



Citation:

Stoykova, V. (2023). Digital approaches to studying mathematical terms in Bulgarian school books from the beginning of the 19th century. *Slavia Meridionalis*, 23, Article 3108. <https://doi.org/10.11649/sm.3108>

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Digital Approaches to Studying Mathematical Terms in Bulgarian School Books from the Beginning of the 19th Century

Introduction

Information Technologies offer new approaches to studying texts from various periods of time, independently of where they were produced. Digital Humanities uses different standards for presenting and encoding Old Printed Books into a computer-readable format that allows various approaches, such as indexing or structuring, to searching and investigating their semantic content and using it as an electronic database.

These approaches allow us to interpret texts written with different spelling and analyze and compare the content using digital versions in computer-readable format. This type of electronic representation offers the use of linked data and electronic search via several platforms, thus allowing researchers to work online.

This work was supported by the Bulgarian Academy of Sciences.

Competing interests: no competing interests have been declared.

Publisher: Institute of Slavic Studies, Polish Academy of Sciences.

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The electronic format also allows the preservation and curation of these historical objects, which can then be related to new interpretations with respect to new cultural contexts.

Metadata standards and encoding

The library and archival tradition includes the extensive use of structured information for library and subject catalogs where specific areas and related signatures are organized in such a way to present a knowledge base with the appropriate structure. Recent library automation, including the use of electronic cataloging and subject classifications, allows the relevant information to be presented as an electronic database (knowledge base), which uses the encoding and related annotations by establishing specific technical standards for them.

For example, The Library of Congress catalog has established standards for electronic representation of bibliographic information (Furrie, 2009). The format for Bibliographic Machine-Readable Cataloging (MARC) includes a format for bibliographic electronic data representation containing types of information fields that present specific numbers and code fields (Title, Physical Description, Linking Entry Fields, etc.) about the described text source as its semantic annotation; it also allows electronic semantic search according to the criteria of the code fields.

Another standard for electronic bibliographic representation has been established by the EUROPEANA initiative. It uses an approach to presenting electronic resource data encoding using the EUROPEANA Data Model (EDM), which is a way of structuring electronic resources using a specific metadata format that includes standards for Linking Open Data (LOD). The EDM allows EUROPEANA's electronic resources to be explored, thus enabling a connection between related digital sources (texts, images, videos, etc.).

Following Bulgarian library standards

The National Academic Library and Information System (NALIS) includes electronic data support and management of print collections, as well as long-term maintenance of digital collections. Its approach to electronic data storage, management and cataloging (Dikova et al., 2011) is compatible with the Library of Congress cataloging standards, the EDM, and LOD.

NALIS allows online access and integrated search for printed and digitized electronic resources of Bulgarian academic libraries through a web portal. It also provides specific services for online searching of the related library catalogs and various electronic resources through the use of different platforms. It employs a complex e-library infrastructure for the implementation of a united national e-catalog of the content of Bulgarian libraries' collections, thus creating a common national platform for digital cultural heritage preservation. The platform implements a combination of several types of open-source software that facilitate e-content management and search procedures.

Thus, it uses the Koha open-source library and information system (Koha Release Team, 2023) for digital information management. Koha is free web-based software that allows acquisition, cataloging, multi-format messaging information exchange, and management. It also employs searching (according to MARC metadata standard encoding) within both NALIS and Google data, and it links text-to-image information when it generates search results. In this way, Koha allows communication and data exchange with other library standards offering a web-based multilingual interface. Within the NALIS platform, Koha is integrated with DSpace (Lyris, 2023) and VuFind (VU Falvey Library, 2023).

DSpace is open-source digital document management software that uses controlled access (impossible to copy e-content) and long-term support (digital archiving). It allows controlled access and combined use of text, audio, image, and video file management with both the DSpace system and other systems' digital repositories.

VuFind is library software for searching and finding information resources. It is developed by the Villanova University Falvey Library and is oriented especially for academic library use. Thus, it is used for integrated search in order to find specific providers' information within catalogs, records, bibliographies, digital repositories, and other digital objects. It also offers a multilingual interface.

