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Report on teacher testing in Ludwigsburg

Items used:	Functional thinking definition Topics and grade levels relevant for functional thinking Feedback questionnaire
Responsible Partner:	LUE, Germany
Background of the participants:	Pre-service teachers (university students) in mathematics education (special needs education, primary and secondary schools) and one other subject in their master study
Sample size:	14
Brief Description of Testing:	Pre-test Long teacher course - 14 weeks - 90 minutes long sessions - Modules used and their allocations: Introduction, functional thinking, design principles and learning environments, curriculum and development of functional thinking Post-test

Method:

Pre-test and post-test took place during the first and last session of the winter semester 2022/23. 14 pre-service teachers participated in both tests. The testing was voluntary and had no influence on the passing or grading of the course. The questions were not previously piloted. The results were coded in alignment with the codebook developed by the FunThink team. There was no interest in how many times a given code occurred for a particular pre-service teacher, but rather if it was present or not. Thus, the numbers in the following tables reflect the number of pre-service teachers for whom the code occurred.

Results and Discussion:

Item 1: 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.

Figure 1 provides an overview of the pre-service teachers' answers in the pre- and post-test. The used coding scheme was developed for the interview study of the FunThink project (Frey et al., 2022) and adapted for this item. The light grey squares indicate the answers in the pre-test, the black squares the answers in the post-test. It can be seen that the rather unspecific categories 8, 9, and 10 appear more often in the pre-test and only rarely in the post-test. In addition, the more specific categories for functional thinking (aspects of functional thinking) 1.1-1.4 were mentioned more often in the post-test. This indicates that the participating pre-service teachers were at the end of the course more familiar with the concept of functional thinking than they were at the beginning.

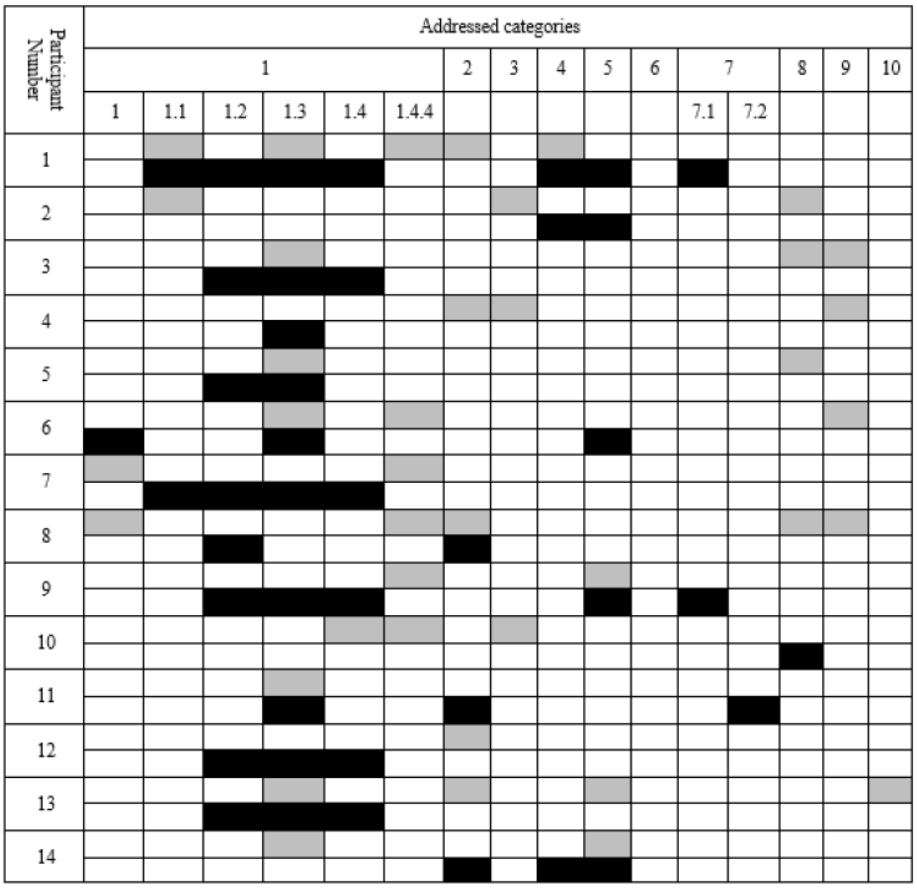

Figure 1: Changes in pre-service teachers' conceptions of functional thinking (Frey & Sproesser, accepted)

After the completion of this item in the pre-test, a short description of what functional thinking entails was provided.

