

## PAPER

# Didactic Design of Teaching Materials Created by Future Teachers in the Czech Republic

Nikola Straková<sup>1</sup>(✉),  
Roman Hrmo<sup>2</sup>

<sup>1</sup>Department of Physics,  
Chemistry and Vocational  
Education, Faculty of Education,  
Masaryk University, Brno,  
Czech Republic

<sup>2</sup>Vice-Rector for Quality and  
Development DTI University,  
Dubnica nad Váhom, Slovakia

[strakova@mail.muni.cz](mailto:strakova@mail.muni.cz)

## ABSTRACT

This paper describes research on the didactic design of teaching materials created by Czech future teachers in their university theses. The results of the research indicate that the teaching materials for future teachers are far from achieving the highest level of didactic design. The average value of the coefficient of the total didactic design is only 26%. The weakest aspect of the teaching materials is the component of the learning management system. This fact implies a significant underestimation of the learning process. Students preparing for the teaching profession have not demonstrated the ability to compile didactically well-developed teaching material in their final theses. They use only a limited number of structural components, and therefore the basic function of teaching materials, the didactic function, is not fully fulfilled. The didactic function ensures the effective usability of textbooks and similar texts in actual education.

## KEYWORDS

didactic design, Czech future teachers, final theses, teaching materials, learning process

## 1 INTRODUCTION

The evaluation of the quality of teaching materials for future secondary school teachers began with an analysis of university theses at the Faculty of Pedagogy at Masaryk University in Brno, in the Czech Republic. From the analysis of the final theses and from the results of three additional exploratory surveys [1], the following facts were found:

- The most frequently chosen topic for the final theses of future teachers is the creation of teaching materials.
- It is expected that the creation of teaching materials will continue to be a topic often chosen by future teachers for their final theses.
- The need to create one's own teaching materials is justified by the absence of a textbook for the given subject or by the inadequacy of existing textbooks to meet the current needs of teachers and pupils.

Straková, N., Hrmo, R. (2024). Didactic Design of Teaching Materials Created by Future Teachers in the Czech Republic. *International Journal of Engineering Pedagogy (iJEP)*, 14(5), pp. 4–23. <https://doi.org/10.3991/ijep.v14i5.47441>

Article submitted 2023-12-18. Revision uploaded 2024-04-02. Final acceptance 2024-04-02.

© 2024 by the authors of this article. Published under CC-BY.

- Pupils consider textbooks to be a relic unsuited to their needs, with an excess of information but uninteresting content.
- Current teachers actually use their own teaching materials in their lessons, adapting the content to meet their own needs and those of their pupils.
- Pupils primarily learn from teaching materials provided by their teachers, where they mainly seek out abbreviated text.

Teachers create their own teaching materials using various resources, such as books, articles, the Internet, and other electronic resources. However, the quality of these teaching materials deserves more attention due to their effective use in real education. The decentralisation of the curriculum in the Czech Republic, along with the aforementioned results of analyses and surveys, indicates that future teachers will likely develop additional teaching materials for their pupils throughout their teaching careers. Teachers should be aware that, just like good textbooks, good teaching materials should not only present information but also arouse interest in pupils, educate them in values, actively involve them in the learning process, adapt to the individual abilities of pupils, connect subjects from different areas, be original, interesting, and develop pupils' thinking. They should also be comprehensible and clear [1].

In this paper, we discuss the distinctions between textbooks, similar teaching materials, and other types of books and texts used for teaching purposes. Textbooks are the fundamental learning tools for pupils. Textbooks and similar educational materials can have a positive or negative impact on the learning process. According to Oates [2], high-quality textbooks can offer substantial support to teachers, and the fundamental distinction between a textbook and other types of books lies in the didactic adaptation of the textbook content. Didactic adjustment of the content of education involves considering the developmental level, existing knowledge and skills, motivation to learn, socio-cultural background, and values of students to ensure effective assimilation of educational content [3]. Insights from textbook theory are applied in this article to similar teaching materials created by future teachers. Various approaches and tools can be used to assess whether the created teaching materials can be effectively used in real education. Current empirical research on textbooks and similar teaching materials indicates that their effective use in education depends on several parameters, including language used, socio-cultural and socioeconomic factors, visual parameters, cognitive, affective, and behavioural parameters, as well as new technological and methodological approaches [4].

The search for fundamental criteria for quality teaching and educational materials, such as textbooks, is a topic of research conducted by scientists worldwide. For example, in Germany, at the University of Augsburg, under the leadership of Dr. Carl-Christian Fey, the Augsburg Analytical and Evaluation Grid for Educational Media (AAER—Das Augsburger Analyse- und Evaluations raster für analogue und digitale Bildungsmedien) was created [5]. AAER is a tool for analysing and evaluating the quality of textbooks. It can be utilised to decide on the selection of appropriate teaching materials, serve as a guide for authors of teaching materials, or evaluate teaching materials that have already been created [6].

In Slovakia, authors Maria Nogová and Jana Huttová address the issue of textbook quality. Nogová and Huttová [7] developed a relatively comprehensive evaluation sheet for assessing textbooks based on six key evaluation categories (referred to as KEC), which are further divided into 24 criteria. The maximum total score for all six KECs is 100 points. To be considered positively evaluated in terms of quality, a textbook must achieve a minimum of 60% in each category.

In the Czech Republic, the state oversees the evaluation of textbooks and teaching materials through the Ministry of Education, Youth, and Sports. The ministry grants

approval and includes the approved textbooks and teaching materials in a public online list [8]. Furthermore, according to Knecht and Janík [9], the following authors address various areas of textbook research in the Czech Republic:

- Content analysis documents the variations among textbooks intended for the same year and type of school (Klapko, 2006; Maňák, 2006; Knecht, 2007).
- Representation of visual components in the textbook (Hrabí, 2006; Novotný, 2007).
- didactic design of textbooks (Banýr, 2005; Jůvová, 2006; Janoušková, 2008).
- The complexity of the textbook content (Greger, 2005; Hrabí, 2007; Janoušková, 2008).
- The continuity of textbooks with the curriculum (Dvořák, 2007; Ježková, 2008).

