DIFFERENCES IN GRAPHIC ILLUSTRATIONS IN THE CONTENTS OF NATURAL SCIENCES IN REGULAR TEXTBOOKS AND TEXTBOOKS FOR STUDENTS WITH SPECIAL EDUCATIONAL NEEDS IN THE REPUBLIC OF SERBIA

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Abstract

The most important source of knowledge in primary school teaching is the textbook. This research aimed to determine the differences in graphic illustrations in the contents of natural sciences in a regular textbook and a textbook for children with special educational needs in the Republic of Serbia. As the number of subjects that deal with the contents of natural sciences for children with special educational needs is small, as well as the number of schools that implement this type of teaching, physics is taken as a subject, because the number of common topics is quite similar. The research aim was to analyze illustrations in selected physics textbooks for the 6th grade of primary education, by the criteria for dividing illustrations by types, for determining abstractness and relative representation of illustrations. In addition, a supplementary classification of illustrations was applied. The obtained results indicate that the number of illustrations concerning the number of words is higher in textbooks for children with special educational needs, as well as that the most represented are illustrations from everyday life and greater abstraction compared to regular textbooks. Since the physics textbook for children with disabilities is quite old, these results can be examined in practice among teachers and help future textbook authors to write the best quality textbook taking into account the needs of teachers and children with special educational needs.
Keywords: *image analysis, teaching physics, type of illustrations, special educational needs*

Introduction

Working with children with special needs is challenging. These children require more attention, and a special approach to each child individually. Modern teaching began slowly with the inclusion of children with special needs in the regular school system in the hope that this will bring benefits to these children to be better accepted in modern society. The process of acquiring knowledge, building skills and habits,

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developing abilities, and adopting value systems and behaviors describe the concept of education (Gvozdenović, 2011). In 1994, in The Declaration of the Rights of the Child, the United Nations emphasized the importance of including children with disabilities in regular education to reduce discrimination and emphasize the equality of all children regardless of socioeconomic status, intellectual disability or other forms of disability. In 2009, inclusive education was introduced in Serbia for the first time with the adoption of the law on the basics of the education system, without discrimination and separation of those from marginalized and vulnerable social groups, as well as those with disabilities (Karić et al., 2014). A set of 54 textbooks for inclusive education was introduced at all levels of study, on which 360 experts worked for four years. The set also includes manuals for teachers, which consist of special education and work. Teachers can change and duplicate assignments, and assignments are also available on CD.

To facilitate and support a child's learning and progress, it is necessary to adjust the strategy used by the teacher. This also helps the other children in the group, who do not have learning difficulties, to master the material faster and easier. An individual educational plan (IEP) is a written document that plans to support the education and upbringing of a child with developmental disabilities. However, if the specificity of students is not known and respected and different ways, forms, and means of learning are not applied, then the IEP will not bring success either. Even the IEP as a document will become something that everyone is afraid of, and that is that everything will be reduced to filling out additional documentation and will require special individual work with the child, which again represents a burden in addition to working with other children in the class. The IEP should be used for planning and monitoring the progress of children, to support their individuality and diversity. Instead of lectures and teaching units, the focus becomes learning and progress. The goal of education is not only the adoption of materials but also preparation for life and work (Janjić et al., 2012).

Research Problem

The most important source of knowledge for students, in addition to teachers' lectures, is the textbook. During school, students are offered several textbooks that help them acquire important competencies, such as how to solve problems more easily or how to learn more efficiently. We can say that students are the most competent when choosing appropriate textbooks. Today, students learn and acquire knowledge with the help of various media and with different teaching strategies. Different didactic theories and pedagogical concepts are applied in practice. In some of them, the role of the textbook is glorified, and it represents the main source of knowledge, while in others the use in teaching is neglected or completely avoided. As information technology advances more and more, progress is visible in the graphic and visual preparation of textual teaching media, so that with their attractiveness and functionality they can attract the attention of new generations of students, which we call the Z-generation (Matijević et al., 2013).

Students' interest is far greater in learning by using illustrated material. It reduces fatigue, trains the imagination and simplifies the learning process. It is also very important to note that the use of visual teaching methods is closely related to verbal and practical techniques. Dimopoulos et al. (2003) classified the illustrations in the textbooks according to the type as realistic illustrations; conventional illustrations and hybrid illustrations.

