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SCHOOL MATHEMATICS EDUCATION IN THE USA AS AN EXAMPLE OF MODELING THE DEVELOPMENTAL ENVIRONMENT

У роботі розглянуто низку аспектів, що стосуються введення загальних стандартів математичної освіти в США, а також з точки зору епістем проаналізовано зміст цих стандартів, виявлено ключові галузі вивчення.

Ключові слова: *шкільна освіта, стандарти освіти в США, математика, епістема, епістемодидактичні подання.*

В работе рассмотрен ряд аспектов, касающихся введения общих стандартов математического образования в США, а также с точки зрения эпистем проанализировано содержание этих стандартов, выявлены ключевые области изучения.

Ключевые слова: *школьное образование, стандарты образования в США, математика, эпистема, эпистемодидактические представления.*

At the present time the emphasis in the USA education system is shifted to STEM (science, technology, engineering and mathematics) studies. Nowdays it is emphasized that «students need math and science to understand and master subjects such as history, geography, music, and art» [5, p. 7].

By the joint efforts of teachers and specialists in the field of mathematics there have been formulated and arranged a special document – Common Core State Standards (CCSS) for Mathematics [1], according to which 44 states made a decision to teach school students starting 2015. These Standards represent a synthesis of the best modern international experience in the field of mathematics and aim to ensure that American students would become recognized leaders in the world in terms of mathematical knowledge proficiency.

CCSS for mathematics are based on the principle of being «focused» [1, p. 3] on a small number of mathematical concepts. The previous approach to teaching mathematics has been criticized and has got a well-known characteristic – «a mile wide and an inch deep» [4].

«The methodology for developing the... standards that are focused on learning progressions proceeded along the following steps: 1) the across-grade organization of topics focuses on the development of mathematical content within a topic...; 2) identify the core mathematics topics for each strand...; 3) for each core topic, identify the learning progressions across grades for that topic from each standard...; 4) create the... standards for each topic that most clearly indicate the learning progression for each topic over the grades» [3].

H. Wu, one of the authors of CCSS for Mathematics, a professor emeritus of mathematics at the University of California, Berkeley, notes that one of the most important features of mathematics is that «preparing to teach proper school mathematics is... about learning a discipline that is cognitively complex and very hierarchical. Each topic, no matter how basic, is essential to some future topic» [6, p. 12].

The Standards have got a unified structure. Specific item of studies is considered a «standard» (e.g., «Count to 100 by ones and by tens» [1], etc.). The standards are combined into «clusters», and it is noted that «standards from different clusters may sometimes be closely related, because mathematics is a connected subject» [1]. In turn, the clusters are combined to form larger groups – the «domains», where also «standards from different domains may sometimes be closely related» [1]. For each year of studies starting the kindergarten up to grade 8 there are presented «areas» of studies. For the respective areas the field of study is defined. Thus, the hierarchical structure of CCSS for school mathematics education is formed as follows: area – domain – cluster – standard. The Standards for high school are organized by the mathematics conceptual categories (not by grades but): number and quantity, algebra, functions, geometry, statistics and probability, and also modeling. Here there are two approaches to mathematics studies: the first one is a traditional approach of sequential courses of study «Algebra 1», «Geometry», «Algebra 2»; the second approach is an integrated approach which involves the study of the sequence of courses «Mathematics 1», «Mathematics 2», «Mathematics 3». Introduction of integrated approach comes from experience of countries that demonstrate the highest levels in international contests in mathematics (in particular, TIMMS) [2].

Each episteme as a knowledge element may have a different substantive content which is determined by experts' assessments and that allows to consider the epistemes of various levels. In Table 1 there are given the epistemedidactic representations of mathematics standards partitions by the school grades, domains and clusters of the studies' materials. In parentheses there are presented the number of epistemes which refer to additional topics for those students who intend to study advanced mathematics within the other math courses.

Partitions and epistemedidactic representations of math standards by the grades of studies allow to visualize the approximate equivalence partitions in the relevant areas, domains, clusters and standards at every level of studies.

Currently, the gradation of students can be represented by the hierarchy where the basis is represented by a large number of students defined as «not fully prepared for college and career», followed by a relatively small number of STEM-oriented students and ready for college and career and on top there is an insignificant number of STEM-gifted students. The changes will lead to transition to a situation where the hierarchy will include only the top two levels – a significant number of STEM-oriented students and a relatively large number of STEM-gifted students [5]. Note that in 2015 there should also be held two important international contests – PISA and TIMMS where the Americans suggest to see the first results of the new education system implementation.

The conducted epistemedidactic analysis of the USA Common Core State Standards for mathematics school education demonstrates that when constructing the modern system of mathematics education explicitly or implicitly the mathematical approaches to creating educational programs and educational material are used: inclusions, intersections, combinations, additions, relationships, functional dependencies between episteme, partitioning, hierarchical coherences, consistency, comparisons of epistemes. In particular, selecting a small number of mathematical areas especially in kindergarten through grade 8 not only allows a deeper material study, but also to form individual learning paths revealing the students' talents and gifts. Quantitative characteristics of the Standards allow to assess the accessibility for understanding the material, thereby to estimate in advance the degree of its complexity and student load, to identify key topics of study.

Table 1

Epistemes' partitions by the school grades

Grade of studies / Conceptual category		Quantity of episteme (areas)	Quantity of episteme (domains)	Quantity of episteme (clusters)	Quantity of episteme (standards)
Grade K (kindergarten)		2	5	9	22
Grade 1		4	4	11	21
Grade 2		4	4	10	26
Grade 3		4	5	11	25
Grade 4		3	5	12	28
Grade 5		3	5	11	26
Grade 6		4	5	10	29
Grade 7		4	5	9	24
Grade 8		3	5	10	28
Grades 9–12	Number and Quantity		4	9	8 (27)
	Algebra		4	11	23 (27)
	Functions		4	10	22 (27)
	Geometry		6	15	37 (43)
	Statistics and Probability		4	9	22 (31)
Total:		31	65	147	341 (384)

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