In Serbia, experts from the University of Belgrade, Ivan Ivić, Ana Pešikan, and Slobodan Antic are involved in the development and analysis of textbooks. Together, they are the authors of the book “Textbook Quality: A Guide to Textbook Standards,” in which they define 43 textbook quality standards [3]. The book is very detailed and has potential uses not only for textbooks but also for generating and evaluating all forms of teaching materials across various types of media (print, electronic, and audiovisual) [3].

From Estonia comes the leading expert on textbook theory and research, Professor Jaan Mikk from the University of Tartu. Professor Mikk is the author of the publication “Textbook: Research and Writing,” which offers an overview of research in the field of textbooks. It also provides textbook authors and editors with a specific proposal for creating an effective textbook [10].

In non-European countries, the quality of textbooks is significantly improved, for example, in Hong Kong and the Republic of Korea. The purpose of developing guidelines for quality textbooks in Hong Kong was to provide teachers with criteria for selecting high-quality textbooks, establish requirements for textbook authors and curriculum developers, and define criteria for reviewers of recommended school textbooks [11]. In 2016, the Textbook Committee in Hong Kong [11] issued guidelines for quality textbooks and similar learning resources, including electronic resources. Education is currently significantly influenced by the rapid development of information and communication technologies (ICT). This fact also has an impact on the form of textbooks and similar teaching materials. They can be entirely electronic or a combination of a printed version and links (QR codes) to information or activities that facilitate learning in the online environment. For e-textbooks, the Committee for Textbooks in Hong Kong [11] sets minimum technical and functional requirements. These include compatibility with a variety of common computing devices, a user-friendly interface, hypertext, functions, index and keyword search capabilities, intuitive content layout, access to online dictionaries, tools for learning facilitation (such as note-making, bookmarking, and highlighting), as well as the integration of appropriate videos and audio recordings. According to researchers from Iraq [12], the use of modern ICT is essential for enhancing the quality and productivity of education. From the results of a survey conducted in Iraq, it was found that the use of ICT is considered by the majority of respondents to be influential, having a positive effect on learning and cognition, effective for the implementation of educational programmes, and effective for designing and planning education [12].

In the Republic of Korea, an evaluation sheet for textbooks and teacher’s manuals was created, which were divided into three sets: 1) common control points (consisting of basic necessary conditions; if any point is not met, the textbook is excluded from possible use, with four areas of assessment as YES/NO), 2) subject control points

(with six assessment areas on the A,B, and C scale), and 3) teacher manual control points (with seven assessment areas on the A,B, and C scale) [13].

When designing a textbook, it is desirable to start with an understanding of the learning process. The process of learning is not the same as memorization. It is an active process of creating meanings by structuring and organising information into their long-term memory [4]. Just as the role of the teacher is not merely to impart information to pupils, the role of the teacher is not merely to present information. A recent study from Vietnam that focuses on the implementation of social constructivist practices in teaching has confirmed the significance of actively engaging students in the teaching process. The study also emphasises the importance of establishing connections between learning and real-world situations [14]. A pedagogical experiment from Iraq also confirmed the positive effect of active learning on students' academic performance and their social intelligence [15]. Based on the actual application of two active learning strategies, the authors of the experiment strongly recommend incorporating similar active learning strategies in teaching at the second intermediate grade and other academic levels [15].

If we want the textbook to support pupils' independent learning, we need to consider the following factors in its design, according to Ivić, Pešikan, and Antić [3].

- The nature and diversity of the knowledge and information comprising the content of the textbook,
- Textbook features
- The user of the textbook is a pupil specific in age, level, and type of education provided.
- Medium in which the textbook is prepared.

Kolbeck and Röhl [16] define textbooks as a collection of spatially organised texts that rely on each other and the physical characteristics of the textbook, such as size, weight, binding, etc. The spatial organisation of a text implies a hierarchical arrangement and organisation of knowledge so that pupils can easily navigate through the text using visual cues and find their own way to effective learning [16]. Textbooks structure the knowledge that is taught and learned, guiding teachers and pupils through the process of teaching and learning in both macro and micro environments [5]. Textbooks should be constructed in a way that allows different teachers to utilise them in ways that best suit both the teachers and their pupils [2]. This is because teachers may work with a textbook in different ways. For example, some use the textbook to demonstrate key concepts, while others find it provides a clear teaching progression. Some see it as a repertoire of good examples and practical applications, while others believe it can support pupils' self-reflection. It can also serve as a tool for home learning, among other uses [2].

Textbooks may contain various structural components that help facilitate and improve learners' acquisition of the presented content, making the textbook easier to use. The aim of including these specific components is to enhance the clarity of the text and to present the content in various ways to facilitate a better understanding of the material, thus improving learning efficiency [3]. Teaching materials should not only include the presentation of specific content but also incorporate other components of the didactic apparatus to ensure that the educational text fulfils all its functions [3], [17]. The structural components of the didactic apparatus can be divided into two basic groups: verbal (textual) and non-verbal (visual). Verbal components should be adequately supplemented with non-verbal ones. Examples of structural components and organisational aspects of a textbook are provided in Appendix A, Section 7.1, and Table A1.

## 1.1 Function and quality of textbooks and similar teaching materials

In developed countries, textbooks are required to fulfil their functions to the best of their ability. In doing so, the functions of the textbook are realised through the use of appropriate structural components. According to D. D. Zujev [18], a textbook should fulfil the following functions:

- Informative: presentation of the curriculum; identification of the core curriculum.
- Transformational: transformation of scientific knowledge into a curriculum based on didactic principles.
- Systemic: ensuring the logical sequence of the curriculum and its arrangement into a system.
- Reinforcement and self-control: assistance, guidance, feedback in learning, orientation, and application of knowledge.
- Self-learning: the ability to independently and rationally formulate the need to learn.
- Integrative: assistance in learning from various sources.
- Coordination involves the use of various aids and didactic techniques to make the curriculum more concrete, extensive, and profound.
- Developmental and educational: focusing on the development of pupils' abilities and the formation of attitudes.

