

THE CUSTOM QUALITIES OF TEXTBOOK IN THE PUPILS' ASSESSING OF BASIC SECONDARY EDUCATION

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The article highlights the results of the pilot study with regard to the evaluation of the custom quality of textbook by students of basic secondary education through their assessment of structural components (student texts, drawings, charts, graphs, diagrams, tasks of different types, field works, educational projects, glossary of terms) of natural science textbooks (biology, chemistry, geography) using the author's methods. The overall assessment as to the custom quality of biology, chemistry and geography textbooks for 9th grades was provided and separately the measurement of custom quality of their polycode texts (drawings, charts, graphs, diagrams), together with all components which require effective implementation (tasks, field works, educational projects, glossary of terms). At the time of this study the following was found out: 1) The proximity of integral assessments of textbooks and affinity of average score of their individual parts which can be attributed to approximately the same experience of every pupil resulting from using of these textbooks, along with linguistic and didactic similarities of their texts and similarity of structural arrangements of textbooks as a whole. 2) The high rate of empirical coefficient of

determination on all data categories of evaluation results that reaffirm that at the time of the study the custom quality of textbook were highlighted from the point of view of pupil.

There are four factors that have been experimentally established («Accessibility», «Visibility», «Interestingness», «Practicality») which characterize the custom quality of textbook from the point of view of the ninth-grader. Thus, the factor «Accessibility» incorporates such characteristics of textbook as simplicity and comprehensibility of its teaching texts, as well as the presence of drawings therein; «Visibility» includes diagrams, graphs and tables; «Interestingness» is a interestingness of study texts and also placement of tests and vocabulary. «Practicality» implies the presence of educational projects and practical works.

The textbook is considered to be a means of scientific activity and the performance measures for the utilization of the latter depends on the quality of method and users' attitude towards structural issues of textbook.

Keywords: structural issues of textbook; factors of custom quality of textbook; natural sciences; basic secondary education.

Problem statement and topicality of the study. Essential differences between textbooks in terms of both quality and integrity for all pupils who are agents involved in education become obvious and consistently relevant due to the fact that practice shows a considerable impact of textbook quality on learning outcomes. A review of the literature devoted to this problem indicates a lack of a common way of thinking among facilitators as regards existing of credible and reliable methodologies for textbook quality assessment. It's in this regard that new approaches and methodologies of textbook assessment as an effort to help fix a problem of rising of their custom quality are constantly emerging and operating.

This study has shown a possible approach to address the problem. The basic thesis of our approach is that designation of significant learning outcome predictors cannot simply wish away from the study of personal perceptual of textbook by pupil as a leading means of education, no matter in what format (printing, electronic, networking or whatever) it is submitted to be used by the pupil. Using textbook study and its usefulness in organizing of private educational activities from the point of view of pupil, in our view, is an important constituent in the definition of quality of a school textbook.

Analysis of recent research and publications. This work is a continuation of author search to develop an objective ways and methodology in quality of school textbooks assessment. In particular, previous research regarded textbook as a coherent means of education that projects a character of a subject in the pupil's perception [1] and, with it, its features and use in the educational process from the pupil's point of view (with the use of semantic differential technology) [2]

was also revealed together with the presented way of the evaluation of quality of a school textbooks with mathematical methods of processing of the results of expert (external) assessment [3].

In the study [4], which uses such an experimental technique, the different approaches the evaluation of quality of school textbooks were considered, the current practice of an experimental expertise of textbooks is analyzed and a justification for pupils acting as evaluators of textbooks quality to increase the objectivity of their evaluation is substantiated. The special manner of perceiving by pupils of 9-11 grades the structural components of a current biology and chemistry school textbooks and bringing these components into organization of educational activities of pupils is experimentally investigated.

At the heart of this work's proposals as to the way of assessing the structural parts of textbook by pupils of basic secondary education the method of integrated assessments is based on, which provides for assessing by pupil of all structural parts of textbook (verbal and polycode texts, tests in a variety of formats, graphics, drawings, diagrams and the like) through their own personal preferences. We consider such an approach as advisable since the review of pedagogical studies highlights the importance of the influence of the particularities of the structural parts of textbook on their custom quality.

In studies dealing with the study of the quality of textbooks the great attention is paid to the issue of influence of different ways of visualizing as characteristic of structural components of educational material on the quality of textbook and consequently on learning outcomes. Indeed J. K. Gilbert in its study [5], based on the assumption that visualization plays a key role in the development of science, claims that is consequently plays a significant role in science education, since scientists should learn to navigate in the way of representation of scientific facts.