More information on results with regard to this item can be found here:

Frey, K. & Sproesser, U. (accepted). Changes in pre-service teachers' conceptions of functional thinking. In *Proceedings of the Thirteenth Congress of the European Society for Research in Mathematics Education.*

Frey, K., Pittalis, M., Veldhuis, M., Geisen, M., Krisakova, M., Sajka, M., Nowinska, E., Hubenakova, V. & Sproesser, U. (2022). Functional thinking: Conceptions of mathematics educators - a framework for analysis. In C. Fernández, S. Llinares, Á. Gutiérrez Rodríguez & N. Planas (Hrsg.), *Proceedings of the 45th Conference of the International Group for the Psychology of Mathematics Education* (S. 349).

Item 2: What topics in the mathematical curriculum (and in which grades) are relevant for functional thinking development? Justify your answer.

In the pre-test, participants mostly focused on grade levels 6 and 7 and the introduction of functions with related topics. In the post-test, the answers were broader and besides the topic of functions, topics related to patterns as well as numbers were mentioned. In the post-test, many pre-service teachers did not focus on specific grade levels but rather on multiple topics.

The following table shows the topics that the pre-service teachers mentioned with regard to developing functional thinking:

	Pre-test	Post-test
Algebra	4	2
Geometry	1	1
Numbers	4	5
Number Sorting	1	0
Counting	1	0
Patterns	2	5
Functions	10	9
Problem solving	1	1

Hence, the total number and distribution of mentioned topics did not vary a lot between pre- and post-test. However, in their answers to this question, the pre-service teachers showed their improved understanding that functional thinking is not restricted to particular topics and grades but can be considered as an overarching concept that can be fostered in the context of various topics already in early ages.

Feedback questionnaire:

In addition to the previously described items, in the post-test the participants were asked to provide feedback regarding the teacher course. The following table displays the provided feedback.

		1	2	3	4	5	M	SD
1.	I learned interesting things in the teacher training course about mathematics.	-	2	2	8	2	3.71	0.88
2.	I learned interesting things in the teacher training course about teaching.	-	-	4	8	2	3.86	0.64
3.	The knowledge I gained is useful for teaching Mathematics.	-	2	-	6	6	4.14	0.99
4.	The structure of the teacher training course was appropriate and effective.	-	2	1	7	4	3.93	0.96
5.	The content of the teacher training course was appropriate and effective.	-	2	-	9	3	3.93	0.88
6.	The way of delivery of the teacher training course was appropriate and effective.	-	2	3	7	2	3.64	0.89
7.	I will use the material of the project in my teaching.	-	2	4	4	4	3.71	1.03
8.	I will use the digital tools of the project in my teaching.	1	1	5	2	5	3.64	1.23
9.	The digital material of the project is interesting.	1	1	-	5	7	4.14	1.19
10.	The digital material of the project facilitates conceptual understanding of the mathematics concepts.	1	1	-	5	7	4.14	1.19

11.	I would recommend this seminar to a colleague of mine.	-	2	-	2	10	4.43	1.05

In the table, 1 indicated absolute disagreement and 5 absolute agreement. Hence, the distribution and mean values show that the majority of the participants were quite satisfied with the teacher course. Additionally, oral feedback was gathered and used to further optimize the teacher course for future implementations.

Discussion:

We can see that the participants increased their knowledge particularly in the area of understanding functional thinking. Slight and rather qualitative changes could also be observed with regard to relevant topics and age groups related to developing functional thinking. A deeper scientific analysis of the participants answers will follow and will be available on the project platform.

The provided feedback indicates that the course was interesting for most participants in relation to teaching mathematics and their future work as a teacher. As the course aimed mostly at future secondary education teachers but also future primary education teachers participated, it is not surprising that not all participants will use the provided materials in their future teaching (question 7, feedback questionnaire).

For the future implementation of the course, we will further improve it in order to enhance the outcomes and to support the participants' future students in developing functional thinking.