HOW TO PREPARE A HELP TASK

METHODOLOGY OF THE SUPERUNIT

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Introduction

The mathematics curriculum is designed to prepare students for the Hungarian secondary school entrance exams, the ninth grade monitor in Upper Hungary and the Transylvanian eighth grade national assessment (skills) exam, i.e. to enable them to successfully acquire the amount of mathematics knowledge and competences expected at the end of primary school. In assessing performance in the mathematics curriculum test, it should be borne in mind that students have worked with a complex, multi-topic (13), large-scale curriculum of varying difficulty levels, often with advanced tasks, in line with the curriculum development objectives, and that the results are therefore satisfactory.
The results and lessons learnt from the test teaching have been summarised in a separate document, while the experiences and aspects relevant from a teaching point of view are presented in this guide.

From a teacher's point of view, the most relevant lessons from the pilot teaching are mainly in the area of content development and methodology. A concrete example is given below to illustrate how it is possible to guide and support the student in the learning process in a way that allows him to make the most progress. In the LTP Mathematics curriculum, the level-jumping content includes a task with a support task and an explanation. The purpose of this is to provide help and explanation to students. At the same time, the most frequently asked question by teachers is how to create a good superunit, i.e. how to provide professionally and methodologically appropriate help and explanation to the student. We would like to support teachers who are interested in the Tanlet application.

In present teaching, if the child is stuck, there is an immediate opportunity to ask questions, to explore the stuckness, but here the teacher has to find out how to help. There are two ways of doing this, depending on the content of the task, the two approaches varied in the mathematics content. In this paper, two methods of unblocking are illustrated with examples: guiding the student through the whole solution process (e.g. using toy engines to repeat the rules for the solution) or trying to unblock the supposed block with little help, the latter being less guided.

Methodological underpinning of the help question

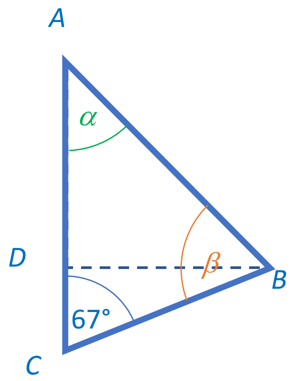
What is a good facilitating question? What can be called a facilitating question? Why ask a facilitating question?

I will try to answer these questions from the specific perspective of mathematics through concrete examples.

Example

Let's take a simple example for the eighth grade.

The basic problem: The vertical line BD of the triangle ABC is shown in the figure. We know that the triangle ABD is isosceles. Calculate how many degrees are the unknown interior angles of triangle ABC?



Solution: The ADB triangle is right-angled and isosceles, therefore the angle α is 45°, from which it can be easily calculated that the angle β is 78° based on the sum of the triangle's interior angles.

What supporting questions can we ask for this task?

We need to determine the reason behind the student's incorrect answer. There can be several possible causes:

- Do they understand the task? Can they interpret what is being asked?
- Do they lack knowledge? Are they familiar with the sum of interior angles of a triangle, the concept of altitude, or the fact that in an isosceles triangle, the angles at the base are equal?
- Do they know how to calculate the solution to the task but made a computational error?
- Did they calculate correctly but made a mistake in writing down the solution?
- Is there any other issue that might have affected their answer?

When the teacher is personally present and interacts with the student, it is easy to determine where the student is struggling by asking a few questions. This option is not available in a digital learning material.

Basically, two methods can be distinguished:

Method I.: We guide the student through a solution step by step by asking questions in a specific order.

Method II.: We attempt to identify the specific point where most students might get stuck and provide targeted support at that particular point with a guiding question.

I will now demonstrate both methods using the example of the previous task.

