MentiMATH - The concept of a function

Application and short description: In this Mentimeter template the concept of a function is elaborated on. The template is designed foremost as an introduction but can also be used in the middle or as a form of reinforcement at the end of a subject block surrounding linear functions.

Target group

- 8th grade (US curriculum)..

Estimated time

- Approximately 40-90 minutes for **all slides**.
- Approximately 1-5 min for **each slide.** (The amount of time each slide takes could depend on several variables, for example the students' mathematical knowledge, the teacher's need for clarification within each slide and what work has been done in advance)

Learning goals

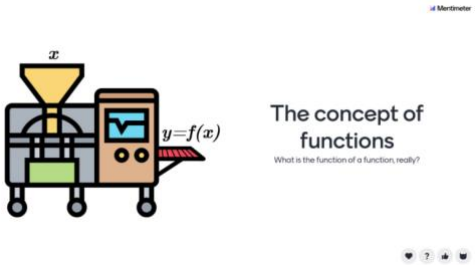
- The students should be able to see a function from different perspectives.
- The students should feel comfortable with using the f(x)-notation.
- The students should be able to create their own functions.

Theoretical background: A *function* is defined as a threshold concept. This means that it is *transformative* - once learnt it opens up new ways of conceiving a concept and it will be impossible to forget. Not grasping the concept of a function will hinder the learner to get a rich mathematical understanding later down the line. To properly grasp the concept of a function, students should be able to conceive a function as an *action*, as a *process* and as an *object*, all in its own right. The transition that the learner needs to go through when transitioning from conceiving a function as a process, to viewing it structurally as an object, can be very challenging. But once the learner has made this shift in perspective, it is possible to see the construct in a new light and the penny suddenly drops [3].

How to use the template: Here follows some ideas on how the slides are intended to be used but feel free to use the template however you like. Included in each cell is the purpose and other information that could be of use for you as a teacher. A general idea regarding all questions is that the students should work after the model Think-Pair-Share (TPS). When implementing TPS the students should first answer the question individually, then discuss in pairs (or groups of three) followed by a classroom discussion led by the teacher. As a concluding remark, the content in the slides are designed primarily for developing students' understanding of *mathematical concepts* rather than the procedural 'know how'. Therefore, discussions and questions from the students is a central part of using the presentation where your expertise as a teacher is important to clarify misconceptions and lead the classroom discussion.

Important keyboard shortcuts: To get the most out of presenting with Mentimeter, there are a few keyboard shortcuts you need to know.

- Toggle between hiding and showing results: **H**. It is important to not show results before everyone has had a chance to give their response since this can influence other students' thinking.
- Countdown timer: **1** (60 seconds), **8** (30 seconds) **9** (10 seconds), **0** (stop countdown). It is good to be flexible and to start a timer (either, 60, 30 or 10 seconds) when you feel that the majority of the group is ready to move on from a discussion.
- Show correct answers: **ENTER.** Wait until all students have answered a multiple choice question before you show the correct answer(s).



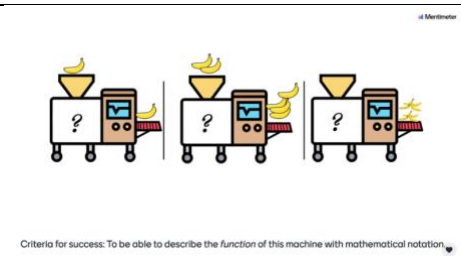
Slide 1 - Introduction.

Introduce the theme of the lecture. For example you could mention that the concept of a function is very central to mathematics.



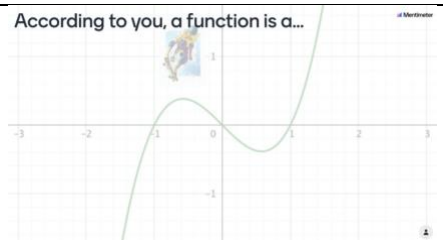
Slide 2 - General information.

Inform the students regarding the TPS methodology, that their responses are anonymous and how they can access the interactive presentation.