The study of I. Devetak and J. Vogrinc [6] highlights that inadequate and inconsistent scientific knowledge filed in textbooks can have a direct negative impact on the ideas of pupils. Nothing but the right combination of visual and verbal aspects in presentation of scientific concepts in textbooks is the ideal option. After all, visual-verbal learning allow for pupils to harmonize the different ways of providing of educational resources and cross — examine information, for example, submitted in the drawing, with the explanations in the text. Researchers have noted that science textbooks contain scientific articles and visual objects (drawings, tables, or whatever) that require pupils to have the ability to «read» it. The methods and tools for data collection were analyzed in this study, which are used in qualitative researches, in particular, a textural analysis that is solid foundation for a thorough analysis of content in textbooks. Much attention was devoted to the description of assessment criteria of the teaching instruments of textbook and the ways to visualize it, along with the level of the scientific format of the text.

The study of R. M. Bernard [7] highlights the results of the research with respect to way the types of signatures under the illustration affect the educational attainment. The author explored two types of signatures, namely, descriptive where contents of illustrations was displayed in writing and educational where the features of illustrations without descriptive text were submitted by. The researcher figured out that use of illustrations alongside descriptive signature produce slightly increased results in educating than using of illustration together with educational signature, and the compound of them both does not add the additional effect.

The influence of text with charts explored K. R. Butcher. In his study [8] he presented the results of an experimental study with respect to differences in the learning results of pupils with the use of following matters: a) text only; b) text with the simplified schemes, which are intended to allocate the crucial structural links; c) text with the most detailed schemes that display a more accurate picture about the substance of the investigated phenomena. The researcher has come to the conclusion in his study that the use of the text with schemes (simplified and detailed), support the development the mental paradigm of pupil, in so doing, simplified schemes in the best way endorse the learning and shall contribute to the formation of the logical conclusion, as well as help to reduce the occurrence of errors and also support the integration of information when studying.

The research findings of M. Kragten, W. Admiraal and G. Rijlaarsdam [9] display that ability to enable responses to questions based on a graphical representation of processes is linked with the preceding pupils' knowledge, as well as with their spatial options and volume of visual-spatial working memory. Differences in the effects of spatial skills were demonstrated within the cognitive interviews while pupils' working on tests based on a graphic representation of the process.

The study of R. A. R. Gurung and R. Martin [10] outlines the research findings as to psychometric properties of textbooks and factors, against which one can predict the dependence of the pupil's score for exam on the time while working with a textbook. On the basis of a structured rating scale developed by the authors, it is shown that a number of significant predictors vary according to a textbook and a class.

R. E. Landrum, R. A. R. Gurung and N. Spann [11] conducted a study among students regarding quality assessment of a textbook, along with an examination of the relationship between the quality of textbooks and connection of students with education and evaluation. They discovered a non- direct communication between the qualities of textbooks, the proportion of material read and actual results of students' training course.

The study of Y. Liu and M. S. Khine [12] analyses the distribution of illustration (diagrams, graphs, charts) in textbooks and workbooks for primary schools in the

Kingdom of Bahrain, the structure and distribution of illustration is revealed and the importance of their role in textbooks, in particular, in the science textbooks is considered to be an important instrument of visualization of primary school pupils' knowledge, which facilitates their conceptual training.

Other study of M. S. Khine and Y. Liu [13] is undertaking an analysis of distribution of illustrations in textbooks and practical tools of natural sciences for primary schools in the United Arab Emirates. The illustrations were analyzed from the viewpoint of their types, functions, thematic cluster, quality, ethnic and gender identities and relation to the text. The authors found that illustrations were essential visualization tool and closely linked to a text in textbooks and practical tools, since most of them transmit statistical information. M. S. Khine and Y. Liu note that every author of textbook must combine text with illustration in his textbook wisely to convey subject knowledge. According to the researchers, the teachers and pupils' point of view can provide an entirely new look on the use of illustrations, since they are the users of textbook. For this reason one of the areas of further research, which they identified, was considering the views of textbook users with regard to illustrations.

So, till then, there is never been a study where pupils would evaluate the quality of textbook through their own attitude to its structural components.

The purpose of the article. *The aim of the research* is to identify factors which characterize the custom quality of science textbooks in terms of pupils' of grade 9 perception to different aspects of building block of textbooks (texts, tasks, figures, tables, etc.), along with their assessment of textbooks' custom quality and polycode texts (figures, tables, graphs, charts) and components that require an urgent implementation (tasks, practical works, educational projects, glossary of terms).

Main part. A textbook as an object of an action is brought not only in a form of a material carrier of subject information before a pupil, who is a subject of activity, but also through substantively and informational relations, which have been engaged into practical issues of subject of learning. In accordance with pedagogical case, pupil uses different structural components of textbook to achieve the goal. In the course of his work he adds properties of things to his own efforts and uses, to the extent of his own understanding, these properties to reach the goal, which facing him as an educational target.

Considering a textbook structure adopted in a pedagogical practice, the experiment could be organized in which a pupil is given an opportunity to evaluate every structural component of textbook in terms of its usefulness for realization of their own educational process. It is clear that such an assessment will be determined by experience of pupil «interaction» with textbook in different training cases. Usually pupils use textbooks to prepare for lesson or exam. Pedagogical

monitoring shows that most pupils hardly use textbook as fully as the teachers and authors expect. It is also should be displayed in some shifting of the school marks of pupils. After all, our experience in examining of expert estimates regarding manuscripts for textbooks, submitted for bidding round, indicates the presence of that shifting facing a sufficiently high number of experts.