Method I, guiding the student through the whole solution step by step:

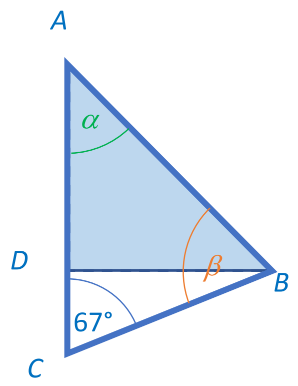
1. Use a true-false task engine to replicate the knowledge needed to solve the task:

The vertical line of a triangle is perpendicular to one of its sides. I/H

The sum of the interior angles of a triangle is 360°. I/H

The two interior angles of an isosceles triangle are equal. I/H

2. Use a quiz engine to clarify that triangle ABD is a right triangle:
By angles, the triangle ABD of the problem belongs to which group?



pointed
right-angled
obtuse-angled

3. Using a quiz engine, we search for a relation that leads to the calculation of the angle α:

We know that triangle ABD is isosceles and right-angled. (Note: This sentence is a little help, summarizing what we know about triangles so far.) Which equation is true for the sum of the interior angles of triangle ABD using the notation in the figure? (There may be several good solutions.)

$90° + \alpha + \alpha = 180°$

$90° + \alpha + \beta = 180°$

$2\alpha + 90° = 180°$

$3\alpha = 180°$

4. Using a bubble grinder motor, we ask for the angle α:

Pop out the wrong answers! What is the angle of α?

180°; 90°; 60°; 45°; 30°; 10°

5. Use a quiz engine to summarise your knowledge of the angles of triangle ABC:

Mark the true statements.

The angle at vertex A of triangle ABC is 45°.

The angle at vertex C of triangle ABC is 67°.

The angle at vertex C of triangle ABC is 37°.

The angle at vertex C of triangle ABC is 45°.

The angle at vertex A of triangle ABC is 67°.

6. Finally, the angle β is calculated and the bubble monster motor is used to ask for it:

We know the two angles of the triangle ABC, what is the angle at the third vertex B?

78°; 76°; 87°; 68; 45°

Method II: We try to find out which step the student is missing and ask a question to help.

In the example problem, I think the child may get stuck because he cannot calculate the interior angles of the triangle ABD. He does not realize that it is right-angled or that it is isosceles. This is where we try to help with a True-False engine.

Decide which statement is true and which is false.

The triangle ABD is equilateral. I/H

The triangle ABD is isosceles. I/H

The three interior angles of isosceles triangles are equal. I/H

All angles of triangle ABD are equal. I/H

All interior angles of triangle ABD have different magnitudes. I/H

A triangle ABD has two equal interior angles. I/H

The triangle ABD has one right angle. I/H

Analysis of the two methods, possibilities, advantages and disadvantages

Now let's look at the two methods in detail in the previous example.

Method I: The learner is guided step by step through a solution with questions in a specific order.
From a didactic point of view, this method is very similar to the question and answer method used in mathematics teaching. Unfortunately, digitally, it is not possible to ask students to brainstorm and tell us everything they can think of in relation to the task. The teacher has to choose one solution method from many and can guide the student along that one path with questions. So we break down the task into small sub-tasks for the student and have him solve these sub-tasks. In this way, we build up the solution to the task in small steps.

Disadvantage:
- There is only one way of working with the student. If the student had another, correct idea for solving the problem, he will unfortunately not know whether his idea was the right one. I would like to emphasise that complex mathematical problems can usually be solved in a variety of ways, using a variety of thinking. For students who can't even begin to solve the problem, it is perfectly helpful to guide them along a single path. However, this can be a particular handicap for a student who has his or her own ideas for solving the problem.

- Just because a learner can solve the sub-tasks does not mean that he or she can solve the whole problem. The student's problem solving is not developed by this method, as the solution strategy is presented to him.

Advantage:
- For students who are not yet able to solve the problem, this method helps them to find the right way of thinking without failing, as they are not given difficult questions to solve, only small, easy to solve sub-tasks.

- The other disadvantage is that the teacher has to work out the steps of the problem, asking more questions to help, so it is definitely more time-consuming to complete the whole problem.

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Method II: We try to find out the one point where most learners might get stuck and support their knowledge at that one point with a targeted help question.