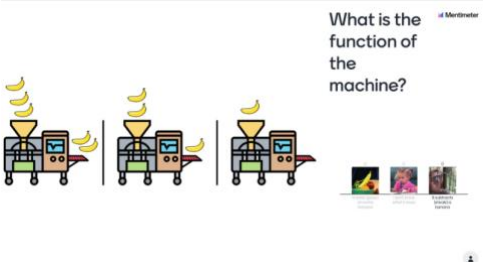
Slide 3 - Criteria for success.

Introduce a 'criteria for success' for the lesson with a problem that will be revisited and solved at the end of the lesson. The idea here is to make the learning visible, so the students can see for themselves that they've actually learned something.



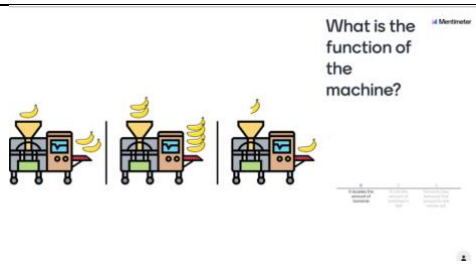
Slide 4 - According to the students, a function is...

Let the students individually write down how they see the concept of a function. This can help clarify potential misconceptions.



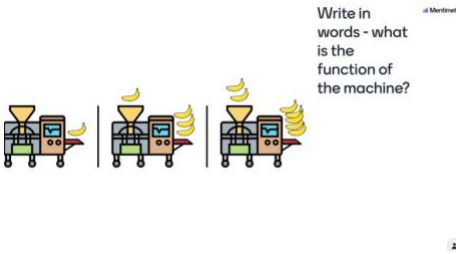
Slide 5 - Banana machine 1.

A warm up to understand the idea of the 'banana-machine'.



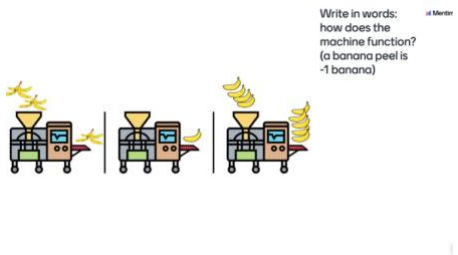
Slide 6 - Banana machine 2

Increase the level of abstraction by introducing a half banana.



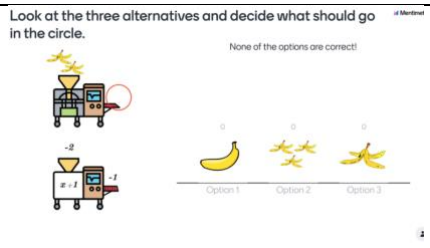
Slide 7 - Banana machine 3.

Get the students to realize that a 'machine'/function can contain all the calculation methods (multiplication, division, addition and subtraction).



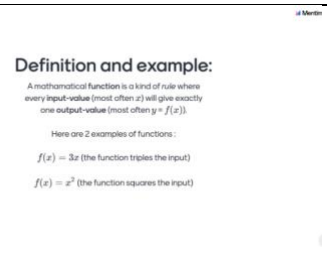
Slide 8 - Banana machine 4.

Get the students to visualize the 'machine'/function in a more abstract manner by introducing negative numbers.



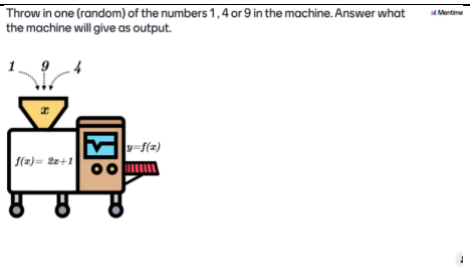
Slide 9 -11 Banana and number machine.

This is key-slides. The idea here is to go from a more concrete idea using bananas and a machine, to the more abstract mathematical language. Try giving probing questions to the students, even if every group has answered correctly



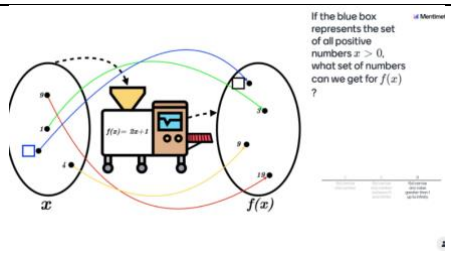
Slide 12- Formal definition.
[Content slide]

Give the students a definition that they (hopefully) can grasp and make sense to them at this point, and give two examples to make it less abstract.