In the exploration we based on the conviction that pupil in the use of textbook assumes the role of the user of the many services offered by textbook as a means of activities. From this perspective, the pupil's assessment of any given element of a textbook should be interpreted as evaluations of custom qualities of this component. Without denying the factual that textbook is an integrated system, with the objective to adapt the methodology of assessment to its use under circumstances if this exploration, and taking into account the age and education level of respondents, we have confined ourselves to 14 questions in the questionnaire, divided into two clusters. Pupils had to assess on the scale of 1 to 10 in the first cluster of questionnaire, how simple, comprehensible and interesting are paragraphs of textbook and tests in it for them; the second cluster also suggested evaluating for pupils on the scale of 1 to 10, how drawings, tables, graphs, diagrams, tasks, practical work, educational projects and dictionaries in a textbook help them cope with paragraphs and handle their content. The work with the dictionary, we considered as a separate mission for learning, which includes definition of objectives for information search with a help of a dictionary, and, with it, information search in it and decision-making on the conformity of the gathered information with that concept, on the basis of which this information is found.

Therefore, the answer which was given by pupil to all questions in the questionnaire and was expressed by a specific number on the scale of 1 to 10 has revealed his personal attitudes toward structural components of textbook.

The commissioning of research and processing of the results. In research participated 77 pupils in grade 9 (50,5% of boys and 49,5% of girls). The average age of pupils was 14,39 years old (standard deviation is 0,53).

An author's questionnaire for pupils was used during the research, which consisted of 14 questions. There was a scale of 1 to 10, on the basis of which pupils rated their attitudes to the structural components (texts, tasks, figures, tables, etc.) of textbooks on biology, geography and chemistry used in grade 9.

The purpose of the questionnaire is to figure out evaluation of pupils who participated in the research in respect of their attitude toward various aspects of structural components of textbooks in terms of engaging these components in organizing their own educational activities.

During the research, pupils gave answers on its own, without receiving any external assessment as to the correctness of an assessment process of characteristics suggested in the questionnaire. The description of particulars

that had been selected for the experiment allowed accommodating them into ordinal scale, which made it possible to enact a linear regularity of objects in a defined axle of indication, that is, to implement the ranking immediately during the assessment. The concept of ranking is understood by us as a process of the immediate ordering of objects by respondent (in this case, is a pupil) in accordance with internal benchmarks accepted by him and this process is a fully subjective [14].

The hierarchy of advantage constructed by respondent was recorded in the tables of object numbers, which then were converted into the matrix of evaluation, that is, the matrix, which accommodate information regarding the position of each object on each assessed origin. The extensive use an ordinal scale for measuring in pedagogical and psychological research due to the fact that for data interpretation, which are obtained with the help of an ordinal scale, a broad spectrum of statistical measurements can be used (such as correlation, dispersed and factor analysis) [15]. An interviewing techniques used in this research was based on the recommendations presented in the study of R. A. R. Gurung and R Martin [10]. The questionnaire used the questions that, in our judgment, evaluate the main components of textbook, namely, educational texts, drawings, tables, graphs, diagrams, tasks of different types, practical work, educational projects, glossary of terms and would in addition provide the opportunity to respondents (pupils) to express its attitude to the level of involvement of these components to their own educational activities and define this in numerical terms.

Thus, each judgment of respondent that has been evaluated during the research concerning components of a textbook was recorded by an integer (score) A_{ij} , in other words, the implementation of judgment quantification process is executed. And therefore, the quality assessment was transferred to an ordinal scale for which the monotonous transformations are permissible.

During the analysis of the research results on the basis of a answers matrix (questioning matrix) $|A_{ij}|$ measuring $n \times m$ ($i = 1, n; j = 1, m$, where n — the numbers of interviewed (respondents), m — the amount of components of a textbook filed with the questionnaire, the average scores (\bar{A}_{ij}) of each component of a textbook were calculated, with which the general (integral) assessment was determined from the perspective of pupils on its custom quality as a means of educational activities. An integrated assessment of custom quality of textbooks was calculated by formula (1):

$$\bar{A} = \sum_{j=1}^m \sum_{i=1}^n \frac{A_{ij}}{m_{ij}n_{ij}} \quad (1)$$

The processing results of a questionnaire matrix dates $|A_{ij}|$ presented in the table 1.

Table 1

The overall ratings of customer qualities of textbooks

Textbooks on subjects	\bar{A}	Standard errors	Confidence intervals*	α Cronbach **	The empirical coefficient of determination (η^2)
Chemistry	7,202	0,244	$\pm 0,478$	0,707	83,37%
Biology	6,847	0,233	$\pm 0,457$	0,893	87,82%
Geography	6,386	0,223	$\pm 0,436$	0,834	88,47%
N = 77; * $\alpha = 0,05$; ** $\delta < 0,0001$					

With a view to determining specificities in attitude of pupils to texts that use polycode texts (drawings, tables, graphs and charts), the matrix «polycode» $|A_{ij, polycode}|$ was singled out from a general questionnaire matrix $|A_{ij}|$, the processing results of which is presented in the table 2.