In this method, there are several difficulties. First and foremost, we do not know where the student is stuck. In the case of non-digital learning material, if the teacher and the student are present, quick questions will reveal the point where the student is stuck and the teacher can then ask the right questions to help. This is not the case here. The teacher's task is to guess in advance which might be the most uncertain point where the student is stuck. Experience can help with this.

The advantage of this method is that the student can work out the solution on his own, with only a little help.

How to ask the right support question?

For now, we'll just deal with what should be the only helpful question to ask in a task. I will show you several ideas.

„A little help disguised as a question”:

I am thinking of the possibility of presenting a fact to the student, but asking a question. In the sample example above, we used a true-false engine to ask whether the two interior angles of an isosceles triangle are equal. So a theorem or a statement is wrapped up as a question and the student is asked to decide whether it is true.

For example, we want him to remember that 2 is the only even prime number. Then we can use a true-false engine to ask the following questions:

Prime numbers can only be divided by themselves and by one. I/H

All even numbers can be divided by two. I/H

2 is not prime. I/H

All prime numbers are odd. I/H

What is the operation?

Basic task: I can hang 12 identical tea towels on 1 piece of drying line. How many pieces of the same size kitchen towels can I dry at the same time on 13 pieces of the same length of drying rope? Choose the correct answer!

Here, in fact, the operation of multiplication is applied. We can lead the student to do this by going from fewer and fewer drying ropes to more and more drying ropes in the help question. E.g. Forbidden with the motor á we ask you to pair the number of ropes with the number of kitchen towels.

1 rope - 12 towels

2 ropes - 24 tea towels

3 ropes - 36 tea towels...

Subresult:

In maths, it is quite clear what we mean. If calculating a result requires calculating other partial results, it is a good help to ask about these partial results. In this way, the student can check for themselves which step they have made a mistake at, and it is also a guide to the correct result. For example: Dorka and her husband are renovating the kitchen and buying new floor tiles. The kitchen floor is rectangular, 4 metres long and 2.7 metres wide. How many boxes of floor tiles should they buy if 10% is at least waste and one box contains 1.44 m^2 of floor tiles?

How many m^2 is the kitchen area?

Of course, there are many other ways to get a good help question, these are just a few ideas.

Create a help question and explanation for a concrete example!

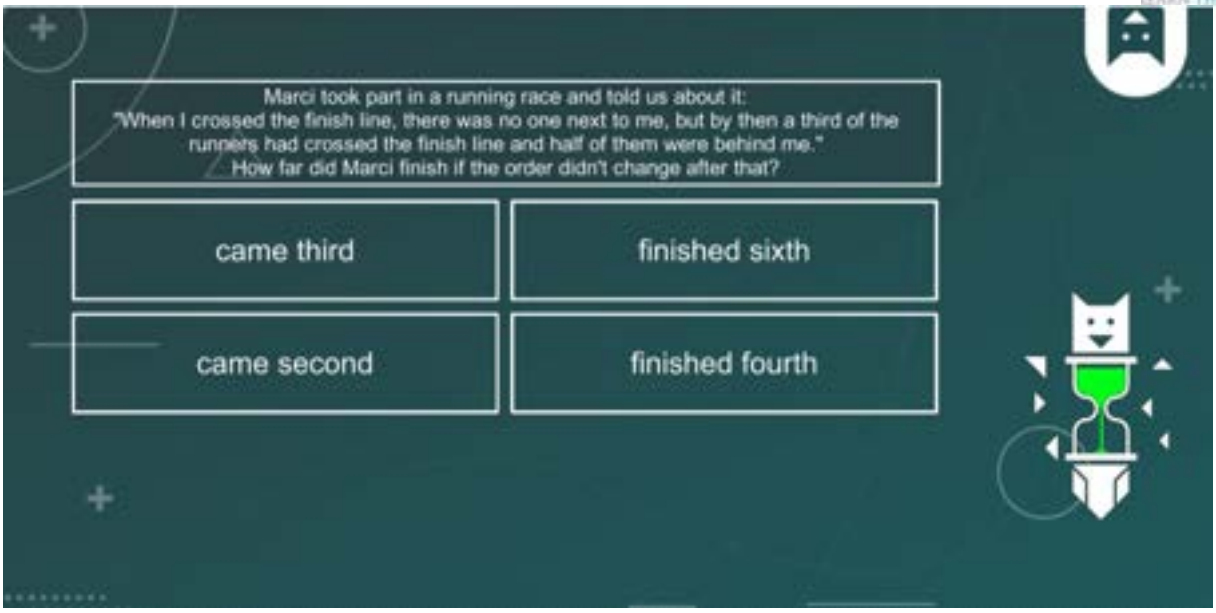
Finally, let's look at a concrete example of how, through a thought process, we can arrive at the right helping question.

