

A Mismatch between Curriculum Intentions and Textbook Design

An Assessment of Mathematics Textbooks for Lower Secondary School in Kosovo

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Abstract. This paper discusses the functionality of mathematics textbooks for lower secondary school in Kosovo, as representations of the curriculum. A summary is given of the main orientations and aims of the current Kosovo curriculum for mathematics in lower secondary school. This is followed by an assessment of the level of implementation of the main curriculum objectives within textbook design and an analysis of the nature of the key elements of textbook content that enable curricular objectives to be met. These elements include the use of motivational factors, real and interdisciplinary application of mathematical concepts and content in the expository parts of the text, worked – out examples, the use of real and interdisciplinary contexts in the tasks for students to work through individually, problems and problem-solving procedures and strategies, as well as the inclusion of a range of individual and group learning activities. The results of the analysis indicate a huge mismatch between the main curriculum objectives and textbook design. The conclusion is that Kosovan students in lower secondary school are not given adequate opportunities for developing critical mathematical skills and abilities in accordance with the orientations of the national curriculum.

Key words: *Mathematics curriculum, Mathematics textbooks, Lower secondary school, Problem-solving*

I. INTRODUCTION

School textbooks are the primary and most important tools for teaching and learning, not only in Kosovo, but also in most other countries. They have a manifold role in modern educational systems. One of the textbook functions - and maybe the most important one – is an accurate and full representation of the respective curriculum for teachers and students. Textbooks are, in fact, official curriculum materials developed to guide and support teaching and learning. One of the basic principles for developing an efficient and functional textbook is therefore aligning it with the curriculum requirements.

“To align textbooks with the curriculum in terms of the coverage of content ... is important and relatively easy. What is more challenging is for textbooks to reflect other aspects that the curriculum intends to achieve...” [1].

In particular, textbooks should be aligned with main curriculum intentions and goals. The relationship between curricular aims and textbook design is supposed to be more

coherent in countries where the education system is more centralized and the publishing of school textbooks is completely controlled by the government, as is the case in Kosovo. The main question that this paper intends to answer is whether Kosovan mathematics textbooks for lower secondary school fulfill their role as curriculum materials, in terms of reflecting the main curricular aims for mathematics education. In particular, do these textbooks represent suitable tools for achieving the core aims of mathematics education at lower secondary school? In order to provide the answer to this question, a content analysis of a textbook series is performed.

II. ON THE KOSOVO MATHEMATICS CURRICULUM FOR LOWER SECONDARY SCHOOL

The current national curriculum for primary and lower secondary school in Kosovo was issued in the 2003/2004 school year, and all public institutions for primary and secondary education were expected to follow it.

The old compulsory education system, valid in Kosovo until the end of August 2003, was organized over eight years of primary schooling, with the first four classes - a lower cycle of primary school - managed by a single teacher, holding the professional title of teacher for the lower cycle. The subsequent four classes - the upper cycle of primary school - were managed through subject teaching. Without wanting to go into a detailed analysis of the former system for the teaching and learning of mathematics, it can be said that its main characteristics were traditional, with teacher-centered teaching, an abstract approach to mathematical concepts, rote learning, and a focus on the development of students' skills for numerical calculations, algorithms and procedures.

The new curriculum brought important changes to the whole education system. Compulsory schooling was extended to nine years, including five years of primary school and four years of lower secondary school. The new curriculum brought important changes in mathematics teaching and learning too, impacting on a new approach to teaching mathematical knowledge, exploring mathematical ideas, seeking connections within and beyond mathematics, as well as changing the range of expected learning outcomes.

In particular, the current mathematics curriculum for lower secondary school consists of the schemes of work for mathematics in grades 6-9, which describe (for each grade):

- The general goals to aim for in mathematics teaching and learning;
- Expectations;
- Content structure and organization;
- Didactic guidelines;
- Assessment standards;
- Recommended literature and textbooks [2], [3], [4], [5].

These course plans are documents focused on aims, in a brief format and very general terms. Three of them contain 11 pages each, while the fourth is 12 pages long. They do not contain detailed descriptions, guidelines and procedures for achieving the intended standards, goals and objectives. A detailed framework is provided only for the purpose of presenting the content structure and organization.