Representation of reality using photographs and drawings as it is natural to human optical perception is called realistic illustrations. It is much easier for students to understand certain concepts when they are presented in forms from everyday life. Visual representations such as graphs, diagrams, symbols and molecular structures represent reality in a transferred symbolic meaning. All these visual representations fall under the notion of conventional illustrations. They are very important for scientific writing and are constructed according to scientific and technological conventions. They contain and connect scientific concepts and large amounts of abstract data in a very efficient way. Visual representations that contain elements of both realistic and conventional illustrations are hybrid illustrations. Most often, these are conventional schematic representations enriched with realistic elements. In this way, it is easier for students to interpret conventional illustrations, which are also the most difficult to understand, supplementing them with natural real elements (Dimopolous et al., 2003).

The illustration emphasizes a certain property of the content of the material and in that way makes the knowledge more complete, more lasting, more interesting, stimulating and more efficient. If after reading a text we do not look at the illustration on the next page, it is very possible that the text will not be very clear to us. When we have a scheme in front of us, we can arrange the details and meaning of the read text. Those who have a scheme or illustration in advance remember and understand the content of the text better because the scheme provides a general expectation of possible scenarios and reduces the number of potential meanings of words and sentences in the text. A scheme or illustration is an understandable representation of a material (Chatman & Sparrow, 2011). Souza and Porto (2012) classified illustrations in textbooks into nine subcategories. This classification is based on the contents shown in the illustrations:

- laboratory equipment and experiments,
- industrial plants and production,
- graphs and diagrams,
- models,
- analogies,
- illustrations from everyday life,
- illustrations of mineral, plant and animal samples,
- illustrations relating to the history of science and,
- concepts of natural sciences.

It is very important to prepare good illustrations that present the topic, in order to make it easier to understand some of the examples related to that topic. The student then actively learns how to observe phenomena and recognize the conditions that determine whether the desired change or result will occur.

Research Focus

The correct didactic design of natural science textbooks is of great importance for the education of students and their complete development. The contents of the classes should enable students, according to their intellectual capabilities, to acquire a certain body of knowledge necessary for further learning and improvement. The research problem is to what extent the selected textbooks meet the standards. The textbook must have as many examples as possible, with the help of which general phenomena

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are explained, to meet the quality standards related to the didactic design of textbooks (Gajtanović & Vait, 2015).

Research Aim and Research Questions

The main aim of this research was the qualification of illustrations according to the content as well as the differences in graphic illustrations in the context of natural sciences in the selected Physics textbook for the 6th grade of elementary school and the Physics textbook for children with developmental disabilities. Differences in graphic illustrations in selected physics textbooks were analyzed using the method of Dimopoulos et al. (2003), and the classification of types of illustrations based on image content, according to Souza and Porto (2012).

The specific objectives of the research are as follows:

1) Analysis of the relative representation of illustrations in selected textbooks,
2) Classification of illustrations according to the type of illustrations and according to the content of the image,
3) Determining the degree of abstractness of illustrations in selected textbooks using different markers

Research Methodology

General Background

Two Physics textbooks that are used in primary education in the Republic of Serbia were selected for the analysis of the illustrations. The selected textbook used by children without developmental disabilities is Čaluković, N. (2013): Physics for the 6th grade of primary school, Krug, Belgrade (*Regular textbook* in future text) and the textbook for children with developmental disabilities by Pejnović, B. (1995): Physics for the 6th Grade of primary school, Institute for textbooks and teaching aids, Belgrade (in future text *Special textbook*). The research was conducted during the summer semester of the academic year 2021-2022.

Instrument and Procedures

The analysis of the illustrations was performed using the method developed by Dimopoulos et al. (2003) and by Souza and Porto (2012). Physics is the only textbook with natural science content that is adapted for children with developmental disabilities. The degree of abstractness of the illustrations in the selected textbooks was determined using different markers that include maximum (high), moderate and minimal (low) abstractness (Dimopoulos et al., 2003). Illustrations with low abstractness are characterized by a numerical value of the index of abstraction from 0 to 1, with moderate from 1 to 2 and with high abstractness from 2 to 3 (Dimopoulos et al., 2003).

