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Analysis of Science Textbooks for the 3rd Year of Primary Schools

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Abstract:
Introduction: The research analyses four science primary school textbooks designed for the 3rd grade.
Methods: The textbooks were analysed using various methods and procedures. It was determined which of the examined textbooks is the most educationally effective, meaning it not only provides information from the respective field and focuses on knowledge acquisition but also develops skills and more complex abilities. A quantitative content analysis of tasks was carried out in terms of the level of cognitive processes.
Results: The findings reveal a significant diversity across these aspects, with all textbooks demonstrating a high level of educational value. However, only one textbook meets the comprehensibility requirements for young learners.
Discussion: Compared to past science textbooks, the educational effectiveness of current textbooks has significantly improved.
Limitations: The limitations of the research include potential errors due to human factors in counting, and also the difficulty in comparing the results of this research with those from studies of foreign textbooks.
Conclusions: The author recommends using these insights to develop new, higher-quality textbooks that reflect inquiry-based educational strategy.

Key words: comprehensibility of text, content analysis, primary school, science, textbook.

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Introduction

The subject of science in primary education aims to develop knowledge, skills, and attitudes that students will use in higher grades, particularly in physics, chemistry, and biology. The educational process should be based on inquiry-based activities, allowing students to discover information and learn through their own inquiry. The trend in science education is to develop scientific literacy, considering the holistic development of the student's personality. Students should not only gain scientific knowledge but also understand the nature of science, develop a relationship with scientific inquiry, and acquire scientific skills (Estapa & Tank, 2017; Mateos-Nunez et al., 2018; Tomkuliaková, 2014), particularly through inquiry-based activities (Kutlu et al., 2023; Rochovská et al., 2024). This should also be reflected in the textbooks[1] used, as they significantly influence the educational process and enable teachers to teach more effectively. According to J. Průcha (1997) and Yalçınkaya-Önder (2022), textbooks affect the teaching process in three ways: as a curricular project, as a source of educational content for students, and as a teaching tool for teachers.

Creating a textbook is a complex and demanding process with its own principles and specifics. It is impossible to create a textbook that satisfies all teachers and students, as each teacher has a unique teaching style and each student has a specific learning style, pace, preferred type of intelligence, method of knowledge acquisition, and interests. However, there are certain general characteristics that every textbook should meet: a certain level of educational suitability (Průcha, 1998), text comprehensibility for younger students (Průcha, 1998; Kopáčová, 2012), meaningful learning tasks (Gašparová & Čiliaková, 2024) designed to develop not only lower but also higher cognitive functions (Rochovská & Huľová, 2021; Droščák, 2015) and to support the development of students' scientific literacy (Mateos-Núñez et al., 2018; Yalçınkaya-Önder et al., 2022; Rochovská et al., 2024). A global perspective on research into science textbooks is also noteworthy. According to Vojíř and Rusek (2019), international research databases increasingly feature studies on this subject. Most research on science textbooks after 2000 has been conducted in Europe and the USA, focusing on the acquisition of concepts, non-textual components, visual representations, and text analysis. In Slovakia, J. Kopáčová (2012) has extensively researched science textbooks, addressing the topic within a historical and international context in

[1] E. Petlák (1997) defined a textbook as the primary teaching tool in the educational process, containing educationally processed material specified by the curriculum. According to Průcha (1997), it is a material teaching tool and an indispensable source of information. Droščák (2015) categorised textbooks as literary aids in his classification of material teaching tools. Currently, the concept of a textbook has evolved; according to Kratochvíl (2022), it is now considered the main medium of education.

her monograph "Development of textbooks of Science in Slovakia" (2012). She shared findings from her study and long-term research on both Slovak and foreign science textbooks. Slovak textbooks for the 3rd grade analysed include those by Nový et al. (1991a, 1991b), Stanko and Stanková (1997), Kubovičová et al. (2000a, 2000b), and Wiegerová et al. (2011). This research study aims to build on Kopáčová's work (2012) by analysing additional textbooks created in line with the State Educational Program for Primary Education - 1st stage of primary school (SEP, 2015). The ambition of this analysis is to provide textbook authors with insights for improving new science textbooks based on the current curriculum.

1 Theoretical background to textbook analysis

Devetak and Vogrinc (2013) state that the analysis of science textbooks should be conducted in three phases: analysis of the text, structure and illustrations. To determine how well a textbook fulfills its functions (presentation of content, management of learning and teaching, organisational function, etc.), we evaluate its educational effectiveness. This assessment is based on the extent to which verbal and visual components are utilised in the textbook. It is not a static quality but a measure of processual effectiveness, meaning its use in real educational processes and self-learning (Průcha, 1998).