Besides the acquiring of basic mathematical concepts, relationships, facts, models and formulae as well as developing students' skills in numerical calculations, algorithms and procedures, the main curriculum aims consist of building students' higher order skills and abilities needed for solving the problems and situations they will face as future citizens and professionals. Specifically, the core curriculum goals are developing students':

- Positive attitude towards mathematics and its importance in real life as well as professional life,
- Skills for problem-solving,
- Habits of mind for independent and team work,
- Abilities for real and interdisciplinary applications of mathematical concepts and content,
- Abilities for accurate and effective mathematics communication [2], [3], [4], [5].

In order to fulfill their role as curriculum materials, it is of prime importance that the textbooks put an emphasis on relevant material and features that reflect these curricular aims.

III. ANALYTICAL FRAMEWORK AND MATERIALS

There is only one series of textbooks that is currently in use for mathematics teaching and learning in lower secondary school in Kosovo. The series consists of four textbooks: Matematika 6, Matematika 7, Matematika 8 and Matematika 9 (Dukagjini Publishing House, Peja). The textbooks are authorized for publication by the Ministry of Education, Science and Technology of Kosovo (MASHT). These textbooks represent the basic compulsory literature for mathematics teaching and learning in grades 6 – 9, and there are no alternative textbooks offered by MASHT. Textbooks are distributed free to students for a year and students have

access to their mathematics textbooks at school as well as at home. The above-mentioned textbooks are examined in terms of the presence, nature and quality of the following textbook features:

A. Motivational factors

The every-day contact and relationship that students have with their mathematics textbooks makes those textbooks a convenient tool that can be utilized for fostering students' motivation and positive attitudes towards mathematics. The appropriate use of motivational factors can increase the textbook's potential for nurturing a student's intrinsic motivation for mathematics learning. For the purpose of current analysis, the Rivers Matrix method is used in identifying such motivational factors. According to this method [6], motivational factors include the use of historical notes, biographical notes, career information, photographs, humor and real-life application, in the design of mathematics textbooks. The role of these features is in providing a motivating learning environment by showing the great utility of mathematics in real life and the professional world, which in turn can help in developing positive feelings and attitude towards mathematics.

B. The real and interdisciplinary application of mathematics concepts and content

Making meaningful connections with students' experiences and interests [7], fostering, at the same time, the development of students' abilities for modeling and application. Currently, the number of instances of application is noted in all the expository parts of the textbooks, as well as note of the presence of real and interdisciplinary contexts in the worked examples and exercises. With respect to their contextual features, textbooks' problems are divided into two categories. The non-contextual problems include all those with reference to pure mathematics, while contextual problems include all those with reference to real life or the artificial reality constructed by the textbook authors.

C. Learning and teaching activities

Well-designed, contemporary mathematics textbooks are expected to contain a range of teaching/learning, student-centered individual and group activities. These activities have a range of functions, such as supplying teachers with ideas for in-class activities and building positive relationships between students and their textbooks. However, their highest contribution is in facilitating students' independent and team work, at the same time as contributing to the development of students' abilities in accurate and effective mathematics communication. Currently, the number of teaching and learning activities used and proposed throughout the textbooks is noted.

D. Problem-solving

The center of the mathematics curriculum in many countries, developing students' abilities in problem-solving is one of the main aims of the Kosovo mathematics curriculum for lower secondary school. Given the fact that textbooks are one of the potential factors for shaping

learning outcomes, the examination of how mathematics textbooks represent problem-solving and problem-solving strategies is of particular interest.

For the purpose of the current analysis, a common categorization of problem types, as well as categorization of problem-solving procedures is used. Firstly, all the examples and exercises presented in the textbooks were counted as problems, according to the definition that a problem is any situation that needs a solution, no matter whether the solution is readily available or not to the solvers [8]. Problems are divided into three categories in terms of their cognitive requirements: problems that can be solved in a straightforward way, only by applying a standard algorithm, formula or procedure available to the student, are characterized as routine problems; problems that require creative thinking and cannot be solved with the simple application of routine procedures or algorithms are characterized as non-routine problems. Grey-area problems include tasks that can be solved only by applying a known algorithm, formula or procedure, but where students have to discover which algorithm or operation to use [9].