The main task (or core task):

Marci took part in a running race and told us about it:

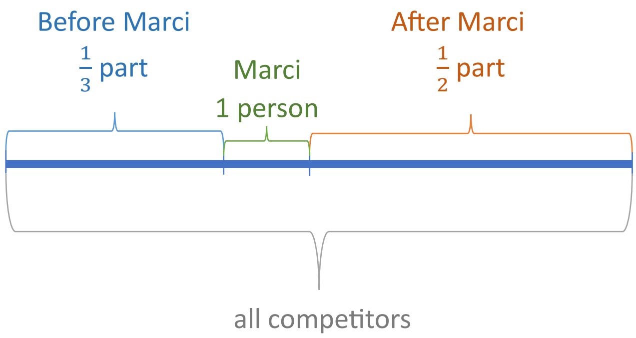
"When I crossed the finish line, there was no one next to me, but by then a third of the runners had crossed the finish line and half of them were behind me."

How far did Marci finish if the order didn't change after that?



A possible solution:

We can divide the participants of the race into 3 parts, and there is no overlap between these parts: the participants who arrived before Marci (one third of all participants), the participants who arrived after Marci (half of all participants) and Marci.



What part is Marci? $1-\frac{1}{3}-\frac{1}{2}=\frac{1}{6}$

Marci is $\frac{1}{6}th$ of all competitors. So there were 6 kids in total. 2 kids finished in front of Marci, so he was third.