The main component of a textbook is the text, which should be understandable and clear to the student. For younger students, it is crucial that the text is appropriately challenging. Therefore, authors should fully empathise with the students for whom the textbook is intended. It is also helpful to follow Mistrík's measure of the text comprehensibility (Průcha, 1998; Kopáčová, 2012).

An essential element of a textbook is the inclusion of learning tasks. According to (2009), learning tasks can be evaluated based on their number, difficulty, and variety. It is beneficial if these tasks reflect various levels of cognitive function taxonomies (as well as affective and psychomotor), especially the higher levels.

For a textbook to meet the criteria of an approved teaching tool for use in education, it must be designed to contribute to achieving the goals defined in the subject for which it is intended and to enable the attainment of all performance standards. It should also support interdisciplinary connections, enhance knowledge and skills, and offer learning activities that promote all levels of knowledge, skills, and abilities as outlined by performance standards. The tasks in the textbook should allow for the assessment of learning progress and the extent of knowledge acquisition. The textbook should encourage the application of active learning methods and the use of diverse teaching strategies. It must align with current pedagogical and teaching knowledge of the relevant subject and be appropriate for the age and developmental abilities of the students for whom it is intended (Criteria for Assessing Teaching Tools, 2020).

1.1 Research aims and research questions

The aim of the research was to analyse science textbooks for the 3rd year of primary school in Slovakia in terms of structure, text and illustrations. The aim was reflected in the research questions: 1. What is the educational effectiveness of the examined textbooks? 2. What levels of text comprehensibility do they achieve? 3. What is the nature of the learning tasks in the textbooks in terms of the taxonomy of cognitive functions?

2 Research methodology

2.1 Sample

The sample was created by all currently used and approved science textbook for the 3rd year pf primary school in Slovakia. They were four textbooks created in accordance with the currently valid state educational programme (2015):

1. Science for third graders. Working textbook for the 3rd year of primary school (Dobišová Adame & Kováčiková, 2018) - further P1;
2. Natural Science. Working textbook for 3rd year of primary school. In accordance with the updated curriculum (Nguyenová Anhová, Sakařová, & Klech, 2018) - further P2;
3. Natural Science for the 3rd year of primary school (Žoldošová, 2020) - further P3;
4. Natural Science for the 3rd year of primary school (Rochovská & Zvončeková, 2022) - further P4.

Working textbooks P1, P2, P3, and textbook P4 were included in the analysis, while the workbook for P4 (Rochovská & Zvončeková, 2022b) was not analysed as it does not contain separate exercises and the illustrations are a black and white version of the illustrations in the textbook. All of the mentioned teaching aids are designed to develop science literacy and enable the achievement of the performance standards (SEP, 2015) for the subject.

2.1.1 Natural Science for Third Graders. Working Textbook for the 3rd Year of Primary School (P1)

According to authors Dobišová Adame and Kováčiková (2018), the content is designed to harness students' curiosity and their natural need to explore the world. This approach allows students to actively engage in the educational process, discovering and understanding the world through inquiry-based activities. The textbook also focuses on developing reading comprehension skills.

The entire working textbook (Figure 1) is themed around sailors and seafaring, which is particularly captivating for younger students. Characters of sailor’s

guide students through the content, often with text in speech bubbles related to the lessons.

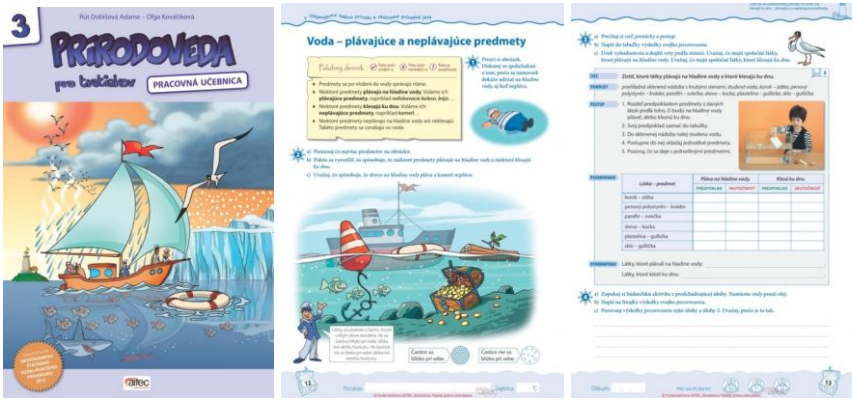


Figure 1. The working textbook P1 and sample double page from the working textbook (Dobišová Adame & Kováčiková, 2018).