Routine problems have a minimal role in providing learning opportunities for developing students' problem-solving skills, while a more significant part is played in this by non-routine problems. Solving of non-routine problems requires using problem-solving strategies and heuristics. Both general problem-solving strategies and heuristics are described in detail in the literature, e.g. [10]. We examine whether the solutions for the worked – out examples presented in the textbooks display all the stages of Polya's general strategy (as the most commonly-used representation of problem-solving strategies [10]): understanding the problem, devising a plan, carrying out the plan and reviewing. The presence of specific heuristics for the third stage of Polya's general strategy is also observed. This framework provides an insight into the presentation and distribution of different problem types and problem-solving procedures, which in turn, defines the degree of textbooks' efficiency in providing the opportunities for developing students' problem-solving skills.

IV. RESULTS AND DISCUSSION

A. Motivational factors

The data obtained from the textbook analysis regarding the presence of motivational factors is presented in Table 1.

TABLE I. THE PRESENCE OF MOTIVATIONAL FACTORS IN THE TEXTBOOKS ANALYSED

	Matematika 6	Matematika 7	Matematika 8	Matematika 9
Historical notes	1	3	1	1
Biographical notes	0	0	1	4
Career information	0	0	0	0
Photographs	0	0	0	0
Humour	0	0	0	0

The collected data indicates a lack of most of the textbook features that have a motivating function. There is no kind of career information or use of proverbs, riddles, or jokes. There is also no use of realistic photos. Across all of the textbooks, references to historical mathematical discoveries and application, as well as information on scientist biographies, are almost non-existent. In general, the use of motivational factors is very rare and isolated, with no functional weight.

B. Real and interdisciplinary application and contexts

Tables 2 and 3 reflect the contextual characteristics of the examined textbooks. Table 2 reflects the quantity of real and interdisciplinary applications in the expository sections, while Table 3 shows the percentage of contextual and non-contextual problems presented across the textbook series. Despite the fact that the Kosovo curriculum emphasizes the establishment of connections between mathematics and the real world, as well as between mathematics and other school subjects, the contextual characteristics of this series of textbooks are very poor. The applications presented in the expository parts are very low in number in comparison to the textbooks' volume: Matematika 6 contains 244 pages and 88 topics; Matematika 7 contains 183 pages and 61 topics; Matematika 8 contains 157 pages and 40 topics; Matematika 9 contains 199 pages and 49 topics. Also, the context embedded problems are in a very low percentage. The majority of the problems are located in the abstract world of mathematics, not allowing much space for one of the important purposes of mathematics teaching and learning, which is the application of mathematical concepts and content

TABLE II. THE PRESENCE OF REAL AND INTERDISCIPLINARY APPLICATIONS IN THE EXPOSITORY PARTS OF ANALYSED TEXTBOOKS

	Matematika 6	Matematika 7	Matematika 8	Matematika 9
Real-life applications	10	13	18	0
Interdisciplinary applications	2	15	3	9

TABLE III. THE PERCENTAGE OF CONTEXTUAL AND NON-CONTEXTUAL PROBLEMS (WORKED EXAMPLES AND EXERCISES) PRESENTED IN THE TEXTBOOKS ANALYSED

	Matematika 6	Matematika 7	Matematika 8	Matematika 9
Pure mathematics Examples	85.62%	76.09%	93.79%	67.92%
Contextualised Examples	14.38%	23.91%	6.21%	32.08%
Pure mathematics Exercises	90.62%	78.91%	90.05%	85.60%
Contextualised Exercises	9.38%	21.09%	4.45%	14.40%

C. Learning and teaching activities

All the examined textbooks have a traditional content structure [11]. That is, all the units presented comprise three

main parts: the textual section containing the necessary explanations on the topic, the worked examples that follow (or sometimes are placed before) the textual sections and the unsolved exercises intended for individual student work. The textbooks merely present mathematics knowledge, and their structure is not much enriched with pedagogical tools that facilitate effective engagement in mathematics teaching and learning.

