

## Report on teacher testing in Kosice

<b>Items used:</b>	Functional thinking definition Linear function definition Goal of teaching about functions Grades and topics appropriate for FT development Misconceptions
<b>Responsible Partner:</b>	UPJŠ / Slovakia
<b>Background of the participants:</b>	pre-service teachers in mathematics and the other subject in their first year of master study with no prior experience with pedagogical courses
<b>Sample size:</b>	12
<b>Brief Description of Testing:</b>	Pre-test Long course <ul style="list-style-type: none"> <li>- 11 weeks</li> <li>- 90 minutes long sessions</li> <li>- modules used and their allocations: Introduction and pre-assessment (1), Knowledge of Topic (2), Functional Thinking (2), Design principles (11), Formative assessment (2), Curriculum (1),</li> </ul> Post-test Final meeting

### Method:

Pre-test and post-test took place during the semester. 12 pre-service teachers participated at both of them. The pre-service teachers were informed about the developmental goals of these tests, and they were not used for scoring and grading pre-service teachers. The questions were not previously piloted. The results were coded in alignment with the codebook developed by the FunThink team. We were not interested in how many times a given code occurs for a particular pre-service teacher, but whether it occurs there at all. Thus, the numbers in the following tables reflect the number of pre-service teachers for whom the code occurred.

### Results and Discussion:

**Question: Have you ever encountered the term functional thinking? If so, what do you consider functional thinking to be? If not, what do you expect it to be? Expand your answer.**

In the pre-test, the majority of pre-service teachers (n=9) were unfamiliar with the concept of functional thinking. They associated it with logical thinking or thinking that can apply learned knowledge in practice. A few (n=3) used a very general description - thinking about functions or their properties.

In the post-test, some pre-service teachers (n=4) stuck to the very general description. Others (n=8) were much more specific. They used aspects of functional thinking, applicability beyond mathematics, understanding and working with representations (in most cases a graph) in their descriptions.

This material is provided by the [FunThink Team](#), responsible institution: Pavol Jozef Šafárik University Košice



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**Question: What topics in the mathematical curriculum (and in which grades) are relevant for functional thinking development? Justify your answer.**

In both the pre-test and the post-test, the pre-service teachers talked about the different levels at which functional thinking can be developed. They naturally focused on the unit on functions and relationships, often mentioning direct or indirect proportionality. The post-test highlighted the position of Years 7-8, where students first encounter the topic of functions. The following table shows the topics that the pre-service teachers mentioned when developing functional thinking:

	Pre-test	Post-test
Functions	11	12
Geometry	4	4
Algebra	4	6
Numbers	2	4
Statistics-Probability	1	0

**Question: What do you consider to be a goal of teaching about functions? Expand your answer.**

Goals which were mentioned in the tests are described in the following table:

	Pre-test	Post-test
Understanding / describing dependencies and relationships	3	4
Important because of real-life contexts	5	7
Functional thinking development	0	3
Understanding functions	6	5
Representations	8	6
Prediction	0	2
General goals	3	4

**Question: What learning difficulties and misconceptions do you expect when teaching functional thinking? Use as many examples as possible to depict your answer.**

Category of misconceptions and difficulties	Pre-test	Post-test
What is and is not a function?	8	10
Linearity	0	3
Continuous vs discrete graphs	0	1
Representations of functions	9	10
Linking representation	5	5
Modelling	4	7
Concept of variable	2	8
Notation	1	6
An input-output aspect	0	3
Covariation aspect	0	2
Correspondence aspect	3	5
The function as object	6	12
General	5	7
Other meaningful answers	4	0

Other meaningless answers	0	0
No answer/ I do not know	0	0

### Discussion:

We can see that the pre-service teachers increased their knowledge particularly in the area of understanding functional thinking and also in the area of pupils with learning difficulties.

Concerning misconceptions and learning difficulties, all but one of the PSTs in the post-test reported students' misconceptions and difficulties (that students might encounter when learning about functions), which fell into more distinct categories based on the proposed codes. The most valuable progress is observed in three pre-service teachers' answers. They mentioned students' misconceptions and difficulties in at least 5 more categories than in pre-test. Only one pre-service teacher mentioned misconceptions and difficulties in the same number of categories.

In the category Concept of variable and function as object the number of newest occurrences increase by 6. In the category Notation, which is aimed at student difficulties related to the unique notational systems in the graphical and algebraic symbols that are used to represent function, the number of newest occurrences increase by 5.

The results showed that most of the preservice teachers scaffolded their knowledge of students' misconceptions and difficulties about functions. On the other hand, we have to pay more attention to some categories of misconceptions, e.g., related to category Continuous versus discrete graphs.

Other areas did not seem to grow so obviously. Although they were very active, they enjoyed the activities and cooperated willingly in small groups. Even though we could see some progress, we will make some changes so that our pre-service teachers' potential to learn more and faster will be used.

The lessons we have learnt and will use in the next rounds of the course are as follows:

First, we need to be aware of the language issue in Slovak, where "funkčné myslenie" (functional thinking) literally means "thinking that works well". This issue needs to be addressed directly with the pre-service teachers.

Secondly, for the group of pre-service teachers reported here, it was their first experience with a course that did not focus on (advanced) topics of their subjects (mathematics and one other). These circumstances probably contributed to their inability to learn adequately from the course focused on pedagogical content knowledge. This will be reflected in the next courses in Slovakia:

- The number of sessions will be lower, but their length will be 135 minutes,
- there will be time for deeper reflection at the end of each session,
- short formative assessment quizzes will be given at the beginning of the sessions.

Thirdly, our pre-service teachers' previous experience of learning and teaching is mostly 'traditional', quite far from the constructivist way. Therefore, their belief systems seemed to be in conflict with the design principles of learning environments. To make the course more effective, their belief systems will be addressed in a more direct way.