The treatment of topics in terms of page count is not uniform. Some topics are covered over two pages, while others span one, three, or four pages. Each topic begins with a title, followed by a "Logbook," which contains several key points essential for the subsequent material. This indicates a deductive approach to knowledge acquisition. Each task in the textbook is generally accompanied by an illustration. The tasks are divided into basic and supplementary material.
Many tasks have an exploratory nature, typically following a similar structure: goal, materials, procedure (in numbered steps), observation, and evaluation (where students complete sentences). This approach supports confirmatory inquiry.

2.1.2 Natural Science. Working textbook for 3rd Year of Primary School. In accordance with the Updated Curriculum (P2)

The working textbook (Figure 2) by L. Nguyenová Anhová et al. (2018) presents content based on students' life experiences, which are then enriched and expanded with new information, allowing them to form a comprehensive understanding of each topic.
The presentation of content throughout the textbook heavily relies on visual aids and reading comprehension, as evidenced by the relatively large colour illustrations and accompanying texts. The extent of each topic varies, sometimes spanning two pages (e.g., States of Matter) and sometimes up to six pages (e.g.,

Air). However, the two-page spreads maintain a consistent structure, typically featuring five to six tasks per spread.

The first task on each spread is always a review, whether from previous years or previous topics. At the end of each spread is a "Remember!" section that summarises the presented information in a few sentences. Most topics also include inquiry-based tasks with a prescribed structure: goal, materials, step-by-step procedure, and a conclusion where students must select the correct statement from two options. This approach supports confirmatory inquiry and a deductive method of knowledge acquisition.

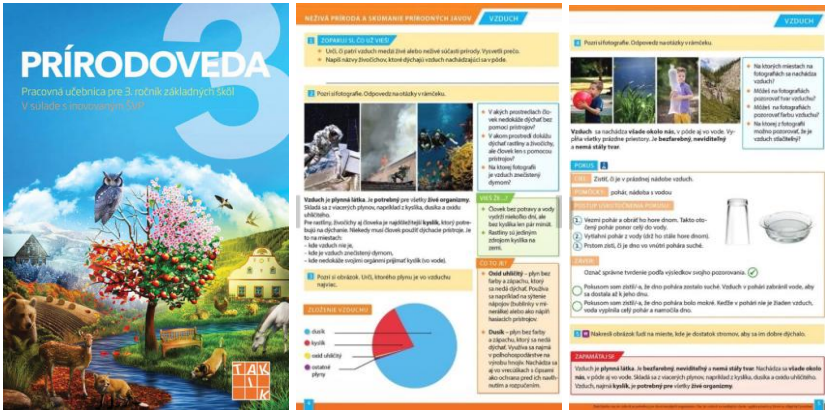


Figure 2. The working textbook P2 and sample double page from the working textbook (Nguyenová Anhová et al., 2018).

2.1.3 Natural Science for the 3rd Year of Primary School (P3)

The working textbook (Figure 3) by Žoldošová (2020) can be considered innovative compared to what Slovak primary school teachers are accustomed to. The author designed the textbook to develop all scientific competencies, particularly investigation and conclusion-making, utilising an inductive approach and higher levels of inquiry, including open inquiry.

A motivating feature is the creation of a student research workspace, where students design a name and logo at the beginning. The content is delivered experientially, allowing students to become part of a research team, receiving an email at the start of each thematic unit. This email presents a research challenge with several questions that guide students in their inquiry-based activities to find answers. There are six such emails in the textbook, one at the beginning of each topic.

Each unit is divided into three to six themes, aptly titled with questions such as "What does it mean when one object is bigger than another?" and "How to determine which object is heavier?" The length of each theme varies, with some spanning two pages and others up to six pages.
Every page of the textbook includes a primary section for students and a margin section for teachers or others guiding the students in their inquiry. There is ample space for writing and drawing. At the end of each theme, nearly an entire page is dedicated to note-taking. Using guiding questions, students formulate a response to the initial research challenge email.

Figure 3. The working textbook P3 and sample double page from the working textbook (Žoldošová, 2020).