The list of functions of a textbook, according to Zujev [18], could be supplemented by others. For example, the motivational and differentiation functions mentioned by Mikk [19]. The functions of a textbook according to Mikk [19] and their fulfilment by specific structural components of a textbook are presented in Table 1.

**Table 1.** Functions of the classroom and the corresponding structural elements [19]

Functions of the Textbook	Structural Elements of the Textbook
Motivational	Illustration
	Interesting fact
	Content of problem tasks
	Easy readability
Information	Easy readability
	Connections with everyday life
	Scientific accuracy
Systematizing	Structuring of the textbook
Coordination	Structuring of the textbook
	Links to other textbooks
Differentiating	Difficulty grading
Controlling	Instructions for learning
Developing learning strategies	Promoting independent thinking
Self-Assessment	Questions and tests
Education to values	Personification

The quality of textbooks and similar teaching materials can be assessed based on their performance. According to Ivić, Pešikan, and Antić [3], a high-quality textbook can enhance the quality of education if it fulfils two fundamental criteria:

1. It is a fundamental tool for organizing the learning process of pupils.
2. It is a tool that supports rich pedagogical interaction between teacher and pupil as well as between pupil and textbook.

Mikk [10] divides evaluation methods for learning materials into three groups:

- Experimental method: It is the most reliable but, at the same time, time-consuming and relatively expensive. Therefore, experiments are used to clarify only some characteristics and parameters of the textbook and to validate the evaluation of textbooks based on experts' opinions.
- Expert method: it is often utilized, relatively complex, yet simple. However, on the other hand, the opinions of experts can vary significantly and are frequently subject to questioning.
- Statistical methods attempt to combine the advantages of the two previous methods. They are cost-effective and objective. However, their disadvantage lies in the challenge of determining the rules and calculation methods for the properties of the textbook and their applicability.

## 2 MATERIALS AND METHODS

In this article, we draw on the insights of textbook theory and apply them to similar teaching materials that teachers create themselves and use in their instruction. Teachers can draw information from a variety of sources that were not primarily created for the purpose of teaching (e.g., professional books, encyclopedias, the Internet, training courses, workshops, etc.), but these materials must be adapted for teaching purposes [20]. By teaching materials similar to those in textbooks, we refer to the teacher's process of searching for and creating new supplementary didactic texts derived from various sources such as textbooks, professional literature, online professional articles, and practical documentation. The results of this activity include developed topics and thematic units presented in paper or electronic format. They can be created using a word processor on a PC, as a presentation, or in e-learning modules. These materials serve as teaching aids and a resource for pupils learning.

### 2.1 Research sample

The research sample consists of 38 teaching materials similar to those found in the textbooks created by Czech future teachers of vocational subjects and practical teaching for secondary school in their university theses. The research started in 2019 by analyzing final theses (approximately 500 bachelor's and 500 master's theses) published in the university archive of Masaryk University in Brno and submitted between 2012 and 2018. The analyzed theses were divided into 8 groups based on the chosen topics. Despite the fact that the topics of students' final theses are very diverse due to their variety of fields of study, each final thesis was classified into one of the 8 identified groups of topics, as shown in Table 2.



**Table 2.** Groups of final these topics [21]

Topic Group Name	Examples of Thesis Topics
Creation of teaching materials	Creation of topics, thematic units, worksheets, workbooks, processing cross-sectional topics such as environment, healthy lifestyle, financial literacy
Pupil's personality	Pupil's motivation to learn, level of knowledge, hygiene in the teaching process, psychohygiene, substance abuse prevention, educational problems
Didactic tools in teaching	Material aids for teaching, innovation in didactic technology, production means used in professional subjects and practical teaching, teaching methods and organizational forms of teaching
Out-of-school and further education	Leisure activities, in-service training
Economics and management	Customer satisfaction in education, school or education promotion, school recruitment activities, employability of graduates on the labor market
Teacher's Personality	Motivation for the profession by the teacher, experience of teachers, didactic and pedagogical knowledge
Pedagogical documents	Analysis and comparison of curriculum documents, regional action plans for education, innovation of the graduate's profile in a particular study field
Occupational health and safety	Work safety at secondary vocational schools, work injuries and occupational diseases

From the group of papers on creating teaching materials (286 papers), 38 most suitable samples were selected from 7 different fields of study: economics, hotel management, chef, waiter, hairdresser, beautician, and confectioner. Please refer to Table 3 for details. The 38 final theses were purposefully selected for the research sample based on the control criteria established by the researcher. The control features were set so that the research sample included final theses from different fields, and the teaching material processed in the final thesis corresponded to the topic/chapter in the textbook (it contains the structure of components commonly used in textbooks). The proportion of bachelor's theses and diploma theses represented was 66% and 34%, respectively. It was not essential for the choice of teaching material, whether it was written in a bachelor's or a diploma thesis. In all 38 analyzed teaching materials, the utilization of structural components (verbal and visual) was assessed. The presence of structural components was assessed based on whether they occur or not. The frequency of their occurrence was not determined.

**Table 3.** Research sample – identification marks [1]

Scope	Identification Marks
Economic	E-Z,A (1-6)
Hotel and tourism	H (1-5)
Hairdresser	Ka (1-10)
Beautician	Ko (1-5)
Chef	Ku (1-5)
Confectioner	Cu (1-3)
Waiter	Ci (1-4)

## 2.2 Research tool

The resulting measures of didactic design were obtained through calculations following Jan Průcha's methodology [17], known as the measurement of didactic design. Průcha's methodology involves calculating the coefficients of the Didactic design measure for the verbal and visual components across three apparatuses: 1) the curriculum presentation apparatus, 2) the learning management apparatus, and 3) the orientation apparatus, as illustrated in Figure 1.

Průcha [17] distinguishes 36 components in the structure of a textbook, and their occurrence in teaching materials is recorded in a sheet. A detailed description of Průcha's methodology for measuring didactic design, including the evaluation sheet, is provided in the appendix in Section 7.2 and Table A2.