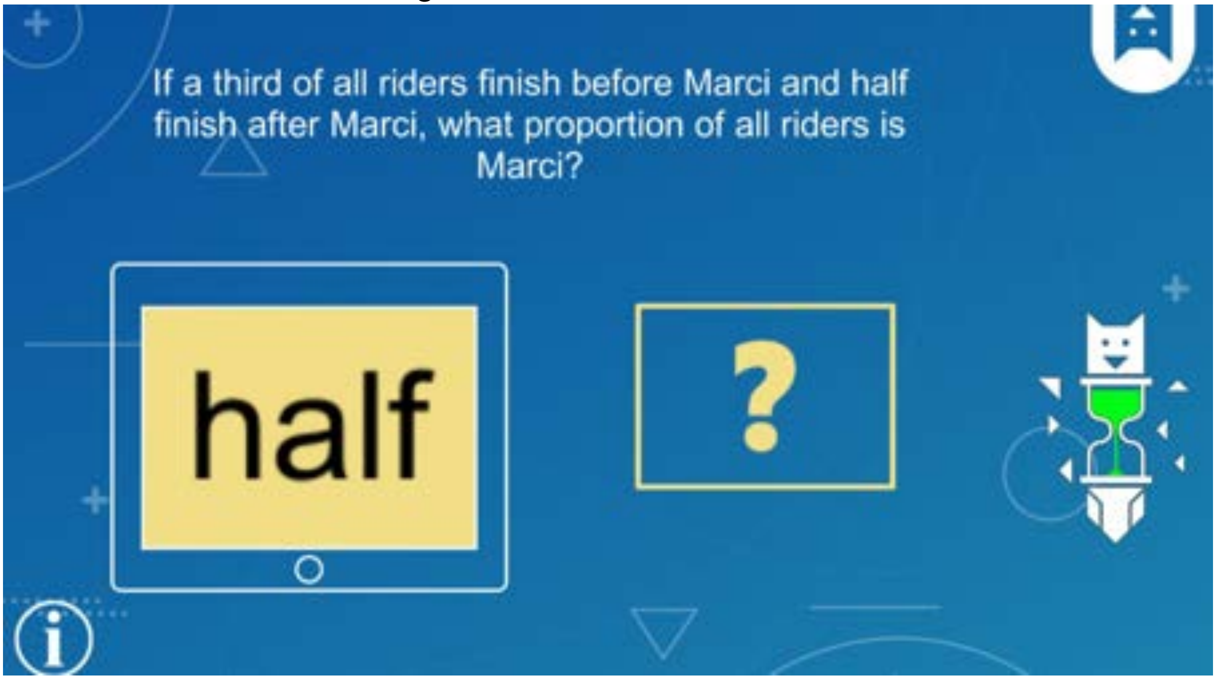
Where could the blockage be:	Help for specific problems:	In the form of a question:
1) You cannot start the exercise because you cannot interpret the data. It doesn't know that Marci is the remainder, i.e. the part of the whole minus a third and a half.	The participants in the competition can be divided into 3 parts, and there is no overlap between these parts: competitors who arrived before Marci (one third of all competitors), competitors who arrived after Marci (half of all competitors) and Marci.	If a third of all riders finish before Marci and half after Marci, what proportion of all riders is Marci?
2) You cannot add or subtract fractions.	Fractions that do not have the same denominator are added together by bringing them to a common denominator.	What will be the common denominator of 1/3 and 1/2?
3) You can't calculate that if Marci is one-sixth of the riders, then how many are the total number of riders.	If Marci alone is one-sixth of the riders, then there are six times as many riders, or six people.	Match the right ones! If Marci is half of the riders, then...................2 is all the riders. If Marci is one third of the riders, then...................3 is the total number of riders. If Marci is one sixth of the riders, then...................6 is all the riders.
4) You can't calculate how many places Marci got.	If 6 children started and a third of them finished before Marci, that's a total of two children, so Marci is third.	Count how many children crossed the finish line before Marci!
5) It accounts for any of these steps.	This can only be solved by recalculation. We can ask for a partial result.	We can ask Marci what proportion is part of the total number of competitors.

As the table shows, there is a question that eliminates several problems at once.

On the other hand, as a teacher, we know which is the detail where the student is most likely to get stuck, or the step that is most difficult to take. It's worth considering this when asking a support question. In my opinion, in our example, the best helping question is:

If a third of all riders finish before Marci and half finish after Marci, what proportion of all riders is Marci?

For this we chose the BOOM engine:



Methodological support for the explanation

What is the form and style of a good explanation? How to write an explanation?

It is important to note that in this digital training software, a large part of the transfer of new knowledge is done through explanation, so I would like to stress the importance of this. The didactical method known in mathematics is the following: posing a problem (the main task in this software), asking a question (help question), generalisation, rule making (in explanation).

Expectations regarding the explanation

- The text must be clearly understandable,
- refer to or contain a generally applicable rule,
- use visual, easy-to-understand illustrations to aid understanding,
- be short,

include a screenshot of a good solution.

We have tried two ways of delivering the explanation: a text in pdf format, possibly illustrated with diagrams, or a video.

An important aspect is to "replace" the teacher who is not present as effectively as possible. A video explanation is closer in appearance to an in-person explanation than a text explanation.

Explanatory pdf file

Benefit

- easy to produce,
- no special software, no IT skills required,
- easy to customise afterwards,
- it does not require a lot of storage space.

Disadvantage

- pupils are reluctant to read,
- there is no teacher presence (no voice, no picture), no teacher-related presence.

Explanatory video

Benefit

- the teacher can be heard/seen in audio (possibly also in pictures),
- can be replayed if the learner requests it,
- more likely to be engaged by the pupils.
-

Disadvantage

- More difficult to produce,
- requires special software and knowledge of it, IT skills,
- usually more difficult to adapt afterwards,
- storage requirements are high.