2.1.4 Natural Science for the 3rd Year of Primary School (P4)
The textbook (Figure 4) by Rochovská and Zvončeková (2022a) is predominantly based on inquiry-based activities, encouraging students to discover as much information as possible through their own actions and exploration. It covers all levels of inquiry, from confirmatory to structured, guided, and open inquiry. The textbook employs a combination of inductive and deductive approaches to learning.
The topics are uniformly structured and presented across double-page spreads. At the beginning, three characters - third graders who enjoy exploring, investigating, and discovering - are introduced to the students. One of the characters has a grandfather who is a scientist, to whom they turn with curious questions. The concept of a scientist is also explained to the students.

Each lesson begins with a motivational picture featuring a conversation between the children, who discuss the situation depicted. After reading the motivational dialogue, students are asked to express their thoughts on the topic and solve a task by answering questions under the picture in the first exercise. This helps the teacher assess students' preconceptions about the topic.

The purpose of the motivational picture is to create cognitive conflict and activate the students' prior knowledge and experiences related to the topic. Based on the discussion, the teacher encourages the students to formulate a question for the scientist. The scientist character - the grandfather - is introduced at the beginning of the textbook along with the child characters. The section "Scientist's Advice" provides students with the essence of inquiry, problem-solving tasks, and a comparison of their observations and findings with the scientist's information.

The textbook is complemented by a workbook, which primarily serves as a space for recording the progress, results, and conclusions from tasks and inquiry-based activities outlined in the textbook. It also includes space for students' notes and sketches. The workbook is intended to become a student portfolio, where, in addition to solving tasks, students can record various interesting findings from their own inquiry, searches in information sources, or even incidental discoveries.

Figure 4. The textbook P4 and sample double page from the textbook (Rochovská & Zvončeková, 2022).

2.2 Instruments and procedures

The textbooks were analysed using various methods and procedures, similar to the analysis of work education textbooks for primary education (Rochovská & Huľová, 2021). Several methods were selected for the analysis of science textbooks. Firstly, it was determined which of the examined textbooks is the most educationally effective, meaning it not only provides information from the respective field and focuses on knowledge acquisition but also develops skills and more complex abilities. The effectiveness of a textbook also lies in the development of the student's personality. Regarding the cognitive aspect of personality, it is important that the textbook not only focuses on knowledge and understanding but also on developing the ability to analyse, evaluate, and create. Therefore, a quantitative content analysis of tasks was carried out in terms of the level of cognitive processes.

On the other hand, even if a textbook includes tasks aimed at developing higher cognitive processes, it is crucial that students understand the task instructions. Consequently, the extent to which the textbooks are understandable to students of the respective age category was also assessed.

2.2.1 Educational Effectiveness of the Textbooks

The educational effectiveness of the textbooks was assessed according to Průcha (1998). We examined the presence of 36 components (see Table 1). The coefficients were calculated using the following formula:

$$E = \frac{(\sum \text{achieved verbal components} + \sum \text{achieved image components})}{\sum \text{all possible components}} \times 100\ \%$$

2.2.2 Mistrik's Measure of the Text Comprehensibility

Furthermore, the text comprehensibility was determined by Mistrik's measure of text comprehensibility in the textbooks studied (according to Průcha, 1998). Three sections of text of at least 200 words to the end of the sentence were selected from each of the teaching resources studied.[2]

For each textbook, we analysed selected passages as follows:

P1: pages 12-13 - 203 words, pages 38-39 - 203 words, page 41 - 204 words, total 610 words.

P2: page 4 - 207 words, pages 14-15 - 203 words, page 74 - 202 words, total 612 words.

[2] In the case of the P3 working textbook, the research sample included texts from the primary part, intended for students. Texts from the peripheral part, addressed to adults (mainly teachers), were not studied, as it can be assumed that they are more difficult for students to understand.

P3: page 2 - 223 words, pages 16-17 - 208 words, pages 81-83 - 207 words, total 638 words.
P4: pages 8-9 - 200 words, pages 32-33 - 205 words, pages 52-53 - 206 words, total 611 words.
We calculated the following metrics:
V - Average sentence length in words (*V* = total number of words / number of sentences).
S - Average word length in syllables (*S* = total number of syllables / number of words).
We removed all repeated words from the text (without distinguishing between different forms of a word) to determine the number of distinct lexical units. We identified:
N - Number of lexical units = total number of words.
L - Number of unique lexical units = number of non-repeated words.
We computed the *Ii* - Index of word repetition, using the formula: $I_i=N/L$. We also calculated *R* - Mistrík's comprehensibility index, using the formula: $R=50-(V.S/I_i)$.