In particular, learning and teaching activities are very rare throughout all the examined textbooks. Matematika 6 contains only five such activities, three of which are activities for pairs, one a group activity and one of an individual nature. Matematika 7 contains 14 different student-centered activities; Matematika 8 contains just five learning activities - for individuals, while Matematika 9 is the worst exemplar in the series, in which not even a single activity could be seen being proposed.

D. Problem-solving

As said before, there are two kinds of problems in the examined textbooks. The first are worked examples located in the main textual sections, and the second are problems intended for students' practice, located at the end of each topic. The worked-out examples serve for investigating the presented problem-solving strategies and heuristics, while unsolved exercises serve for investigating the presented problem types.

Table 4 shows the distribution of the types of exercises and it is obvious that there is a huge imbalance between the three types. The majority of the exercises are routine problems, whose sole contribution is to memorizing procedures and algorithms.

Table 5 shows the number of stages displayed in the solutions of the worked examples. As we can see from Table 5, none of the examples is solved using all four stages of Polya's strategy and only one example (presented in Matematika 6) is solved using three stages. The majority of the examples are solved using just one stage, the third one. As for specific heuristics, only five of them could be found.

TABLE IV. THE DISTRIBUTION OF THE TYPES OF PROBLEMS (UNSOLVED EXERCISES) PRESENTED IN THE TEXTBOOKS ANALYSED

	Matematika 6	Matematika 7	Matematika 8	Matematika 9
Routine problems	77.78%	64.10%	84.96%	70.77%
Grey-area problems	8.94%	17.22%	0.83%	10.77%
Non-routine problems	13.28%	18.68%	14.21%	18.46%

They are "act it out", "work backwards", "use an equation", "make a table" and "use a model". The first two heuristics are used only once each, and the remaining three have a very low frequency of use. The majority of the

examples are solved simply using the reproduction of learned formulas, procedures and algorithms. Moreover, nowhere in the whole series of textbooks could even a single explicit presentation or explanation of any of the procedures for problem-solving or heuristics be found. All the above results indicate that Kosovan lower secondary school students are not even properly introduced to these procedures and heuristics.

TABLE V. THE PERCENTAGE OF WORKED EXAMPLES BY THE NUMBERS OF STAGES DISPLAYED IN THEIR SOLUTIONS

	Matematika 6	Matematika 7	Matematika 8	Matematika 9
One-stage solutions	81.44%	82.78%	74%	74.57%
Two-stage solutions	18.14%	27.22%	26%	25.43%
Three-stage solutions	0.42%	0%	0%	0%
Four-stage solutions	0%	0%	0%	0%

V. CONCLUSIONS

From a comparison of the curriculum documents and the textbooks, the existence of significant differences between the intended learning opportunities for Kosovan students and those actually offered, is very clear and obvious. These differences are manifested as follows:

- Textbooks have low potential for providing a motivating learning environment, even though student motivation is an essential element for quality education [12] and helps foster positive student attitude towards mathematics.
- Textbooks have a low incidence of pedagogical tools used. This is particularly true for learning and teaching activities that help students engage efficiently in independent and team work.
- Textbooks have low potential for providing connections between mathematical content and real and interdisciplinary contexts. Students who learn mathematics with these textbooks therefore find themselves in an abstract mathematics world with almost no opportunity for developing the abilities for application and modeling.
- Textbooks have low potential for developing students' problem-solving abilities. This comes as a result of the high amount of routine and non-contextual problems that the textbooks contain. Furthermore, Kosovan students are not at all familiarized with problem-solving procedures and heuristics. The procedures presented and used for problem-solving are, in general, routine.

Knowing that MASHT gives priority to the textbooks which we examined as the main source for mathematics teaching and learning in secondary school, we can conclude that in terms of the learning opportunities offered by their curriculum materials, Kosovan students are isolated from contemporary perspectives on and approaches to mathematics teaching and learning.

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