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Data Analysis

First, the relative representation of illustrations in selected Physics textbooks was analyzed, which is seen as the number of illustrations per 1000 words. Then the illustrations were analyzed according to the type of illustrations (realistic, conventional and hybrid) and according to the content of the image. To determine the degree of abstraction of each image, the following formula was used: the average value of the marker, whether there is a numerical symbol or a geometric shape in the image; color palette, which refers to the appearance of color in the illustration, and contextualization, which shows what the background of the image is. The collected data were analyzed using Microsoft Office Excel software programs.

Research Results

Analysis of the Relative Representation of Illustrations

The relative representation of illustrations of the content of natural sciences was observed in selected *Physics textbooks for the sixth grade* and was viewed as the number of illustrations per 1000 words. A comparison was made on the following topics covered in textbooks that are common in both textbooks:

1. Introduction to Physics
2. Physical quantities
3. Force
4. Motion

In addition to these common topics, topics that differ in these two textbooks, namely *Mass, density and pressure* represented in the Regular textbook as well as the topic of *Substance structure* represented in the Special textbook.

Topics that do not contain a sufficient number of words (1000) are usually not considered. However, although *textbooks* for children with disabilities do not have extensive topics, these topics (less than 1000 words) were averaged per 1000 words that the topic would have. Before presenting the tables of results of the analysis on the above-mentioned topics, Table 1 shows the average representation of illustrations of both textbooks that are being analyzed - *Special* and *Regular* to more easily explain the further obtained results as well as the previously mentioned results (relative representation index).

Table 1
Average Representation of Illustrations in Physics Textbooks

Topics	Special textbook			Regular textbook		
	Number of words	Number of illustrations	Number of illustrations per 1000 words	Number of words	Number of illustrations	Number of illustrations per 1000 words
Introduction to Physics	301	5	16	1189	10	8
Motion	404	3	7	1395	25	24
Force	533	13	24	1132	34	17
Physical quantities	375	27	72	962	10	30

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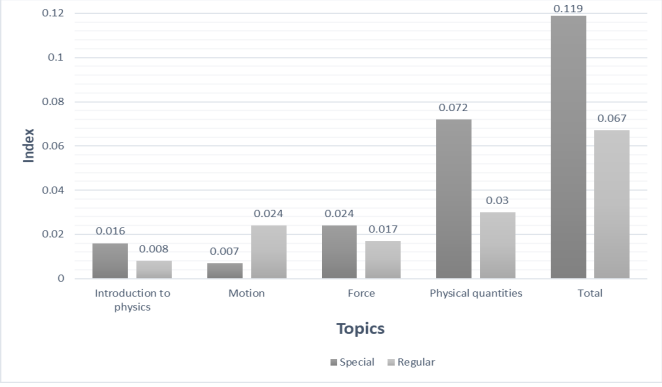
The results in *Table 1* show that the number of words in each topic is significantly lower in a special textbook than the number of words in a regular textbook. However, the results also show that the total number of illustrations per 1000 words is higher in a special textbook than in a regular textbook. *Figure 1* shows the results of the index of relative representation of illustrations in textbooks. Based on the results obtained, it is concluded that the index of relative representation of illustrations in the regular textbook is significantly lower in all topics, except for the topic of movement.

Figure 1

Index of the Relative Representation of Illustrations in Selected Physics Textbooks



Analysis of Types of Illustrations in Textbooks

As previously noted, there are three types of illustrations: realistic, conventional and hybrid. Further in the research, the representation of all types of illustrations in selected physics textbooks will be explored, followed by the classification of illustrations according to the type of illustrations and the degree of abstractness of all three types of illustrations. In Figure 2, the results are presented that show the representation of types of illustrations in selected textbooks.

Figure 2

Percentage of Illustrations by Type

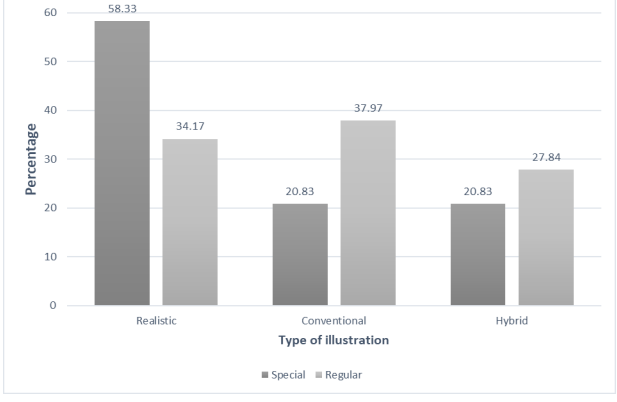


Figure 2 clearly shows that the number of realistic illustrations is the largest, while the number of conventional and hybrid illustrations is equal in a special textbook, while in a regular textbook, the most common are conventional illustrations, then realistic and hybrid illustrations.