2.2.3 Analysis of learning tasks
The analysis of learning tasks was conducted based on Bloom's taxonomy of cognitive functions. In alignment with J. Maňák (1992, p.55), a learning task is defined as any requirement through which a student engages with a specified part of the curriculum, serving as an impetus for activity. This includes prompts that mobilise cognitive or practical effort to solve, perform, or create something, as opposed to merely presenting information, which typically focuses on memory. Therefore, in this analysis, explanatory texts were excluded, and only clear instructions for activities were included.

3 Results

3.1 Educational effectiveness of the textbook
The results of the research on the educational effectiveness of the textbooks are presented in Table 1 and Figure 1. The examined textbooks demonstrate above-average educational effectiveness. The highest scores were achieved by textbooks P4 and P3, although the differences compared to the other two textbooks are not significant. All textbooks show consistently high scores overall. This indicates that their use extends beyond merely enhancing scientific knowledge to developing more complex skills, such as text navigation, symbol comprehension, and the use of various information sources.
The coefficients of learning control apparatus are uniformly balanced. Notably, the coefficient for the use of image components reaches 100% across all

textbooks, which is immediately apparent upon initial inspection. The coefficient for the use of learning control apparatus and verbal components was slightly higher in textbook P4 compared to the other textbooks assessed. This textbook's advantage lies in its ability to develop students' skills in navigating the textbook, utilising supplementary information, understanding the structure of content, and distinguishing between key and supplementary sections.
Textbook P3 also exhibited a high coefficient for the use of verbal components. However, it had the lowest text comprehensibility score among the textbooks studied, indicating a potential area for improvement in ensuring clarity for students.

Table 1

Educational effectiveness of the researched science textbooks

		Science Textbooks			
	Educational Effectiveness of a Textbook	*P1*	*P2*	*P3*	*P4*
	I. Apparatus for the presentation of teaching				
	Verbal components				
1	Simple explanatory text	x	x	x	x
2	Explanatory text made clearer	x	x	x	x
3	Summary of learning for the whole year				
4	Summary of the topics	x		x	x
5	Summary of the previous year's syllabus				
6	Additional texts	x	x	x	x
7	Notes and explanations	x	x	x	x
8	Descriptions for the pictures	x	x	x	x
9	Glossary of terms	x	x	x	x
	Number of verbal components	7	6	7	7
	Image components				
1	Art illustration				
2	Educational illustration	x	x	x	x
3	Photographs	x	x	x	x
4	Maps, plans, and charts	x	x	x	x
5	Image presentation in colour	x	x	x	x
	Number of image components	4	4	4	4
	E I - Coefficient of use of the apparatus of presentation of the curriculum	78.57%	71.43%	78.57%	78.57%
	II. Learning control apparatus				
	Verbal components				
1	Preface, introduction	x		x	x
2	Instructions for working with the textbook	x	x	x	x

3	Total stimulation	x	x	x	x
4	Detailed stimulation	x	x	x	x
5	Distinguishing the level of learning	x	x	x	x
6	Questions and tasks after the chapters			x	x
7	Questions and tasks for the whole year				x
8	Questions and tasks for the previous year				
9	Instructions of a more complex nature			x	x
10	Extracurricular activity examples	x	x	x	x
11	Explicit statement of learning objectives for students	x	x	x	
12	Means or instructions for self-assessment	x			
13	Results of tasks and exercises				x
14	Links to other sources of information	x	x	x	x
	Number of verbal components	9	7	10	11
	Image components				
1	Graphic symbols indicating certain parts of the text	x	x	x	x
2	Using a different colour for certain parts of the verbal text	x	x	x	x
3	Using a different typeface for certain parts of the verbal text	x	x	x	x
4	Using the front or back cover	x	x	x	x
	Number of image components	4	4	4	4
	E II - Coefficient of learning control apparatus	72.22%	61.11%	77.78%	83.33%
	III. Orientation apparatus				
	Verbal components				
1	Content of the textbook	x	x	x	x
2	Dividing the textbook into thematic units, chapters	x	x	x	x
3	Marginalia, live headers	x	x	x	x
4	Register (subject, nominal, combined)				
	Number of verbal components	3	3	3	3
	E III - Coefficient of orientation apparatus	75%	75%	75%	75%
	Ev - Coefficient of use of the verbal components	70.37%	59.26%	74.07%	77.78%
	Eo - Coefficient of use of the image components	100%	100%	100%	100%
	E - overall coefficient of educational effectiveness of the textbook	75%	66.67%	77.78%	80.56%

