based on the output value of his/her calculations (subtract 5 from the last two digits of the outcome to find the date and subtract 2 from the other two digits to find the month).

For example: If a student says that the result is 1230, then the student was born on the 25th of October ($30-5=25$ and $12-2=10$).

Instructions:

Make the following calculations.

- Write down the number that corresponds to your month of birth
- Multiply by 5
- Add 7
- Multiply by 4
- Add 13
- Multiply by 5
- Add the number that corresponds to your date of birth
- What is your result?

Suggested tools/materials/: Students Handout

Estimated duration: 15 minutes

Investigation

The teacher marks four spots in the classroom (the blue, the red, the yellow and the green) and acts as the function machine. Each student approaches the teacher and the teacher asks three to four questions privately. One of the questions is how many brothers/sisters they have. Based on the answer to this question, he/she sends the student to the appropriate spot (blue: no brothers/sisters, red: 1, yellow: 2, green: three or more). The students do not know the rule. Students at each color spot are asked to figure out why they were sent to the same spot.

In the whole-class discussion students present their ideas. The teacher intuitively emerges fundamental ideas of the function concept: Each student could be sent only to one color spot, based on the rule of the machine and a number of students could be sent to the same color spot.

Next, students suggest their own machines, explain the rule and the possible values of the two sets.

Suggested tools/materials: Coloured papers

Estimated duration: 20 minutes

Activity 1.

Students work in pairs on the Gizmos app on their tablet devices, as shown below.



- a. Students are asked to choose function machine A (additive structure) and explore how it works by inserting into the machine different values. After that, they fill in the following table and explain the rule of the machine.

Input	Output
0	
3	
5	
7	
10	
12	
15	

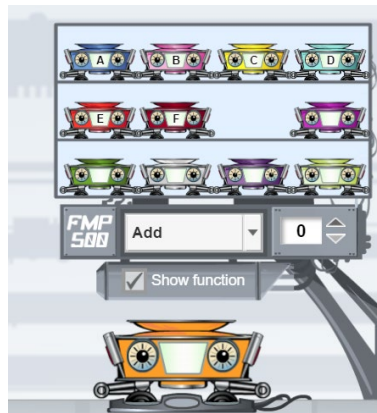
- b. After that, students are asked to choose function machine D (multiplicative structure) and explore how it works when they insert into the machine different values. The teacher initiates a discussion in whole class on which machine works with additive rules and which one works with multiplicative rules.

Suggested tools/materials: Tablet devices, App, Students Handout

Estimated duration: 10 minutes

Activity 2.

Students continue working in pairs on the Gizmos app on their tablet devices. In this task, students are asked to drag an empty – machine and program it using one of the four operations.



At first, they program two function machines that create the following tables:

Input	Output
1	7
2	14
4	28
7	49

Input	Output
6	2
7	3
8	4
10	6

Then, they asked to program their own machine and fill in a table of values. After that, every student shows their filled table to one of their classmates and asks them to program a function machine that gives that table.

Input	Output

Suggested tools/materials: Tablet devices, App, Students Handout

Estimated duration: 15 minutes

Activity 3.

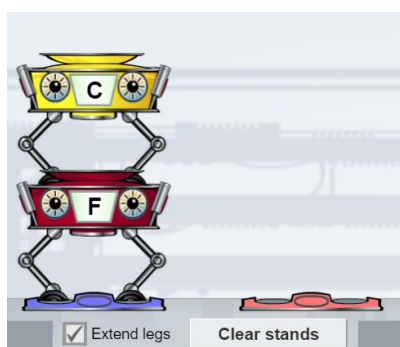
Students are asked to combine functions machines, machines *F* and *C*, as shown in the following picture.



Students fill in the table and explain how the output value is calculated.

Input	Output 1	Output 2
1		
3		
5		
10		
12		

Then, they change the order of the machines and complete the new table.



Input	Output 1	Output 2
1		
3		
5		
10		
12		

The teacher asks them to compare the two tables and explain how the change in the order of the machines modifies the output values of the table, using examples from their work.

Students work independently for Question (e)-(f) and then exchange ideas in whole class discussion.

Suggested tools/materials: Tablet devices, App, Students Handout

Estimated duration: 15 minutes

Activities for Practice:

Activity 4:

Students are asked to provide a combination of two function machines that give the following tables:

Input	Output
1	3
2	5
3	7
4	9

Input	Output
1	0
2	3
3	6
4	9

The teacher asks students to explain their work and describe the rules of each combination of machines.

Activity 5:

Students are asked to provide a combination of function machines (at least two) that give the following result: "The input value is the same with the output value".

(This task could be adjusted for other machine combinations, if further practice is needed)

Suggested tools/materials: Tablet devices, App, Grid paper, Cubes

Estimated duration: 10 minutes

Extension Activities:

This section presents tasks of different difficulty level.

In Activity 6, students are engaged in programming a machine with the rule "add 4" and a second one with the rule "multiply by 5". Students fill in the tables with their own input values. They are asked to use as input values, number 0 and 1, and find the output values. Also, they explain how the output value changes when the input value increases by 1. Then, the students insert in both machines the values 30, 31, 32 and 33 and then 50, 51, 52 and 53. Students explain how the output value changes when the input value increases by 1 and compare the unit change in the two machines.

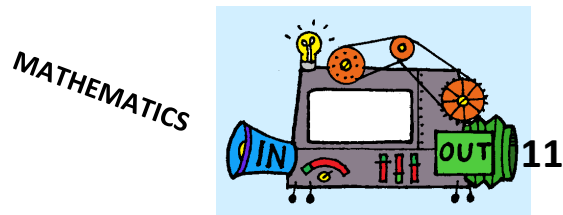
In Activity 7, students engage with a mathematical problem "Company A rents a bicycle based on the following: €8 for each hour and additional €5 for insurance." Students create a combination of machines that gives the cost of renting a bicycle per hour and explain how they worked. Also, they describe the graph and answer questions. Furthermore, students create a combination of machines to show Company B (Company B is cheaper than Company A for renting a bicycle for less than 4 hours) and explain their answer based on the graphs.

Suggested tools/materials: Handout

Estimated duration: 30 minutes

Assessment

1. In the following machine, words are entered and the machine gives as an output the number of letters of the word (see example).



- (a) Find the output values for the following input:

- GEOMETRY
- ALGEBRA
- FUNCTION
- NUMBERS

- (b) Suggest possible input values for the following output values:

- 8
- 9
- 10

2. Find below the rules of 5 function machines.

MACHINE A: Add 5

MACHINE B: Subtract 2

MACHINE C: Multiply by 3

MACHINE D: Divide by 2

Provide a combination of machines that could give the following tables. Explain the order.

TABLE 1

Input	Output
1	4
2	5
4	7
7	10

TABLE 2

Input	Output
1	8
2	11
5	20
10	35

TABLE 3

Input	Output
1	3
3	4
7	6
15	10

TABLE 4

Input	Output
5	9
7	15
10	24
11	27

Digital Tools:

Activity 1, 2, 3:

<https://gizmos.explorellearning.com/index.cfm?method=cResource.dspView&ResourceID=1035>