Table 2

The ratings of customer qualities of polycode texts in textbooks

Textbooks on subjects	$\bar{A}_{polycode}$	Standard errors	Confidence intervals *	α Cronbach **	The empirical coefficient of determination (η^2)
Chemistry	7,045	0,428	$\pm 0,839$	0,527	58,49%
Biology	7,098	0,359	$\pm 0,703$	0,774	71,41%
Geography	7,295	0,208	$\pm 0,408$	0,718	89,94%
N=77; * $\alpha = 0,05$; ** $\delta < 0,0001$					

With a view to determining specificities in attitude of pupils to tests of a different types, including practical work, educational projects and dictionaries, the matrix «tests» $|A_{ij, tests}|$ was singled out from a general questionnaire matrix $|A_{ij}|$, the processing results of which is presented in the table 3.

Table 3

The rating of customer qualities of textbook's elements that require implementation

Textbooks on subjects	\bar{A} tests	Standard errors	Confidence intervals *	α Cronbach **	The empirical coefficient of determination (η^2)
Chemistry	7,464	0,110	$\pm 0,216$	0,302	96,95%
Biology	6,964	0,092	$\pm 0,179$	0,570	98,37%
Geography	5,977	0,169	$\pm 0,331$	0,571	95,73%
N=77; * $\alpha = 0,05$; ** $\delta < 0,0001$					

The empirical coefficients of determination (η^2) show in terms of the percentage how personal views of pupil influence his attitude to the structural components of textbook. To process the results of the research the software package *MS Excel for Windows* was used.

We used a factor analysis to reduce the dimension of dynamic database set that described the attitude of respondents to structural components of textbook. In particular, the factors have been singled out by the principle component analysis and used the factor level after the rotation by the method of varimax. This allowed interpreting the factors based on the differences of factor load, and also allowed for the classification of factors and build a four-factor model of the investigated phenomena.

This research, whose goal is test a hypothesis as to differences in the minds of pupils with respect to custom qualities of a textbook, is carried out on a small-scale sample (N = 77). However, the study of J. C. F. de Winter, D. Dodou and P. A. Wieringa [16] has proof that the volume of the sample N = 50 is an acceptable minimum. Given the results of the research of K. J. Preacher and R. C. MacCallum [17], who recommended that there has to be a limitation in the number of anticipated factors for small samples, the four factors that determined dispersion on the level 67,68% were singled out by us. According to the research of U. Lorenzo-Seva [18] and J. L. Horn [19], if cumulative (accumulated) percent of general dispersion reaches 60% and more, you can stop at a given number of factors.

While processing the data by means of *Statistica 10 for Windows* the factor structure was figured out and scales load on factors was found. The dominant load of each factor had such characteristics, which are submitted below in order of decreasing of factor load. Set of characteristics that make up the designated factors, allow their

interpretation and formulating an appropriate title. The titles of designated factors are formulated conditionally and open to discussion.

Accessibility	<i>Factor 1</i>
Simplicity of the text	0,838610
Comprehensibility of the text	0,789599
Drawings	0,449293
<i>Fraction of general dispersion</i>	20,65%
Visibility	<i>Factor 2</i>
Diagrams	0,837454
Graphics	0,824961
Tables	0,508955
<i>Fraction of general dispersion</i>	16,55%
Interestingness	<i>Factor 3</i>
Interest of the text	0,812441
Tasks	0,598475
Dictionary	0,582490
<i>Fraction of general dispersion</i>	15,95%
Practicality	<i>Factor 4</i>
Educational projects	0,854455
Practical work	0,687681
<i>Fraction of general dispersion</i>	14,53%

Four factors that were figured out («Accessibility», «Visibility», «Interestingness» and «Practicality») make up a tetrad of «custom qualities of a textbook» from the point of view of a ninth-grader.

The division of characteristics between factors is quite interesting, including components of a textbook. So, tests and dictionary are included in the factor «Interest» and educational projects and practical work joined the factor «Practicality». Drawings are one of the characteristics of the «Accessibility» factor and not the «Visibility» factor which includes charts, graphs and tables. The placement of drawings in the «Accessibility» factor, in our view, comes from the fact that they form an integral part in the paragraphs of the science textbooks (biology, chemistry, geography) and assist pupils to understand their content. So, there are plants, animals, their structure, the structure of the plants' organs, the

structure of animals' life support systems, and the structure of different cells can be seen in the drawings of biology textbooks, geographic features (nature, industries, cities, etc) are in geography textbooks, the structure of molecules of various chemical elements and the pictures of different chemical research (chemical reactions) are in chemistry textbooks, etc.

Conclusions.