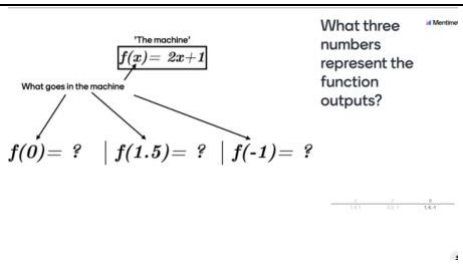
Slide 13. Three numbers machine.

Give the students knowledge about how three different 'inputs' corresponds to precisely three unique outputs. In other words a bijective function or '1-to-1' relation.



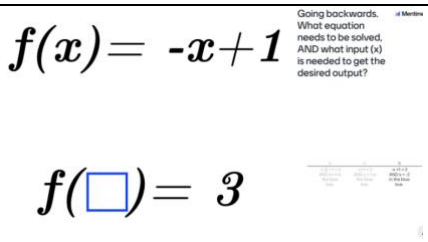
Slide 14 -The concept of a function.

This is a key slide. The idea here is to give the students a visual representation of a linear function, where every input corresponds to a unique output. Try giving probing questions to the students, even if every group has answered correctly.



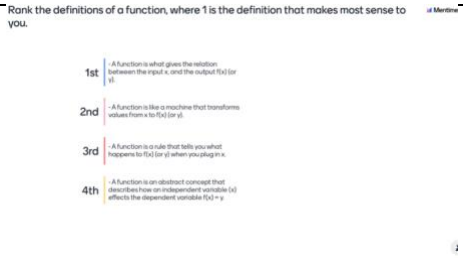
Slide 15 - Using the function with x as input.

The purpose here is that the students should be accustomed to the mathematical notation of a function and be able to apply it.



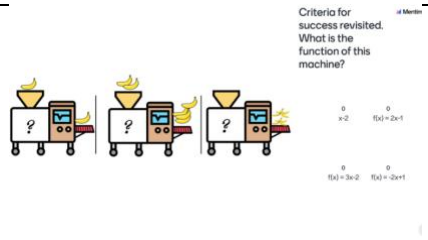
Slide 16 - Going backwards.

The purpose for the students here is to understand that functions and equations solving are interlinked.



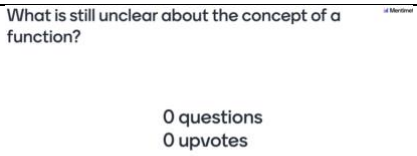
Slide 17 - Rank the different definitions of a function.

Let the students individually rank the alternatives in order for them to decide how they conceive a function.



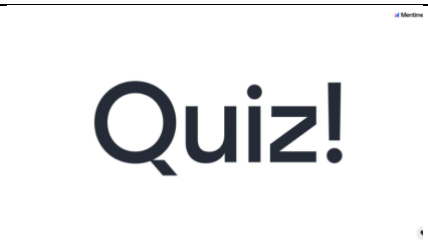
Slide 18 - Criteria for success revisited.

Return to the problem that was introduced in the beginning of the lecture to make the students realize they've actually learnt something.



Slide 19 Q & A.

Let the students individually write down what they still feel is unclear about the concept of a function.



Slide 20-26 - Quiz Competition.

Ask the students to enter their real names. Let the students compete in a fun way while you as a teacher can get a sense of the individual level of knowledge. This information could be used to give support for students in need of guidance.

References:

1. Pettersson, K. (2012). The threshold concept of a function–A case study of a student's development of her understanding. In Eighth Swedish Mathematics Education Research Seminar, Umeå, Sweden.

2. Flanagan, M. (2016). Threshold Concepts: Undergraduate Teaching, Postgraduate Training, Professional Development and School Education A Short Introduction and a Bibliography. Hämtad 2016-03-11, från http://www.ee.ucl.ac.uk/~mflanaga/thresholds.html

3. Dubinsky, E. and McDonald, M.A. (2001), APOS: A constructivist theory of learning in undergraduate mathematics education research, In: D. Holton ed., The Teaching and Learning of Mathematics at University Level. Dordrecht: Kluwer Academic Publishers, pp.275-282.