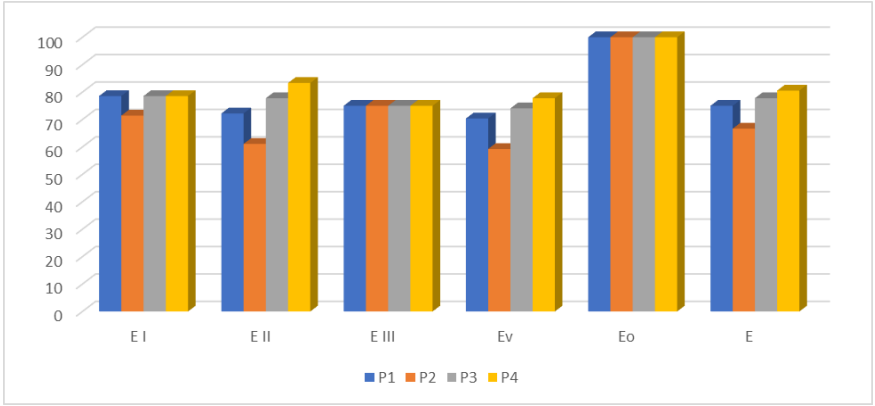


Figure 5. Educational effectiveness of the researched science textbooks.

3.2 Measure of the text comprehensibility

The obtained and computed data of Mistrik's text comprehensibility (*R*) are presented in Table 2. The results can be interpreted as follows: The computed value *R* for textbook P4 falls within the range of 40-50, indicating that the text in P4 has a high level of comprehensibility, meeting the recommended standards for younger students. In contrast, textbooks P1, P2, and P3 have *R* values that do not fall within the 40-50 range. Therefore, the texts in these textbooks do not achieve a high level of comprehensibility. However, it is worth noting that the text in P1 is approaching the lower end of this interval.

Table 2

Mistrik's measure of the text comprehensibility of the science textbooks

The textbook	*N*	*V*	*S*	*L*	I_i	*R*
P1	610	7.18	2.26	386	1.58	39.73
P2	612	8.38	2.18	382	1.60	38.58
P3	638	11.6	2.06	391	1.63	35.34
P4	611	6.11	1.97	360	1.70	42.92

The most comprehensible texts, according to the calculated Mistrík's comprehensibility index, were found in textbook P4. The other textbooks have less comprehensible texts, with the least comprehensible text found in textbook P3. For example, here is a passage from the beginning of the school year for third-grade students:

"After discussing in our team, we agreed that we don't actually understand what it means for one object to be bigger than another. It seems as if one object is heavier, but it doesn't look much larger than the one that seems lighter. It would really help us if you could also find out how to compare the size of two objects and their weight, so that in the future, we can identify differences between objects without your help." (Žoldošová, 2020, p.2)

As evident, understanding this text requires a high level of abstraction from primary school students.

3.3 Learning tasks in the textbooks studied in terms of the development of cognitive functions

The analysis of the learning tasks is presented in Figure 6. The analysis of educational tasks in terms of cognitive processes revealed both similarities and differences among the textbooks examined (see Figure 6). Tasks were scored according to their cognitive demand: creativity (6), evaluation (5), analysis (4), application (3), comprehension (2), and memorisation (1). The total score for each textbook's tasks was then divided by the number of tasks to obtain the average score. The resulting average scores were ranked as follows: P3 (3.81), P4 (2.84), P2 (2.15), and P1 (2.09).

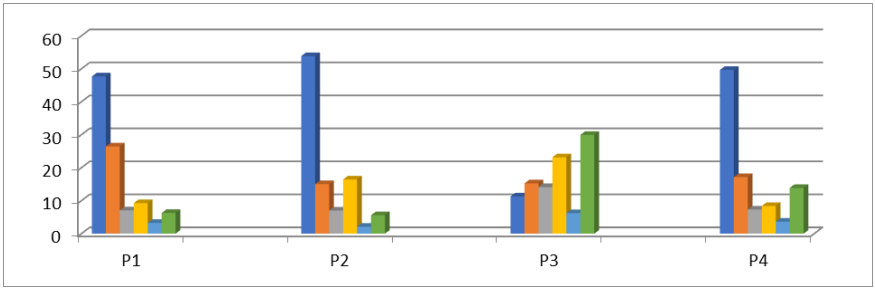
The data indicates that all textbooks include tasks designed to develop both lower and higher cognitive functions, but to varying degrees. Textbooks P1, P2, and P4 predominantly feature tasks aimed at developing lower-order cognitive functions. In contrast, textbook P3 contains a disproportionately higher number of tasks focused on creativity, particularly involving independent creation and formulation of responses to research problems. However, it should be noted that the tasks in P3 often had less comprehensible text for younger students.