Recently, the NALIS foundation published its standards for Digitized 19th Century Books Online annotations, which offer unified standards for encoding collections of digitized Bulgarian books printed in the 19th century that are held by different libraries.

Another standard for digital preservation of cultural heritage objects that is used by the Bulgarian library community is I-Lib (Prima-soft, 2023), which allows electronic cataloging (eLib), visualizing, as well as several types of search, including for context, synonyms, dictionary, and index. This digital standard for electronic presentation was created for use by major Bulgarian regional libraries within the framework of several projects for libraries' digitization.

We will present an analysis of three digitized school mathematics books published in the Bulgarian language in the first half of the 19th century from the Bulgarian library digital collections. We shall study the mathematical terminology presented in the books for the related basic mathematical concepts introduced.

Mathematical terms representation

First school mathematics books in the Balkans

At the beginning of the 19th century, the Balkan nations started the process of their national Revivals. This process started as a pursuit of national independence and education in the native language.

Thus, in 1803 in Wien, a school mathematics book in Greek authored by Darvaros (Δάρβαρος, 1803) was published. The first school mathematics book in Serbian, authored by Dosenovic, was published in 1809 in Budim (Дошенович, 1809). Later, in 1835, the first school mathematics books in the Bulgarian language appeared in Belgrade and Kragujevac.

The study of the cultural contexts of influences in the formation of mathematical terms for the same concept in different languages is a new area of ethno-mathematics, whose basis is introduced in D'Ambrosio (1990, 2006).

Bibliographic sources

The book *Българска възрожденска книжнина: Аналитичен репертоар на българските книги и периодични издания 1806–1878* [Bulgarian Literature of the Period of National Revival: Repetitorium of Books and Periodicals 1806–1878] includes the description and indexing of bibliographic information, classified into several types (Стоянов, 1957). This reference source presents specific bibliographic information on the included sources using the traditional library approach to subject field descriptions.

Six school books in natural sciences were published in the Bulgarian language during the first half of the 19th century, and all of them were published abroad. Three of these were published in Belgrade, Serbia and have already been analyzed (Stoykova, 2017). The other three have still not been analyzed. The list includes (i) the book of N. Bozveli and E. Vaskidovich (Бозвели Хилендарец & Васки-

дович, 1835), (ii) the book of S. Radulov (Радулов, 1843), and (iii) the book of Hr. Sichan Nikolov (Сичан Николов, 1845).

For further analysis, we will use the digital resources of these books, which are available from the digital collection “Old Printed Books” of the St. Cyril and Methodius National Library; however, some digital copies can be found in the collections of other Bulgarian libraries, as shown below.

The mathematical terms used by N. Bozveli and E. Vaskidovich

The school book *Аритметическое руководство за наставление на българските юноши* [Guide to Arithmetic for Bulgarian Adolescents] (Бозвели Хилендарец & Васкидович, 1835) is part of the first Bulgarian extensive educational program, which included studying several school subjects and was supported by related school books. The school books were published in 1835 in Kragujevac, Serbia and were used in schools of various Bulgarian towns at that time.

The book (Fig. 1) contains 3 Parts and a List of Subscribers; it covers whole numbers and operations with them, fractional numbers and operations with them, compound units, proportions, and operations with them. It starts with a definition of arithmetic as *science about calculating*, and its related Bulgarian terms “числителна наука” or “числителное художество” (*art of calculation*) are introduced. Thus, from its very beginning, mathematics was defined as both a science and an art.

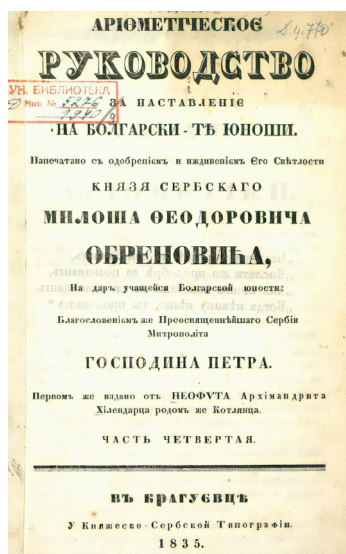


Fig. 1. The book *Аритметическое руководство за наставление на българските юноши* 1835. [Public domain], via DSpace (<http://unilib-dspace.nasledstvo.bg/xmlui/handle/nls/36085>).