1. The science textbooks on biology, chemistry, geography include rather complicated scientific concepts and terms. The variety of forms of presentation of educational material submitted in it, contributes to learning of educational information, as well as to the competency forming while researching the subject matter, along with cognitive and metacognitive developing of personal qualities.
2. The closeness of integral assessments of the science textbooks, which participated in the research, along with proximity of average scores of their separate parts (tables 1-3) can be attributed to roughly the same level of pupils' experience which are shaped during the use of these textbooks, and also to the likeness of linguistic and didactic features of the texts in textbooks and finally to the likeness, in general, of structural arrangements of the textbooks mentioned above.
3. High rates of empirical coefficients of determinations of all positions of assessment results attest to the fact that pupils' statements concerning structural components of textbooks based on their own awareness as to usability of these components in order to organize their own educational activities, that is, reflects the custom qualities of textbook from the pupil's point of view.
4. The four factors, which have been figured out based on the processed results the research, namely («Accessibility», «Visibility», «Interestingness» and «Practicality») that characterize the custom quality of textbook from the point of view of a ninth-grader are generally consistent with the views of the majority of educators, as well as with the formed theoretical insights as to the basic qualities of textbook, which in turn, may by an indication of a correctness of the chosen direction in building of the technique of estimation of the quality of textbooks used in schools.
5. It is proposed to consider the further research as viable and proceed with it as to the quality of textbooks and the developing of relevant methodologies of their assessment through detail of characteristics of textbooks in accordance with designated factors of custom qualities with the use of methods of experimental psychosomatics, and also regarding the assessment of custom qualities of textbooks of various educational fields, for example, textbook on Ukrainian language, math textbook and one of a science textbook put together.

References

- [1] Yu. O. Zhuk, «Influence of school textbooks on the formation of academic subject image», *Problems of a modern textbook* : scientific works collection, articles part 1, issue 15, pp. 200-211, 2015. [Online]. Available: <http://lib.iitta.gov.ua/106527/>. Accessed on: Sept. 10, 2020. (in Ukrainian).
- [2] Yu. O. Zhuk, «A textbook image in perception of upper-formers», *Problems of a modern textbook* : scientific works collection, issue 16, pp. 148-166, 2016. [Online]. Available: <http://lib.iitta.gov.ua/166248/>. Accessed on: Sept. 10, 2020. (in Ukrainian).
- [3] Yu. O. Zhuk, «Evaluation of school text-books quality level: model of a priory expertise results processing», *Problems of a modern textbook* : scientific works collection, issue 9, pp. 7-18, 2009. [Online]. Available: <http://lib.iitta.gov.ua/2882/>. Accessed on: Sept. 10, 2020. (in Ukrainian).
- [4] Yu. O. Zhuk, and L. S. Vashenko, «Assessment of the role of the structural components of the natural cycle textbooks in the organization of their own educational activity by high school students», *Problems of a modern textbook* : scientific works collection, issue 23, pp. 81-97, 2019. [Online]. Available: <https://lib.iitta.gov.ua/719003/>. Accessed on: Sept. 10, 2020. (in Ukrainian).
- [5] J. K. Gilbert, «Visualization: A Metacognitive Skill in Science and Science Education», in *Visualization in Science Education*, J. K. Gilbert, Ed. Dordrecht, The Netherlands: Springer, 2007, pp. 9-27. [Online]. Available: <https://www.springer.com/de/book/9781402036125>. Accessed on: Sept. 10, 2020. (in English).
- [6] I. Devetak, and J. Vogrinc, «The Criteria for Evaluating the Quality of the Science Textbooks», in *Critical Analysis of Science Textbooks*, M. S. Khine, Ed. Dordrecht, The Netherlands: Springer, 2013, pp. 3-15. [Online]. Available: <https://www.springer.com/gp/book/9789400741676>. Accessed on: Sept. 10, 2020. (in English).
- [7] R. M. Bernard, «Using extended captions to improve learning from instructional illustration», *British Journal of Educational Technology*, vol. 21, issue 3, pp. 215-225, 1990. [Online]. Available: <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-8535.1990.tb00040.x>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1111/j.1467-8535.1990.tb00040.x>. (in English).
- [8] K. R. Butcher, «Learning from text with diagrams: Promoting mental model development and inference generation», *Journal of Educational Psychology*, vol. 98, no. 1, pp. 182-197, 2006. [Online]. Available: <https://psycnet.apa.org/record/2006-02666-015>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1037/0022-0663.98.1.182>. (in English).
- [9] M. Kragten, W. Admiraal, and G. Rijlaarsdam, «Students' Ability to Solve Process-diagram Problems in Secondary Biology Education», *Journal of Biological Education*, vol. 49, issue 1, pp. 91-103, 2015. [Online]. Available: <https://www.tandfonline.com/doi/full/10.1080/00219266.2014.888363>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1080/00219266.2014.888363>. (in English).
- [10] R. A. R. Gurung, and R. C. Martin, «Predicting Textbook Reading: The Textbook Assessment and Usage Scale», *Teaching of Psychology*, vol. 38, issue 1, pp. 22-28, 2011. [Online]. Available: <https://journals.sagepub.com/doi/full/10.1177/0098628310390913>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1177/0098628310390913>. (in English).