Further analysis results showed that in the Regular textbook, the most represented were realistic illustrations belonging to illustrations from everyday life (40.74%), then those belonging to laboratory equipment and experiments (22.22%) and then those belonging to the history of physics (18.51%). On the other hand, the results of the analysis of realistic situations from the special textbook also showed that most illustrations belonged to laboratory equipment and experiments (39.28%), while realistic illustrations with graphics and diagrams and illustrations of industrial production and plants had the same percentage (21.43%), while illustrations from the history of physics were not presented.

Based on the analysis of conventional illustrations, it was obtained that the Special textbook had the most illustrations that belonged to illustrations from everyday life (40%), followed by graphics and diagrams (20%), and then laboratory equipment and experiments (13.33%), and analogies (13.33%). In the regular textbook, illustrations were represented in the same order, only differing in percentage amount.

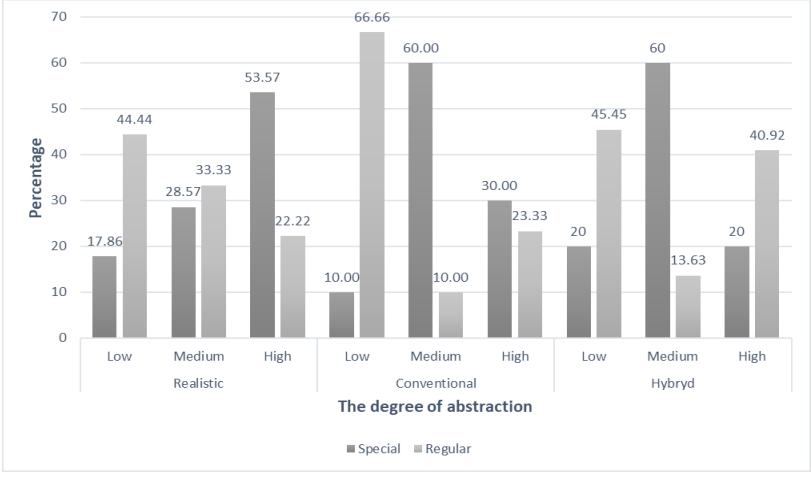
Further analysis of hybrid illustrations, showed that the most represented hybrid illustrations in the Regular Textbook are illustrations belonging to graphics and diagrams (36.36%), followed by laboratory equipment and experiments (31.81%) and illustrations from everyday life (13.63%). The analysis of the special textbook showed that the most common illustrations from everyday life (40%) are illustrations belonging to graphics and diagrams (30%) and then those belonging to laboratory equipment (20%).

Analysis of the Degree of Abstractness of Illustrations in Textbooks

Figure 3 shows the results of the analysis of the degree of abstraction of illustrations.

Figure 3

The Degree of Abstraction of Illustrations



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The results show that in the textbook for students with special educational needs, realistic illustrations are dominated by highly abstract illustrations, while conventional and hybrid illustrations are predominantly illustrations of moderate abstractness. In regular textbooks, illustrations of low-level abstractness are the most represented in all three types of illustrations.

Discussion

Based on the total number of illustrations, it is noticed that a greater number of illustrations in the textbook for children with special educational needs is understandable because children with special educational needs can more easily adopt concepts through graphic representations. Textbooks play a crucial role in shaping the image using its textual and visual representation (Gulya & Fehervari, 2023).

Considering the differences between textbooks, some trends and differences in illustrations in physics textbooks can be observed (Souza & Porto, 2012). A physics textbook for children with disabilities contains a much larger number of images compared to the number of words compared to a regular textbook. This is understandable because the image is much more valuable than the text (Hibbing & Ranckin-Erikson, 2003). As for the abstractness of illustrations, they are more complex in textbooks for children with special educational needs. This suggests that some children with special educational needs may have difficulty reading, and visual displays can be easier to understand than the text itself (Levin et al., 1987).