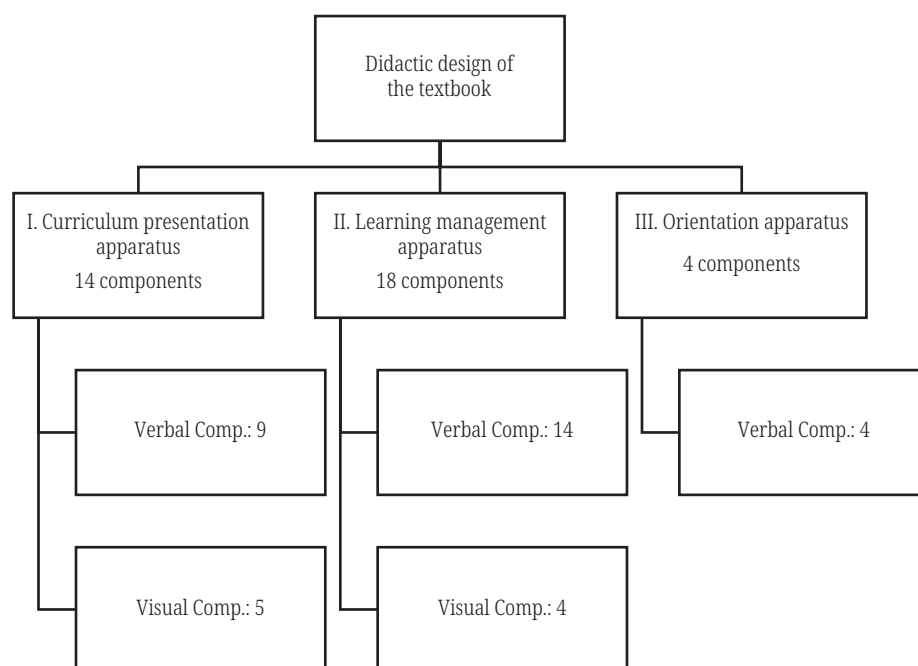


Fig. 1. Diagram of structural components [17]

A chi-square test of independence was used to determine whether individual results were significantly different from the mean. The significance level was set at 5%. All calculations were performed in MS Excel.

## 2.3 Objectives of the research

The objectives of the research investigation were set as follows: to measure the didactic design of teaching materials created by future Czech teachers of vocational subjects.

- To investigate the didactic design of teaching materials developed by prospective teachers in their university theses (bachelor's and master's theses).
- To compare the didactic design coefficients of each teaching material with each other.
- To compare the didactic design coefficients of individual teaching materials within a subject area.



- To compare the didactic coefficients of the examined teaching materials across different fields.
- To compare the level of didactic design of the teaching materials created in diploma theses and bachelor theses.
- To compare the level of didactic design between teaching materials created under the supervision of different university teachers (thesis supervisors).

### 3 RESULTS

Table 4 presents the outcomes of the didactic design of the teaching materials in terms of the total points calculated (the number of components identified out of 36 possible), the coefficient value of the total didactic design (E), and the p-value (differences from the average total scores  $\bar{E} = 9$  p.;  $\bar{E} = 26\%$ ). These values are displayed in the p column. The p-values of teaching materials with an above-average number of points are highlighted in bold. The p-value was calculated using an independence test (chi-square test). A significance level of 5% was used to assess the statistical significance of the difference between the E values and the average  $\bar{E}$  value. If the p-value is  $> 0.05$ , the difference between the average and the measured E value is not statistically significant.

None of the analyzed teaching materials achieved a total didactic design coefficient (E) value higher than 50%. Only two teaching materials obtained E values higher than 40% (H-4 44%, H-5 42% in the field of hotel and tourism). The lowest value of E was measured for the teaching material from Hairdresser/Hairdresser Ka-1 (E = 8%). This teaching material contained only 3 out of 36 possible structural components. It consisted solely of plain text and partially abbreviated text, with the use of bold and italics in some places.

The p-values of tutorials with above-average scores are in bold. A statistically significant deviation from the average ( $p < 0.05$ ) was found only at the highest and lowest values of the coefficient E. In all other cases, the coefficients E did not show a statistically significant deviation from the average. In other words, *the educational effectiveness of the teaching materials under study (excluding extreme cases) does not show statistically significant differences from the average value.*

**Table 4.** Comparison of individual coefficients from the average value [1]

	Points	E	p (Chitest)		Points	E	p (Chitest)
H-4	16	44%	<b>0.023</b>	Ku-2	11	31%	<b>0.550</b>
H-5	15	42%	<b>0.053</b>	Ku-5	11	31%	<b>0.550</b>
Ku-3	13	36%	<b>0.206</b>	Cu-3	11	31%	<b>0.550</b>
Ka-5	12	33%	<b>0.351</b>	H-3	10	28%	<b>0.792</b>
Ci-1	12	33%	<b>0.351</b>	Ku-1	10	28%	<b>0.792</b>
E-Z1	11	31%	<b>0.550</b>	Cu-1	10	28%	<b>0.792</b>
E-Z3	11	31%	<b>0.550</b>	E-Z4	9	25%	<b>0.944</b>
E-A1	11	31%	<b>0.550</b>	Ko-2	9	25%	<b>0.944</b>
H-2	11	31%	<b>0.550</b>	Ko-3	9	25%	<b>0.944</b>
Ka-7	11	31%	<b>0.550</b>	Ci-3	9	25%	<b>0.944</b>
Ko-1	11	31%	<b>0.550</b>	Ci-4	9	25%	<b>0.944</b>

(Continued)

**Table 4.** Comparison of individual coefficients from the average value [1] (Continued)

	Points	E	p (Chitest)		Points	E	p (Chitest)
E-Z2	8	22%	0.686	Ka-10	7	19%	0.460
E-A2	8	22%	0.686	Ku-4	7	19%	0.460
Ka-4	8	22%	0.686	Ka-2	6	17%	0.284
Ko-4	8	22%	0.686	Ka-6	6	17%	0.284
Cu-2	8	22%	0.686	Ka-9	6	17%	0.284
H-1	7	19%	0.460	Ko-5	6	17%	0.284
Ka-3	7	19%	0.460	Ci-2	6	17%	0.284
Ka-8	7	19%	0.460	Ka-1	3	8%	0.038

Using statistical analysis, as shown in Table 5, it was confirmed that the values of the coefficient of the total didactic design of all teaching materials are similar. No statistically significant differences were found in the values of the total didactic design after eliminating the extreme outliers. This was evidenced by the almost identical results of average values (9% and 26%) and median values (9% and 25%). The values of the mode (11 and 31%, respectively) do not differ significantly from the average either. The standard deviation is small (SD 3 and 7%) and the coefficient of variation (29%) indicates the relative reliability of the calculated average values.