The analysis of textbook P1 clearly demonstrated that the tasks within a single topic are smoothly graduated from those requiring lower-order cognitive operations to those demanding higher-order cognitive processes. A similar finding was reported in an analysis of work education textbooks from the same publisher (Rochovská & Huľová, 2021).

In textbook P2, instructional tasks are presented in bright orange boxes. Some of these tasks were labelled as "experiments" and focused primarily on applying knowledge. There were a total of 30 such tasks in the textbook. Additionally, there were tasks aimed at developing psychomotor skills, which involved creating a product according to a precisely described procedure, such as a rain gauge. These tasks were not investigative activities but rather linked to practical work. There were three such tasks in the textbook, which were not included in the cognitive function analysis.

In textbooks P1, P2, and P4, experiments or inquiry-based activities often involve simply following the instructions in the textbook. Students typically only

name and describe what they have observed, which focuses on developing memory-based cognitive operations. Nevertheless, such illustrative teaching methods have their place in primary education, as students more easily remember what they have seen, touched, or experienced sensorially. Furthermore, each teacher has their individual teaching style, which can influence how tasks in the textbook are processed. A task designed to develop lower-order cognitive operations can be adapted to foster higher-order cognitive skills by first encouraging students to propose their own procedure. Alternatively, teachers can provide materials and challenge students to devise a research procedure using those resources.



Legend: From left memorisation (in blue), comprehension (in oragnge), application (in gray), analysis (in yellow), evaluation (in turquoise), creativity (in green).

Figure 6. Learning tasks according to Bloom's revised taxonomy of cognitive functions.

4 Discussion

The research results highlight the diversity of the examined textbooks, along with their strengths and weaknesses. The educational effectiveness of the science textbooks studied generally achieves above-average indicators, except for the use of visual components, which reaches 100%. This was confirmed by the analysis of illustrations regarding their quantity, scope, character, and function.

The coefficient for the use of apparatus of the presentation of curriculum in all the examined textbooks was lower due to the lack of a review section from the previous year. Textbook creators for primary education aim to adhere to certain page limits to avoid increasing the weight of the textbooks, which could lead to spine strain for students. This may be one reason why the review of material from the previous year is omitted. Additionally, all publishers of the examined textbooks state in their online presentations that the textbooks build on the content of the previous year's textbooks published by the same publisher.

Therefore, end-of-year reviews from the previous year's subject can be used for revision at the beginning of the school year in the third grade.

The inclusion of a glossary of terms is also debatable. In primary education, such elements are not commonly used as standalone chapters or appendices. However, all the examined textbooks do include explanations of certain terms in separate paragraphs or sections. Therefore, the presence of this structural element was noted in the analysis of educational effectiveness.

Similar suggestions for extracurricular activities using the curriculum were noted across the examined textbooks, although none explicitly specified where these activities should be carried out. Each textbook included tasks of a long-term or interdisciplinary nature that could be addressed through extracurricular activities. Additionally, each textbook was accompanied by a methodological guide containing numerous tasks extending into extracurricular activities.

The coefficient for the learning control apparatus was almost universally reduced due to the nature of the tasks and exercises included. Its inclusion in primary education textbooks could be debatable, as primary school students generally lack the self-regulation mechanisms needed to avoid prematurely looking at the task or exercise outcomes. This element was incorporated into textbook P4 under the "Scientist's Advice" section, which has not yet been sufficiently validated through practice. Moreover, the author's intention was to include not only the task outcomes but also to provide an additional source of information for students who might struggle to reach the solution through other means.

Instructions of a more complex nature were only noted in textbooks P3 and P4. In P3, these mainly consist of exploratory challenges for students presented via emails. In P4, they include observations of real-life scenarios through videos, from which students make their own notes and sketches in their textbooks, seeking answers to questions without a prescribed structure. Additionally, in P4, the questions for the scientist created by the students also represent a more complex instructional task.

The coefficient for the use of orientation apparatus was reduced across all textbooks, partly due to the absence of registers (such as thematic or name registers), which are typically not included in primary education textbooks. Considering the above comments, the educational effectiveness of all the examined textbooks was found to be very good.