Then, the definitions of the concepts of *number* (“число”) and *unit* (“единица”) are outlined in order to explain how calculation works (“счисление”). It is interesting to note that the words for these Bulgarian terms have common morphological roots.

The next chapter introduces the difference between numbers and digits and gives the names of the digits and their pronunciation in the Bulgarian language. Also, the Bulgarian term for *zero* is introduced as “ничтожный знак”. The techniques for counting and performing different operations with numbers are introduced by explaining that counting is done from left to right, whereas the calculation is from right to left.

Chapter 3 starts with a definition of *addition* and its related terms like *addend*, *summand*, and *sum*, for which the Bulgarian terms are “приложение”, “собираеми”, “собрание” and “сума”. Then, the technique for addition is demonstrated by the given examples and exercises.

Chapter 4 introduces the definition of subtraction and related terms *subtrahend*, *minuend*, and *difference*, for which the Bulgarian counterparts are “изятие”, “отложение”, “уменьяемо”, “изятелно”, “разност” and “останок”.

Chapter 5 presents a definition of *multiplication* and the related terms *multiplicand*, *multiplier*, and *product*, for which the Bulgarian terms are “(у)множимо”, “множител”, “произведенное”. The *multiplication table* (*Table of Pythagoras*) is given, the Bulgarian term for which is “Питагорическа таблица”.

Chapter 6 starts with a definition of *division* and its related terms *dividend*, *divisor*, and *quotient*, for which the Bulgarian terms are “деление”, “делимо”, “делител” and “количество”.

Part 2 includes a description of the basic arithmetic operations of addition, subtraction, multiplication, and division with fractional numbers. The Bulgarian terms related to *fractional numbers* (*fractions*), *numerator*, and *denominator* are “раздробленни числа”, “числител”, and “знаменател”. Part 2 also includes types of *compound units*, for which the Bulgarian term is “инородни (разнородни) числа”, as well as conversion and other operations on them.

Part 3 deals with *arithmetic expression* (“дума”), and particularly *equations*, for which the Bulgarian term “(о)равнения” is introduced. The book also includes study materials on proportions, as well as techniques for computing with them.

The mathematical terms used by S. Radulov

The book “Стихийная арифметика” [Elementary Arithmetic] was printed in 1843 in Smugna (Радулов, 1843). It is a translation of a mathematical school book

written in the Greek language by G. Geraki (Γεράκη, 1842). It contains a Preface, 2 Parts, a List with Mistakes, a Supplement, and a List of Subscribers (Fig. 2).



Fig. 2. The book *Стихийная арифметика* 1843. [Public domain], via NALIS (<http://digilib.nalis.bg/xmlui/handle/nls/913>).

The Preface is written by S. Radulov, who explains that studying mathematics is very useful for everyone. The book aims to give more than basic knowledge that can be acquired by studying not only elementary mathematics and basic arithmetic operations (whose names are given also in the Turkish language) with whole numbers but also fractional numbers, proportions, arithmetic and geometric progression, the power of a number, the root of a number, etc.

Part 1 starts with the Introduction, which presents the definition of mathematics as a science about magnitude and quantity and their measurement with related units assigned by numbers. Then, the definition of arithmetic is given, describing it as a science about the properties and similarities of numbers and how to use these to receive new numbers which measure hidden relations. It is defined as the basics of mathematical science.

Part 1, Chapter 1 is about whole numbers and their order and counting, which are defined as natural. Their names, pronunciation, related notation (Arabic numbers), and left-to-right reading are introduced as well. The basic *operations* (Bulgarian term is “действия”) with whole numbers are outlined. *Addition* (for which the Bulgarian term is “приложение”) is introduced with its definition

and related terms *addend*, *summand*, *sum* (for which the Bulgarian terms are “собираеми”, “сумма”). Also, the rules of addition and practical techniques to master arithmetic operations are presented by related examples.