- [11] R. E. Landrum, R. A. R. Gurung, and N. Spann, «Assessments of Textbook Usage and the Relationship to Student Course Performance», *College Teaching*, vol. 60, issue 1, pp. 17–24, 2011. [Online]. Available: <https://www.tandfonline.com/doi/full/10.1080/87567555.2011.609573>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1080/87567555.2011.609573>. (in English).
- [12] Y. Liu, and M. S. Khine, «Content Analysis of The Diagrammatic Representations of Primary Science Textbooks», *Eurasia Journal of Mathematics, Science & Technology Education*, vol. 12, issue 8, pp. 1937-1951, 2016. [Online]. Available: <https://www.ejmste.com/article/content-analysis-of-the-diagrammatic-representations-of-primary-science-textbooks-4582>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.12973/eurasia.2016.1288a>. (in English).
- [13] M. S. Khine, and Y. Liu, «Descriptive Analysis of the Graphic Representations of Science Textbooks », *Textbooks. European Journal of STEM Education*, vol. 2, issue 3, 2017. [Online]. Available: <https://www.lectitopublishing.nl/Article/Detail/descriptive-analysis-of-the-graphic-representations-of-science-textbooks>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.20897/ejsteme/81285>. (in English).
- [14] J. Grzegorek, and A. P. Wierzbicki, «Multiple Criteria Evaluation and Ranking of Social Penetration of Information Society Technologies», *Journal of Telecommunications and Information Technology*, no. 4, pp. 3-13, 2012. [Online]. Available: <https://www.itl.waw.pl/czasopisma/JTIT/2012/4/3.pdf>. Accessed on: Sept. 10, 2020. (in English).
- [15] L. Kroker, and Dzh. Algina, *An Introduction to Classical and Modern Test Theory : a textbook*. Moskva, Rossiya: Logos, 2010. (in Russian).
- [16] J. C. F. de Winter, D. Dodou, and P. A. Wieringa, «Exploratory Factor Analysis with Small Sample Sizes», *Multivariate Behavioral Research*, vol. 44, issue 2, pp. 147-181, 2009. [Online]. Available: <https://www.tandfonline.com/doi/abs/10.1080/00273170902794206>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1080/00273170902794206>. (in English).
- [17] K. J. Preacher, and R. C. MacCallum, «Exploratory Factor Analysis in Behavior Genetics Research: Factor Recovery with Small Sample Sizes», *Behavior Genetics*, vol. 32, issue 2, pp. 153-161, 2002. [Online]. Available: <https://link.springer.com/article/10.1023/A:1015210025234>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1023/A:1015210025234>. (in English).
- [18] U. Lorenzo-Seva, *How to report the percentage of explained common variance in exploratory factor analysis. Technical Report*, Tarragona, Spain: Universitat Rovira i Virgili, Department of Psychology, 2013. [Online]. Available: http://psico.fcep.urv.es/utilitats/factor/documentation/Percentage_of_explained_common_variance.pdf. Accessed on: Sept. 10, 2020. (in English).
- [19] J. L. Horn, «A rationale and test for the number of factors in factor analysis», *Psychometrika*, vol. 30, issue 2, pp. 179-185, 1965. [Online]. Available: <https://link.springer.com/article/10.1007/BF02289447>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1007/BF02289447>. (in English).