**Table 5.** Results of descriptive statistics [1]

	Points	E
Average	9	26%
Median	9	25%
Mode	11	31%
Standard deviation	3	7%
Coefficient of variation	0.29	29%

The total coefficients of didactic design were also compared among the teaching materials from the individual fields of study. The average values of the scores and the E coefficient for each discipline are shown in Table 6. Once again, there were no statistically significant differences in the didactic design of teaching materials across different subject areas at the 5% significance level.

**Table 6.** Comparison of E coefficients of teaching materials from different fields of study from the average value [1]

	Points	E	p (Chitest)
H	12	33%	0.387
Ku	10	29%	0.691
Ek	10	27%	0.879
Cu	10	27%	0.879
Ci	9	25%	0.944
Ko	9	24%	0.838
Ka	7	20%	0.523

The partial coefficients of didactic design for all examined teaching materials were evaluated, and the materials were divided into groups based on fields of study. The total didactic design (E), according to the methodology used, is comprised of three apparatuses: curriculum presentation (EI, 14 components), learning management (EII, 18 components), and orientation (EIII, 4 components). These components are further categorized into verbal (Ev : 27 components) and visual (Eo: 9 components).

Table 7 shows that the strongest aspects of the teaching materials were the visual components ( $\bar{\varnothing} Eo = 41\%$ ) and the curriculum presentation apparatus ( $\bar{\varnothing} EI = 35\%$ ). The orientation apparatus ( $\bar{\varnothing} EIII = 29\%$ ) was also above average. On the other hand, the weakest aspects of didactic design in teaching materials were the learning management apparatus ( $\bar{\varnothing} EII = 19\%$ ) and the utilization of verbal components ( $\bar{\varnothing} Ev = 22\%$ ). The highest values in a coefficient are always highlighted in bold.

**Table 7.** Average values of the sub-coefficients of Didactic design [1]

	$\bar{\varnothing}EI$	$\bar{\varnothing}EII$	$\bar{\varnothing}EIII$	$\bar{\varnothing}Ev$	$\bar{\varnothing}Eo$
H	<b>46%</b>	<b>24%</b>	25%	<b>27%</b>	<b>49%</b>
Ku	40%	21%	25%	24%	44%
Ek	29%	23%	38%	24%	35%
Cu	33%	19%	<b>42%</b>	21%	44%
Ci	34%	18%	25%	20%	39%
Ko	36%	14%	25%	19%	40%
Ka	29%	13%	25%	16%	34%
Average	35%	19%	29%	22%	41%

Differences in didactic design according to the type of thesis (diploma or bachelor) were also compared. It was assumed that teaching materials from diploma theses would be better prepared didactically than teaching materials from bachelor theses. However, no statistically significant difference was found at the 5% significance level. Please refer to Table 8 for the results of the chi-square test of independence ( $p > 0.05$ ).

**Table 8.** Differences in the didactic design of teaching materials according to the type of theses [1]

Type of Final Theses	p (Chitest)
Bachelor Theses	0.597
Diploma Theses	0.639

Possible differences in the didactic design of teaching materials were also examined in theses written under the supervision of various university instructors. The assumption was that the overall instructional design of teaching materials prepared under the supervision of various university teachers would differ significantly from one another. However, even in this case, no differences were found in the didactic design of the teaching materials. The values of the total didactic design are nearly identical. Please refer to the results of the chi-square test of independence in Table 9.

**Table 9.** Differences in the didactic design of teaching materials according to the supervisors [1]

Theses Supervisor	p (Chitest)
č.1	0.994
č.2	0.995
č.3	0.996
č.4	0.999
č.5	0.999
č.6	1.000
č.7	1.000
č.8	1.000
č.9	1.000

## 4 DISCUSSION

Research on didactic design according to Průcha's methodology is primarily conducted in the Czech Republic as part of dissertations and diploma theses. In most cases, textbooks for the second level of primary schools and secondary school textbooks for various subjects such as chemistry, natural history, history, and geography are evaluated. The results of the total didactic design (E) of the textbooks examined range from 30% to 92% and are presented in Appendix, Section 7.3, Table A3.

- The apparatus with the lowest level of didactic design is the learning management apparatus (LMS).
- The rate of use of visual components is higher than the rate of use of verbal components ( $E_o > E_v$ ).

The low level of use of the learning management apparatus indicates a significant underestimation, a greater lack of recognition, and an underestimation of the importance of the process of pupils learning in the development of textbooks and teaching materials.

Textbooks and similar teaching materials should serve as a guide for pupils learning, tailored to their individual activities. Learning is an active process. The idea that teaching involves simply telling pupils information and expecting them to memorize it is outdated. According to Petty [4], successful learning involves pupils creating their own understanding of the information (personal hypotheses) they are familiar with. The teacher can help pupils create their own experiences by discussing, thinking about, and using facts, thereby restructuring them into personal meanings [3]. This idea of learning is elaborated in detail in the constructivist conceptions of education that go beyond traditional transmissive teaching, as discussed by authors such as Piaget, Bertrand, and Vygotsky. Constructivism posits that learning involves integrating new knowledge into existing knowledge structures. However, the critical and fundamental point is that the learner's engagement and active participation in their knowledge are necessary to progress from the current level of understanding to a new level [22].

The apparatus of learning management is distinguished from the apparatus of curriculum presentation by structural components that fulfil different functions in

teaching materials. In the apparatus context of curriculum presentation, teaching materials primarily serve an informational function, which is conveyed through *explanatory text, summaries, and visual representations*. In the apparatus realm of learning management, the functions of motivation, differentiation, control, the development of learning strategies, and self-assessment are implemented. The range of structural components that support learning management is extensive, but based on the findings, they are not utilised to their full potential.