Compared to past science textbooks, the educational effectiveness of current textbooks has significantly improved. The first Czechoslovak science textbook (Nový et al., 1991a, 1991b) had a total educational effectiveness coefficient of 47%, with a verbal component coefficient of 41% and an image component coefficient of 67% (Kopáčová, 2012). These values were relatively high given the printing capabilities available at the time of its creation.

The science textbook by Stanko and Stanková (1997) achieved an overall educational effectiveness coefficient of 44%, with a verbal component coefficient of 41% and an illustrative component coefficient of 56%. The textbook had a relatively low value for the learning control apparatus, at 39%. During the period when this textbook was in use, an alternative textbook titled *Natural Science for 3rd year of primary school* (Kubovičová et al., 2000) was created. This textbook featured an inductive approach to content and visual presentation inspired by high-quality foreign textbooks. Its overall educational effectiveness coefficient was 61%, significantly bolstered by high values for the orientation apparatus (100%) and image components (100%) (Kopáčová, 2012).

Following the 2008 school reform in Slovakia, textbooks developed by a team led by A. Wiegerová (2011) were used. These textbooks exhibit much higher educational effectiveness values, at 67%, which are comparable to those of the current science textbooks. The verbal component coefficient was 74%, the image component coefficient was 78%, and other indicators were also around the higher end of the average (Kopáčová, 2012).

The research revealed that the examined textbooks did not exhibit a high level of text comprehensibility for students. Similar findings were reported in earlier studies abroad (Daniels, 1996; Moss, 1991; Bryce, 2013), which demonstrated that science textbooks were challenging for students to read and understand.

Based on the research findings, the advantages and disadvantages of the examined textbooks can be summarised:

Working textbook P1 offers a relatively good level of educational effectiveness. However, it has notable disadvantages, including low comprehensibility for students, a predominance of tasks focused on developing lower cognitive functions, an excessive number of miniature illustrations within a single task, and a high number of illustrations that serve only a decorative function.

Working textbook P2 also demonstrates a good level of educational effectiveness and features appropriately sized illustrations. Despite these advantages, it suffers from low comprehensibility for students and an overemphasis on tasks aimed at developing lower cognitive functions.

Working textbook P3 stands out with its above-average educational effectiveness and the highest number of tasks designed to foster creativity. Nonetheless, it has significant drawbacks, including insufficient text comprehensibility and an excessive number of miniature illustrations within individual tasks.

The textbook P4 excels with its above-average educational effectiveness and high level of text comprehensibility for students. It also includes the most visual material per page and features QR codes that provide access to video recordings of animals, plants, and fungi. The main disadvantage of this textbook is its overemphasis on tasks that develop lower cognitive functions.

The limitations of the research include potential errors due to human factors in counting, such as the number of syllables in a specified text segment, or accurately representing the level of a learning task. However, it can be stated that even with a few such errors, the research findings would not be significantly altered. The researcher aimed to mitigate these undesired effects by repeatedly classifying learning tasks according to their cognitive function levels and by repeatedly counting illustrations, words, syllables, etc.
Another limitation is the difficulty in comparing the results of this research on Slovak textbooks with those from studies of foreign textbooks. The entire research framework is based on the study conducted by Kopáčová (2012), so comparisons are restricted to the results obtained by this author.
A further limitation is the rather formalistic approach to evaluating textbooks, which could be supplemented by additional research. For example, future studies could explore the development of attitudes towards scientific inquiry and the stimulation of activities aimed at enhancing scientific skills (e.g., Yang & Liu, 2016; Yalçınkaya-Önder et al., 2022).

Conclusions and implications

The aim of this study was to highlight various aspects of current science textbooks for primary education. Given the open market for textbooks, there is potential to enhance the current offerings by developing new textbooks that combine the strengths of those analysed. It would be beneficial if new, "living" alternative textbooks were created - texts that continually improve and reflect modern educational concepts, particularly inquiry-based approaches to science education. The challenge of creating new textbooks should not undermine the value of existing ones that formed the research sample. As noted by Kopáčová (2012), the average lifespan of a textbook is about five years, and given the upcoming curriculum reforms and the advancement of communication technologies, this period may be even shorter.
We recommend that creators of new science textbooks incorporate as many elements as possible with respect to the educational features of the textbook, including both visual and verbal components and learning control tools. They should ensure the text is comprehensible for younger students, apply a balanced range of learning tasks that develop all levels of cognitive functions—especially analysis, evaluation, and creativity.

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