Then, the definition of *subtraction* of whole numbers (“изятие”) and the subsequent terms *subtrahend*, *minuend*, and *difference* are given in the Bulgarian language (“умаляемо”, “умалител”, “остаток” or “разност”). The rules for calculating subtraction and related examples with practical tasks are presented. Also, techniques for *verification* (“опит”) of the results of addition and subtraction are demonstrated by supporting examples.

The definition of *multiplication* of whole numbers together with related Bulgarian terms for *multiplicand*, *multiplier*, and *product* (“умножение”, “множимо”, “множител” and “производители”, “произведение”) are presented, and the *multiplication table* (*Table of Pythagoras*) is given as “Питагорическа таблица”. The definition is supported by examples presenting the rules for calculating multiplication and the properties of multiplication (commutative). Related exercises for mastering this operation are offered.

Chapter 1 ends with the definition, notation, and related techniques to compute *division* (“деление”) of whole numbers. The Bulgarian terms used for *dividend*, *divisor*, *quotient*, and *remainder* are “делимо”, “делител”, “частно число”, and “остаток”. A technique for verification (“опит”) of the results of multiplication and division is also introduced. Also, a technique for calculating the *greatest common divisor* (“общ най-голям делител”) is presented and explained. All definitions are supported with related tasks and examples for computing.

Chapter 2 starts with the introduction of the notion of fractions (“дроби”). The definitions of fractions, their properties, and operations with them are presented with the appropriate notations and examples. The Bulgarian terms introduced for *numerator*, *denominator*, *proper fraction*, *improper fraction*, *mixed fraction*, and *common denominator* are: “числител”, “знаменател”, “правилна дроб”, “неправилна дроб”, “смешана дроб”, and “общ знаменател”.

Further, operations with fractions, such as addition, subtraction, multiplication, and division, are presented, explained, and supported with related resolved examples and tasks for students for mastering these operations. Also, operations with *decimal fractions* (“десетични дроби”) are introduced with related notations, explanations, and examples of appropriate techniques to use. Chapter 2 also introduces *compound units* (“смешенни числа”) and the related techniques for conversion from one to another, as well as the four arithmetic operations with them.

Chapter 3 introduces of the notion of the *power of a number* (“сила на число”) and its opposite concept the *root of a number* (“изведение корена”), as well as related calculation techniques with resolved examples and tasks for mastering these concepts. Also, suitable tables and formulas are given.

Part 2 of the book begins with Chapter 1, which contains demonstrations of approaches and techniques on how to apply the acquired mathematical knowledge to resolve several types of *tasks* (“задачи”). The typology includes a task for comparison of *mathematical expressions* (“слово”), i.e., resolving equations, calculating arithmetical and geometrical progression, etc.

Chapter 2 includes illustrations and demonstrations of other types of mathematical rules by presenting related resolved examples of them. The book ends with a Supplement with additional resolved examples of types of mathematical tasks and a List of Subscribers who ordered the book.

The mathematical terms used by Hr. Sichan Nikolov

The book *Българска аритметика* [Bulgarian Arithmetic] was printed in 1845 in Bucharest (Сичан Николов, 1845). It is an original work composed by Hr. Sichan Nikolov that aims to serve as a school arithmetic book in Bulgarian schools. The book (Fig. 3) consists of a Preface, 2 Parts, a Table of Arithmetic Numbers, and a List of Subscribers.



Fig. 3. The book *Българска аритметика* 1845. [Public domain], via I-Lib resource of the Regional Library “P. R. Slaveykov” of Veliko Tarnovo (<http://sever.libraryvt.com/bg/lister.php?iid=DO-8S0000426&page=5>).

The Preface is written by the author, who outlines his motivation to write an arithmetic school book in the Bulgarian language. It also contains a linguistic analysis with assumptions on the need for standard orthography when dealing with different Bulgarian dialects. Generally, the book follows the style of Radulov's book but uses a slightly different approach to the presentation of mathematical concepts (such as a question answering) and the terminology used.

Part 1 starts with an introduction to the notions of *units*, *numbers*, types of numbers (*whole* and *fractions*), etc., as well as the terms for *counting* and *calculating*, *arithmetic operations*, etc., respectively “единици”, “числа” (“цели” and “дробителни (ломителни)”, “дробения”), “броение”, “числение”, “числителни деяния”.