The analysed teaching materials could enhance the stimulation of pupils and guide their cognitive activities through *structural components that encourage thinking about the material, instructions for working with the teaching material, differentiation of basic and extension material for easier individualization of teaching, tasks, questions, and assignments to stimulate pupils' interest and develop different levels of knowledge (according to Bloom's taxonomy), guidance on higher-level tasks including extracurricular activities, components for pupils' self-assessment, and links to other sources of knowledge*.

The higher use of visual components compared to verbal components suggests that visual structural components are more effectively utilised in creating teaching materials than verbal structural components.

The visual components are intended to enhance the cognitive, aesthetic, and emotional impact of learning. While visual components enhance the appearance and appeal of teaching materials, their presence alone does not ensure their effectiveness as educational tools.

The visual components include illustrations (*pictures, photographs, technical drawings, diagrams, and maps*) and the graphic design of the textbook (*font type, colours used, and graphic symbols*). The verbal components consist of words and sentences.

What may be the reason for not using a wide repertoire of structural components? The authors of the examined teaching materials are students from teacher training colleges, and the teaching materials were part of their final theses (bachelor's and master's theses). The students have taken several didactic courses during their studies (e.g., General Didactics, Didactics of Professional Subjects, Didactics of Practical Teaching, Seminar in Didactics of Professional Subjects, etc.), where they were introduced to the didactic system and the basics of the theory of the textbook. The final theses are demanding to prepare. Students demonstrate their ability to apply the knowledge acquired during their studies. Careful consideration of the topic and study of the relevant literature are expected. Nevertheless, it is evident from the results presented in this article that the learning management system has been undervalued.

In the context of discussing the results of didactic design, it is worth noting that Průcha's method was developed at the end of the 20th century, which is more than 20 years ago. Since then, many aspects of education have changed, primarily due to the rapid advancements in sciences, information technologies, and society. Educational strategies have evolved by reducing the curriculum content, emphasising the acquisition of key competencies, and utilising a wide array of didactic tools and aids, both material and non-material.

Although Průcha's measurement of didactic design is relatively simple, fast, and universally applicable, it has its drawbacks. The evaluation process does not take into account the frequency of occurrence of each structural component. Some of the structural components measured are outdated. For example, future teachers never used *artistic illustrations* in their teaching materials, *such as front and back covers for diagrams and tables, marginalia, exclusions, and vivid headings*. Last but not least, it should be emphasised that in this paper, the teaching materials evaluated focused

on a single topic or thematic unit, not entire textbooks. Therefore, it can be assumed that some structural components will not be used, and the didactic design will be lower compared to the textbooks.

Only 4 out of 36 structural components (*summary of the whole year, summary of the previous year, questions and tasks for the whole year, questions and tasks for the previous year*) appear to be unsuitable for teaching materials. A lower level of didactic design is justified, but certainly not below 50% of the total didactic design.

From today's perspective, it would be advisable to develop a new evaluation tool that prioritises the incorporation of structural components (quality criteria) that align with current educational strategies and findings from research on quality criteria for teaching materials across different countries globally. The purpose of the new evaluation tool should be to provide guidance to future and current teachers on how to create effective teaching materials for pupils. Teaching material should encompass all necessary content to meet the requirements of both the teacher and the pupils.

It should be noted that this article and the analysis presented in it are only concerned with didactic design and thus do not cover the complete issue of textbook theory and similar teaching materials. For example, the teacher's creativity, the choice of appropriate teaching methods, varied, entertaining, and practically oriented activities, organisational forms, teacher-pupil interaction, issues of didactic transformation of content, etc., could be the subject of further research.

## 5 CONCLUSION

A total of 38 materials from various fields of study were examined. The average value of the coefficient of total didactic design is 26% (9 points). The differences between the coefficients of total didactic design (E) of the teaching materials as a whole are not statistically significant. Similarly, comparisons of teaching materials within the same fields of study, across different fields of study, in diploma theses and bachelor theses, and under the guidance of different supervisors do not reveal statistically significant differences.

Future teachers at Czech secondary vocational schools did not demonstrate the ability to compile didactically high-quality teaching material in their final theses during their university preparation for the teaching profession. Differences in individual teaching materials exist, but these differences have not been proven to be statistically significant. The didactic design of the teaching materials for various students is similar (low). Based on this finding, students preparing for a teaching profession struggle to create well-structured teaching materials that can effectively educate their future pupils. Students utilised only a limited number of structural components. The teaching materials focused more on presenting the curriculum than on managing the learning process or guiding pupils through the material.

Educational materials used to educate pupils should, like textbooks, fulfil their functions to the maximum extent possible through structural components. The degree of use of the available structural components can be used to assess the level of didactic design of the teaching materials. In order to create effective teaching materials, teachers should understand which verbal and visual components can be applied and included in them. Learning is an active process based on more complex processes than simply remembering what is heard or seen. A successful learning process activates learners to think about facts, discuss them, and apply them practically.