Використані джерела

- [1] Ю. О. Жук, «Вплив шкільного підручника на формування в учнів образу навчального предмета», *Проблеми сучасного підручника* : зб. наук. праць, Ч. 1, Вип. 15, с. 200-211, 2015. [Електронний ресурс]. Доступно: <http://lib.iitta.gov.ua/106527/>. Дата звернення: Вересень 10, 2020.
- [2] Ю. О. Жук, «Образ шкільного підручника в уявленні старшокласників», *Проблеми сучасного підручника* : зб. наук. праць, Вип. 16, с. 148-166, 2016. [Електронний ресурс]. Доступно: <http://lib.iitta.gov.ua/166248/>. Дата звернення: Вересень 10, 2020.
- [3] Ю. О. Жук, «Оцінювання рівня якості шкільних підручників: модель опрацювання результатів апіорної експертизи», *Проблеми сучасного підручника* : зб. наук. праць, Вип. 9, с. 7-18, 2009. [Електронний ресурс]. Доступно: <http://lib.iitta.gov.ua/2882/>. Дата звернення: Вересень 10, 2020.
- [4] Ю. О. Жук, та Л. С. Ващенко, «Оцінювання старшокласниками ролі структурних складників підручників природничого циклу в організації власної навчальної діяльності», *Проблеми сучасного підручника* : зб. наук. праць, Вип. 23, с. 81-97, 2019. [Електронний ресурс]. Доступно: <https://lib.iitta.gov.ua/719003/>. Дата звернення: Вересень 10, 2020.
- [5] J. K. Gilbert, «Visualization: A Metacognitive Skill in Science and Science Education», in *Visualization in Science Education*, J. K. Gilbert, Ed. Dordrecht, The Netherlands: Springer, 2007, pp. 9-27. [Online]. Available: <https://www.springer.com/de/book/9781402036125>. Accessed on: Sept. 10, 2020.
- [6] I. Devetak, and J. Vogrinc, «The Criteria for Evaluating the Quality of the Science Textbooks», in *Critical Analysis of Science Textbooks*, M. S. Khine, Ed. Dordrecht, The Netherlands: Springer, 2013, pp. 3-15. [Online]. Available: <https://www.springer.com/gp/book/9789400741676>. Accessed on: Sept. 10, 2020.
- [7] R. M. Bernard, «Using extended captions to improve learning from instructional illustration», *British Journal of Educational Technology*, vol. 21, issue 3, pp. 215-225, 1990. [Online]. Available: <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-8535.1990.tb00040.x>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1111/j.1467-8535.1990.tb00040.x>.
- [8] K. R. Butcher, «Learning from text with diagrams: Promoting mental model development and inference generation», *Journal of Educational Psychology*, vol. 98, no. 1, pp. 182-197, 2006. [Online]. Available: <https://psycnet.apa.org/record/2006-02666-015>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1037/0022-0663.98.1.182>.
- [9] M. Kragten, W. Admiraal, and G. Rijlaarsdam, «Students' Ability to Solve Process-diagram Problems in Secondary Biology Education», *Journal of Biological Education*, vol. 49, issue 1, pp. 91-103, 2015. [Online]. Available: <https://www.tandfonline.com/doi/full/10.1080/00219266.2014.888363>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1080/00219266.2014.888363>.
- [10] R. A. R. Gurung, and R. C. Martin, «Predicting Textbook Reading: The Textbook Assessment and Usage Scale», *Teaching of Psychology*, vol. 38, issue 1, pp. 22-28, 2011. [Online]. Available: <https://journals.sagepub.com/doi/full/10.1177/0098628310390913>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1177/0098628310390913>.

- [11] R. E. Landrum, R. A. R. Gurung, and N. Spann, «Assessments of Textbook Usage and the Relationship to Student Course Performance», *College Teaching*, vol. 60, issue 1, pp. 17-24, 2011. [Online]. Available: <https://www.tandfonline.com/doi/full/10.1080/87567555.5.2011.609573>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1080/87567555.2011.609573>.
- [12] Y. Liu, and M. S. Khine, «Content Analysis of The Diagrammatic Representations of Primary Science Textbooks», *Eurasia Journal of Mathematics, Science & Technology Education*, vol. 12, issue 8, pp. 1937-1951, 2016. [Online]. Available: <https://www.ejmste.com/article/content-analysis-of-the-diagrammatic-representations-of-primary-science-textbooks-4582>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.12973/eurasia.2016.1288a>.
- [13] M. S. Khine, and Y. Liu, «Descriptive Analysis of the Graphic Representations of Science Textbooks », *Textbooks. European Journal of STEM Education*, vol. 2, issue 3, 2017. [Online]. Available: <https://www.lectitopublishing.nl/Article/Detail/descriptive-analysis-of-the-graphic-representations-of-science-textbooks>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.20897/ejsteme/81285>.
- [14] J. Grzegorek, and A. P. Wierzbicki, «Multiple Criteria Evaluation and Ranking of Social Penetration of Information Society Technologies», *Journal of Telecommunications and Information Technology*, no. 4, pp. 3-13, 2012. [Online]. Available: <https://www.itl.waw.pl/czasopisma/JTIT/2012/4/3.pdf>. Accessed on: Sept. 10, 2020.
- [15] Л. Крокер, и Дж. Алгина, *Введение в классическую и современную теорию тестов* : учебник. Москва, Россия: Логос, 2010.
- [16] J. C. F. de Winter, D. Dodou, and P. A. Wieringa, «Exploratory Factor Analysis with Small Sample Sizes», *Multivariate Behavioral Research*, vol. 44, issue 2, pp. 147-181, 2009. [Online]. Available: <https://www.tandfonline.com/doi/abs/10.1080/00273170902794206>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1080/00273170902794206>.
- [17] K. J. Preacher, and R. C. MacCallum, «Exploratory Factor Analysis in Behavior Genetics Research: Factor Recovery with Small Sample Sizes», *Behavior Genetics*, vol. 32, issue 2, pp. 153-161, 2002. [Online]. Available: <https://link.springer.com/article/10.1023/A:1015210025234>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1023/A:1015210025234>.
- [18] U. Lorenzo-Seva, *How to report the percentage of explained common variance in exploratory factor analysis. Technical Report*, Tarragona, Spain: Universitat Rovira i Virgili, Department of Psychology, 2013. [Online]. Available: http://psico.fcep.urv.es/utilitats/factor/documentation/Percentage_of_explained_common_variance.pdf. Accessed on: Sept. 10, 2020.
- [19] J. L. Horn, «A rationale and test for the number of factors in factor analysis», *Psychometrika*, vol. 30, issue 2, pp. 179-185, 1965. [Online]. Available: <https://link.springer.com/article/10.1007/BF02289447>. Accessed on: Sept. 10, 2020. Doi: <https://doi.org/10.1007/BF02289447>.