Science textbooks tend to rely on visuals rather than text (Dimopoulos et al., 2003). Due to the limitations of children with special visualization needs, this textbook relies more on everyday life than on models or historical facts. Abstract knowledge is more represented as the educational level rises (Dimopoulos et al., 2003). In the initial classes, there are concepts of high abstractness, and such concepts can be clarified and brought closer to students by applying illustrative-graphic methods by selecting and applying high-quality and appropriate illustrations (Hrin et al., 2016).

Some children had difficulties gathering information presented in the textbooks because textbooks are organized so that the task of reading them is difficult for some children (Ciborowski, 1992). Further, the Ministry and institutions used to offer little help and a small number of textbooks for teachers who teach children with special education needs. Appropriate instruction in classrooms with diverse learners requires at first a variety of instructional methods to address individual needs (Mercer et al., 1996) and also a variety of textbooks. The key role of this research is to enable better development of textbooks both in physics and for students with special needs. Research that had to focus on the comparison of illustrations of regular textbooks and textbooks for children with special needs has not been done so far. The differences of the visual images in the two types of textbooks can possibly lead to the development of different teaching strategies and more effective use of visual material in physics teaching for both groups of students (Dimopoulos et al., 2003).

What is crucial is that these results can be momentum in further research. Some form of survey or questionnaire that could be solved by children with special needs, and which would rely on these results could be the wind at the back to develop instructional aids specifically addressed to learners' special needs.

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This study had some limitations. First of all, this was a small study that examined only two physics textbooks by one researcher. There was no measured interreliability in categorizing the images in the textbooks and the findings should not be considered applicable to all physics textbooks. The big limit of this study is the textbooks themselves. It is also necessary to refresh the field of textbooks for children with special educational needs because the analyzed textbook is almost thirty years old. More and more children with minor developmental disabilities are also being included in schools with regular education so this should be taken into account.

Conclusions and Implications

In this research, the contents of two selected Physics textbooks from different publishers were analyzed. It should be noted that the first edition is used in regular physics classes (regular textbook) for the sixth grade of elementary school (out of eight), while the second publisher's textbook is used in teaching children with special educational needs (Special textbook). The entire contents of these textbooks were analyzed: the number of illustrations, the index of relative representation of illustrations and the degree of abstractness analysis of illustrations. A comparison was made on common topics covered in both textbooks: Introduction to Physics, Physical Quantities, Force and Motion.

The results showed that the total number of illustrations on the number of words in the regular textbook was much lower than in the textbook for children with special educational needs. The number of words in the regular textbook is significantly higher than in the special textbook, while the number of illustrations is higher in the textbook for children with special educational needs, which is understandable because the textbook for children with special educational needs should present as many illustrations as possible, to make their content more accessible and comprehensible. The type of illustrations on the same topic in the regular textbook is more complex and usually with the text, while the type of illustrations in the textbook for children with special educational needs is simpler and clearer.

The results of the analysis of the degree of abstraction show that in the regular textbook, all types of illustrations are of low abstractness, while in the textbook children with special educational needs are variable. Realistic illustrations are mostly high, while conventional and hybrid illustrations are mostly of medium abstractness.

The results of the analysis of the types of illustrations according to the content have shown that the special textbook illustrations belong to only a few types of illustrations: everyday life, laboratory equipment and graphics and diagrams, while the results in the regular textbook showed that all types of illustrations are represented, but the most are the illustrations from everyday life and graphic and diagrams. It can be concluded that the content in books for children aged in the sixth grade of elementary school has a wide variety of illustrations, while the textbook for children aged sixth grade of elementary school with special educational needs has a greater number of illustrations but is as unique as possible and those from every day and real life.

For the physics textbook to give inspiration to students for independent and research work, it should contain as many laboratory exercises as possible, and tasks explained by pictures, drawings, and diagrams. The laws of physics need to be explained

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through realistic examples for students to understand the purpose of this very important natural science and apply it in everyday life. A picture is worth a thousand words. Therefore, the graphic allocation of concepts makes it easier to understand.

Future directions of research can be a potential survey among teachers who teach in schools about the quality of graphic illustrations as well as textbooks themselves.

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Declaration of Interest

The authors declare no competing interest.

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