## 6 REFERENCES

- [1] N. Straková, "Creation of the concept of final theses in the field of teaching of professional subjects and practical training and its use in school practice," *Dissertation. Dubnica nad Váhom: DTI College*, 2022.
- [2] T. Oates, "Why textbooks count: A policy paper," *University of Cambridge Local Examination Syndicate*, 2014. <https://www.cambridgeassessment.org.uk/Images/181744-why-textbooks-count-tim-oates.pdf>
- [3] I. I. Iivić, A. Pešikan, and S. Antić, "Textbook quality a guide to textbook standards," *Göttingen: V&R Unipress*, 2013. [https://www.gei.de/fileadmin/gei.de/pdf/publikationen/Expertise/fulltext/EE2\\_quality.pdf](https://www.gei.de/fileadmin/gei.de/pdf/publikationen/Expertise/fulltext/EE2_quality.pdf)
- [4] G. Petty, "Teaching today, a practical guide," *Cheltenham: Nelson Thornes*, 2009.
- [5] C.-C. Fey and E. Matthes, "Textbook quality criteria and evaluation," *The Palgrave Handbook of Textbook Studies*, New York: Springer Nature, 2018. [https://doi.org/10.1057/978-1-137-53142-1\\_11](https://doi.org/10.1057/978-1-137-53142-1_11)
- [6] AAER: "Die onlineversion des augsburger analyse- und evaluationrasters, augsburg: Univesitat augsburg," *Zentrum für digitales Lehren und Lernen*. 2023. <https://digillab.uni-augsburg.de/online Dienste/das-augsburger-analyse-und-evaluationsraster-aaer/>
- [7] M. Nogová and J. Huttová, "Process of development and testing of textbook evaluation criteria in slovakia. Caught in the web or lost in the textbook?" *Eighth International Conference on Learning and Educational Media*, 2006.
- [8] Act No. 561/2004 Coll.: Act on pre-school, primary, secondary, higher vocational and other education (Education Act). Prague: Parliament of the Czech Republic, 2004.
- [9] P. Knecht and T. Janík. "Textbook from the perspective of pedagogical research," Brno: Paido, 2008.
- [10] J. Mikk, *Textbook: Research and Writing*. Frankfurt am Main: Lang, 2000.
- [11] Education Burea, *Guiding Principles for Quality Textbooks*, Hong Kong: The Government of the Hong Kong Special Administrative Region, 2016. <https://www.edb.gov.hk/en/curriculum-development/resource-support/textbook-info/GuidingPrinciples/index.html>
- [12] H. TH. Salim ALRikabi, M. J. Al-Dujaili, B. H. Majeed, and I. R. N. ALRubeei, "Information and communication technology and its impact on improving the quality of engineering education systems," *International Journal of Engineering Pedagogy (ijEP)*, vol. 14, no. 1, pp. 4–19, 2024. <https://doi.org/10.3991/ijep.v14i1.46943>
- [13] Ch. Gim, "A critical review of textbook authorization system in the republic of Korea," *Eighth International Conference on Learning and Educational Media: Caught in the Web or Lost in the Textbook*. Paris: IARTEM, 2006.
- [14] T. T. A. N. Ngo, "Perception of engineering students on social constructivist learning approach in classroom," *International Journal of Engineering Pedagogy (ijEP)*, vol. 14, no. 1, pp. 20–38, 2024. <https://doi.org/10.3991/ijep.v14i1.43101>
- [15] M. R. Yousif, L. T. Ameen, B. M. Jassim, and B. H. Majeed, "The impact of two proposed strategies based on active learning on students' achievement at the computer and their social intelligence," *International Journal of Engineering Pedagogy (ijEP)*, vol. 14, no. 1, pp. 39–49, 2024. <https://doi.org/10.3991/ijep.v14i1.47085>
- [16] G. Kolbeck and T. Röhl, "Textbook practices: Reading texts, touching books," *The Palgrave Handbook of Textbook Studies*, 2018. [https://doi.org/10.1057/978-1-137-53142-1\\_29](https://doi.org/10.1057/978-1-137-53142-1_29)
- [17] J. Průcha, *Textbook: Theory and Analysis of Educational Media*, Brno: Paido, 1998.
- [18] D. Zujev, *How to Create Textbooks*. Bratislava: SPN, 1986.
- [19] J. Mikk, "Textbooks: the future of the nation," *Textbook Evaluation*, Brno: Paido, 2007.
- [20] T. I. Hansen and S. T. Gissel, "Quality of learning materials," *IARTEM e-Journal*. Kongsberg: IARTEM, 2017. [Online]. Available: <https://doi.org/10.21344/iartem.v9i1.601>

- [21] N. Straková, "Analysis of diploma theses in the field of teaching of vocational subjects for secondary vocational schools – the first research probe," in *13th International Scientific Didactic Conference*. Brno: Masaryk University, 2019.
- [22] Y. Bertrand, *Contemporary Theories and Practice in Education*, Madison, WI: Atwood Publishing, 2003.

## 7 APPENDIX

### 7.1 Textbook components

**Table A1.** Examples of structural and organizational components of a textbook [3]

Structural Components	Organisational Components
Content	Content
Main text	Different types of indices
Introductory questions for the whole chapter or thematic unit (key questions)	Subject index
Maps, charts, diagrams	Author Index
Timelines	List of abbreviations
A field with key information related to a specific topic unit	List of illustrations
Frame containing keywords	Various types of supplementary tables (for logarithms, climatic properties, chemical elements, etc.)
A box with interesting facts or information	An introductory explanation of the structure of the textbook,
Box with puzzles	An introductory explanation of each image, symbol or colour,
Box with content from original sources	Tags and links for each illustration, chart, source, etc.,
A box containing stories with content relevant to the thematic unit	Bibliographies,
Question or tasks in addition to the main text of the thematic unit	Notes on the authors.
Photographs, pictures or illustrations	
Questions and tasks placed next to photographs, pictures or illustrations	
Questions and tasks at the end of the topic	
Historical sources relevant to the thematic unit	
A checklist to monitor pupils' understanding of a small section of text ("Is everything clear?") – something between summary and follow-up questions and tasks	
A box containing a summary of a part of the topic, thematic unit	

(Continued)

**Table A1.** Examples of structural and organizational components of a textbook [3] (*Continued*)

Structural Components	Organisational Components
A list of key terms to remember from the topic, from the whole chapter	
A concept map providing an organizational chart, all key concepts from the thematic unit and how these concepts relate to each other	
An overview of the entire content, indicating how each topic relates to the others	
A concept map or diagram for a thematic unit,	
Metacognitive materials (explanations and instructions on how to interpret diagrams, charts, tables and graphs, illustrations, etc.)	
An overview of the material that has been previously listed	
Links to other parts of the text in the textbook	
A timeline or list of key dates and events from the thematic unit	
Links to other resources, CDs, websites, etc.	
Glossary at the end of the textbook	
Biographies of important historical figures at the end of the textbook	
Reading list	
Suggestions for further reading	
“Leap” in time (shows how the phenomenon discussed in the thematic unit is related to the present)	

## 7.2 Procedure for measuring didactic design

The measurement of didactic design is based on the premise that textbooks and similar teaching materials are composed of structural components of various natures. The structural components perform different functions and work together to serve the main purpose of teaching materials, which is to act as an educational medium.