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КОРИСТУВАЦЬКІ ЯКОСТІ ПІДРУЧНИКА В ОЦІНЦІ ЗДОБУВАЧІВ БАЗОВОЇ СЕРЕДНЬОЇ ОСВІТИ

У статті висвітлено результати експериментального дослідження щодо оцінювання здобувачами базової середньої освіти користувацьких якостей підручника через оцінювання структурних складових (навчального тексту, малюнків, таблиць, графіків, діаграм, завдань різних типів, практичних робіт, навчальних проєктів, термінологічного словника) підручників з природничих предметів (біології, хімії, географії) з використанням авторської методики. Представлено загальні оцінки користувацьких якостей підручників біології, хімії і географії для 9-го класу та окремо оцінки користувацьких якостей їх полікодових текстів (малюнків, таблиць, графіків, діаграм) та складових, що вимагають виконання (завдань, практичних робіт, навчальних проєктів, термінологічного словника). Під час дослідження виявлено: 1) близькість інтегральних оцінок підручників та близькість середніх оцінок їх окремих складових, що можна пояснити приблизно однаковим досвідом здобувачів освіти, сформованим у процесі використання цих підручників, схожістю лінгвістичних і дидактичних особливостей їх текстів та схожістю в цілому структурної побудови підручників; 2) високі показники емпіричних коефіцієнтів детермінації за всіма позиціями результатів оцінювання, які підтверджують, що під час дослідження було висвітлено користувацькі якості підручника з погляду здобувача освіти. Експериментально визначено чотири фактори («Доступність», «Наочність», «Цікавість», «Практичність»), які характеризують користувацькі якості підручника під кутом зору дев'ятикласників. Так, до фактора «Доступність» увійшли такі характеристики підручника, як простота і зрозумілість його навчальних текстів та наявність у ньому малюнків; «Наочність» — розміщення діаграм, графіків і таблиць; «Цікавість» — цікавість навчальних текстів та розташування завдань і словника; «Практичність» — наявність навчальних проєктів і практичних робіт. Підручник розглянуто як засіб навчальної діяльності, результативність використання якого визначається якостями засобу й особистісним ставленням користувача до його структурних складових.

Ключові слова: структурні складові підручника; фактори користувацьких якостей підручника; природничі предмети; базова середня освіта.

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ПОЛЬЗОВАТЕЛЬСКИЕ КАЧЕСТВА УЧЕБНИКА В ОЦЕНКЕ УЧАЩИХСЯ БАЗОВОГО СРЕДНЕГО ОБРАЗОВАНИЯ

В статье представлены результаты экспериментального исследования по оценке учащимися базового среднего образования пользовательских качеств учебника через оценивание ими структурных составляющих (учебного текста, рисунков, таблиц, графиков, диаграмм, задач различных типов, практических работ, учебных проектов, терминологического словаря) учебников по естественным предметам (биологии, химии, географии) с использованием авторской методики. Представлены общие оценки пользовательских качеств учебников биологии, химии и географии для 9-го класса и отдельно оценки пользовательских качеств их поликодовых текстов (рисунков, таблиц, графиков, диаграмм) и составляющих, требующих выполнения (задач, практических работ, учебных проектов, терминологического словаря). В ходе исследования были выявлены: 1) близость интегральных оценок учебников и близость средних оценок их отдельных составляющих, что можно объяснить примерно одинаковым опытом учеников, сложившимся в процессе использования этих учебников, сходством лингвистических и дидактических особенностей их текстов и сходством в целом структурного построения учебников; 2) высокие показатели эмпирических коэффициентов детерминации по всем позициям результатов оценки, подтверждающие, что в ходе исследования были представлены пользовательские качества учебника с точки зрения ученика.

Экспериментально определены четыре фактора («Доступность», «Наглядность», «Интересность», «Практичность»), которые характеризуют пользовательские качества учебника с точки зрения девятиклассников. Так, в фактор «Доступность» вошли такие характеристики учебника, как простота и понятность его учебных текстов и наличие в нем рисунков; «Наглядность» — размещение диаграмм, графиков и таблиц; «Интересность» — интересность учебных текстов и размещение задач и словаря; «Практичность» — наличие учебных проектов и практических работ.

Учебник рассмотрен как средство учебной деятельности, результативность использования которого определяется качествами средства и личностным отношением пользователя к его структурным составляющим.

Ключевые слова: структурные составляющие учебника; факторы пользовательских качеств учебника; естественные предметы; базовое среднее образование.