It also includes sections for introducing operations on whole numbers such as *addition* and *subtraction* with their Bulgarian terms, respectively “приложение” (and the related term “количество”), “изятие” (and related terms “умаляемо”, “умалител”, “различие” and “остаток”). These operations are both defined and demonstrated by various resolved examples.

Further, the *multiplication* and *division* of whole numbers are introduced, the Bulgarian terms for which are “множение” (and related terms “множимо”, “множител”, “произведение”), “деление” (and related terms “делимо”, “делител”, “количество”). The Bulgarian term used for the *multiplication table* (*Table of Pythagoras*) is “Питагорова табла”. All operations are explained by appropriate examples that are resolved and explained.

Later, the notion of *fractions* (“дробения”) is introduced with a related definition, and terms for *numerator* (“числител”), *denominator* (“именовател”) and *common denominator* (“еднаков именовател”) are outlined. Subsequent types of *proper fractions* and *improper fractions* (“правилни дробения” and “неправилни дробения”) are presented together with the related operations on fractions, supported by resolved examples with related tasks. Also, operations on *decimal fractions* (“десетни дробения”) and *compound units* (“смешенни числа”) are presented in the same way.

The next section deals with the *power and root of numbers* (“силите и корените на числата”) by presenting related techniques for calculating them and subsequent tables.

Part 2 of the book deals with the comparison of arithmetic expressions, outlining several cases that are explained in detail by introducing several rules and related examples for resolving them.

Finally, the Table of Arithmetic Numbers presents a comparative list of Bulgarian numbers, Latin numerals, Turkish numbers, and Arabic numerals (with

their Bulgarian names). At the end, a List of Subscribers outlines the families and towns of users who ordered the book, i.e., the distribution of the edition.

Conclusion

The presented analysis supports the conclusion that, at the beginning of 19th century, the Bulgarian mathematical terms used in the analyzed school books were in the process of formation as there are no common terms for the studied concepts.

Mostly terms in Bulgarian language were used. Additionally, the semantics of terms is expressed through the use of different parts of speech (nouns, adjectives, participles, etc.), which indicate their function. The mathematical terms used by the regarded authors mainly vary in their word formation but are produced by the same or similar words. However, terms originating from Latin and Greek like *sum* (“сума”), *arithmetic* (“аритметика”), etc. are also used.

In summary, the basic mathematical terms of the Bulgarian language appeared and were elaborated during the period of the National Revival and were subject to further development in order to standardize them.

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Cyfrowe podejścia do studiowania terminów matematycznych w bułgarskich podręcznikach szkolnych z początku XIX wieku

W artykule przedstawiono analizę treści zdigitalizowanych kopii trzech podręczników z matematyki, opublikowanych w języku bułgarskim w pierwszej połowie XIX wieku. Badanie stanowi pierwszy w swoim rodzaju przegląd podejść pedagogicznych stosowanych w nauczaniu matematyki z punktu widzenia tworzenia terminów matematycznych. Analiza zawiera porównawczy opis podręczników pod względem podejścia i treści, jak również związanych z nimi tematów i ćwiczeń. Na koniec przedstawiono wniosek dotyczący struktury i pochodzenia terminów używanych do nauczania pojęć matematycznych w języku bułgarskim w badanym okresie.

Słowa kluczowe: tworzenie terminów; terminy matematyczne; podręczniki do matematyki; humanistyka cyfrowa; stare drukowane książki; historia edukacji; język bułgarski

Digital approaches to studying mathematical terms in Bulgarian school books from the beginning of the 19th century

The paper presents an analysis and survey of the content of digitized copies of three school mathematics books published in the Bulgarian language during the first half of the 19th century. The study offers the first overview and outline of the pedagogical approaches used to teach mathematics through mathematical term formation in that period based on the text of school mathematics books. The analysis includes a comparative description of the approach and study content as well as related topics and exercises connected to them. Finally, a conclusion regarding the structure and origin of the terms used to teach mathematical concepts in the Bulgarian language at the time is outlined.

Keywords: mathematical terms; term formation; school books in mathematics; digital humanities; old printed books; history of education; Bulgarian language

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