Průcha [17] distinguishes 36 organization components in the structure of a textbook, as shown in Table A2. The structural components are divided into three apparatuses based on their respective didactic functions (presentation of the material, learning management, and orientation apparatus) and two apparatuses based on their modes of expression (verbal and visual apparatus). The measurement procedure, as outlined by Průcha [17], is as follows:

1. The occurrence of individual structural components in a particular textbook is identified and recorded on special sheets.
2. Several coefficients are calculated from the observed values.
  - a. Partial coefficients of the didactic design of the textbook:
    - i) Coefficient of use of the curriculum presentation apparatus (EI, 14 components);

- ii) Coefficient of use of the learning management apparatus (EII, 18 components);
  - iii) Coefficient of use of the orientation apparatus (EIII, 4 components);
  - iv) Coefficient of use of the verbal components (Ev, 27 components);
  - v) Coefficient of utilization of the visual components (Eo, 9 components);
  - b. Overall coefficient of didactic design of the textbook (E, 36 components);
3. The values of these coefficients are interpreted in terms of how a particular textbook uses or does not use the possibilities from the existing repertoire of structural components of the textbook. That is, in which didactic functions the textbook is appropriately or inappropriately constructed.
  4. Correction of any didactic deficiencies in the textbook.

The calculation of all coefficients (E I, E II, E III, Ev, E o, E) corresponds to the percentage of structural components actually used out of the total possible structural components.

$$E = \frac{\text{The real number of structural components}}{\text{Ideal number of structural components}} \times 100$$

I.e., a particular textbook uses 9 components out of 14 possible components from the apparatus for the presentation of the curriculum (EI), the calculation of the coefficient  $EI = 9/14 \times 100 = 64.28\%$ . All coefficients can take values in the range of 0 to 100%. As the value of the coefficient approaches the upper limit, the didactic design becomes more effective (in the respective apparatus or the entire didactic text).

**Table A2.** Structural components of the textbook [17]

I. Apparatus for the Presentation of the Curriculum	
(A) Verbal Components	
1.	Explanatory plain text
2.	Explanatory text in a clear manner (overview diagrams, tables, etc. for interpretation of the curriculum)
3.	Summary of the lessons for the whole year
4.	Summary of the topics (chapters, lessons)
5.	Summary of the previous year's learning
6.	Supplementary texts (documentary material, quotations from sources, statistical tables etc.)
7.	Notes and explanations
8.	Subtexts to the illustrations
9.	Glossaries of terms, foreign words, etc. (with explanations)
(B) Visual Components	
1.	Artistic illustration
2.	Scientific illustrations (schematic drawings, models)
3.	Photographs
4.	Maps, cartograms, plans, charts, diagrams, etc.
5.	Image presentation in colour (i.e., use of at least one colour different from that of the regular text)

*(Continued)*

**Table A2.** Structural components of the textbook [17] (*Continued*)

<b>II. Learning Management Apparatus</b>	
(C) Verbal Components	
1.	Preface (introduction to the subject, grade for pupils)
2.	Instructions for working with the textbook (for pupils and/or teachers)
3.	General stimulation (thought-provoking questions, questions, etc. before the overall learning year)
4.	Detailed stimulation (thought-provoking, questions, etc. before or during lessons, topics)
5.	Differentiation of levels of learning (basic - extension, compulsory - optional)
6.	Questions and tasks for topics, lessons
7.	Questions and tasks for the whole year (revision)
8.	Questions and exercises for the previous year (revision)
9.	Instructions for tasks of a more complex nature (instructions for experiments, laboratory work, observations, etc.)
10.	Suggestions for extra-curricular activities using the curriculum (applications)
11.	Explicit statement of learning objectives for pupils
12.	Means and/or instructions for self-assessment for pupils (tests and other ways of assessing learning outcomes)
13.	Results of the tasks and exercises (correct solutions, correct answers, etc.)
14.	References to other sources of information (bibliography, recommended literature)
(D) Visual Components	
1.	Graphic symbols indicating certain parts of the text (lessons, rules, tasks, exercises)
2.	Use of a special colour for certain parts of the verbal text
3.	Use of special fonts (bold, italics) for certain parts of the verbal text
4.	Use of front or back cover (front cover) for diagrams, tables, etc.
<b>III. Apparatus of Orientation</b>	
(E) Verbal Components	
1.	Contents of the textbook
2.	Division of the textbook into thematic blocks, chapters, lessons, etc.
3.	Marginalia, excrescences, live headers, etc.
4.	Index (subject, name, mixed)

### 7.3 Research on didactic design

**Table A3.** Results of similar research on didactic design [1]

	E	Apparatus with the Lowest Value	Eo > Ev	Scope
Teplá (2021)	42.00%–67.00%	EII	Yes	Chemistry
Smutkova (2012)	41.70%–86.10%	–	Yes	Natural History
Šimik (2017)	38.89%–63.89%	EII	Yes	Man and his world
Průcha (2006)	36.10%–75.00%	EII	–	History and Natural History
Jůvová (2006)	58.33%–75.00%	EII	Yes	Natural History
Janoušková (2008)	33.30%–66.70%	EII	Yes	Geography
Tannenberg (2009)	58.33%–91.67%	EII	Yes	History
Researched teaching materials by Strakova (2022)	8.33%–44.44%	EII	Yes	Miscellaneous

## 8 AUTHORS

**Bc. Ing. Nikola Straková, PhD**, Department of Physics, Chemistry, and Vocational Education, Faculty of Education, Masaryk University, Brno, Czech Republic (E-mail: [strakova@mail.muni.cz](mailto:strakova@mail.muni.cz)).

**Prof. Paed Dr. Ing. Roman Hrmo, PhD, MBA, ING-PAED IGIP**, is a Professor and the Vice-Rector for Quality and Development at DTI University in Dubnica nad Váhom, Slovakia.