International Journal of Innovative Research and Scientific Studies, 8(1) 2025, pages: 665-678

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

School terminology: Exploring the terminological apparatus of textbooks in natural and mathematical subjects

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Abstract

Textbooks on mathematics and natural science are two important contexts for using terminological vocabulary. Research and a thorough examination of these textbooks' terminological apparatus appear pertinent given the variety of issues they develop, including theoretical, methodological, and cultural ones. Nevertheless, there has never been an evaluation of the apparatus of the terminology used in math and science textbooks. The study aims to evaluate the quality of the terminological apparatus in school textbooks covering natural and mathematical subjects. The questionnaire consisted of 12 items and covered terminological definition, clarity, supportive examples, etymology, and appropriateness of terms for students. The results showed that while the majority of teachers felt that the textbooks adequately defined new terms and provided helpful examples or illustrations, issues such as vague or misspelled definitions, inappropriate borrowed terms, and awkward pronunciation were also noted. Regression analyses revealed significant sociodemographic predictors of teachers' responses, including experience, age, language of instruction, and qualification category. This study demonstrates the importance of thinking about the quality of the terminological apparatus in school textbooks covering natural and mathematical subjects. The findings highlight the strengths and weaknesses of the terminological apparatus in these textbooks, emphasizing the need for continuous improvement to enhance educational quality. Future research should explore psychological and pedagogical factors influencing students' assimilation of terms, the role of terminological work in professional orientation, and strategies for improving the terminological literacy of future teachers.

Keywords: Terminological apparatus, School textbooks, Mathematics education, Natural science education, Terminology evaluation, Terminological literacy, Textbook analysis.

DOI: 10.53894/ijirss.v8i1.4413
Funding: This research is supported by Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant number: AP19677837).
History: Received: 26 November 2024/**Revised:** 3 January 2025/**Accepted:** 13 January 2025/**Published:** 31 January 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Institutional Review Board Statement: The Ethical Committee of the Abai Kazakh National Pedagogical University, Kazakhstan has granted approval for this study on 14 September 2023 (Ref. No. 3).
Publisher: Innovative Research Publishing

1. Introduction

A textbook has a unique role in improving the quality of teaching and students' knowledge. A textbook plays a unique role in improving the quality of teaching and students' knowledge. Extensive literature exists on the effectiveness and utilization of textbooks in education.

A secondary school textbook provides knowledge of the fundamentals of science, so the task of academic disciplines is to provide general information, expressed in generalized terms, while also incorporating it into the system, consistently introducing new ones, and revealing to students the main links of the system of concepts [1]. This is how a vertical knowledge system is formed when new concepts are introduced based on existing ones and within the range of perception of a schoolchild of a certain age. The most obvious is the adherence to the logical rules for dividing these concepts and the accuracy in formulation when establishing concepts. The logical structure of the educational text is built around a set of concepts that must be mastered by the class curriculum [2, 3]. This system, in its generalized form, reflects the logic of the corresponding branch of knowledge and is distinguished by the order in which terms related to concepts are introduced and connections between them are established. The main ones in the system are the main and fundamental concepts (and thus terms) between which derivatives are situated. However, systematic knowledge formation involves not only the sequence of familiarization with new terms but also the selection of the most rational method of introducing terms into the text by their generally accepted nomenclature, ensuring that schoolchildren understand, memorize and reproduce educational material. The process of understanding an educational text involves two components: knowledge of the meanings of the words used and the presence of a stock of certain scientific concepts required to establish relationships between old and new knowledge. The advancement of science necessitates constant terminological modernization of school textbooks: introducing new terms, changing the content of existing ones (expansion or compression), and clarifying the relationships between terms used in Kazakhstani school textbooks. A clear explanation of the purpose of introducing a new term, including its purpose, correct pronunciation and spelling, and origin, contributes to schoolchildren's success in mastering scientific language and optimizes the process of understanding, memorizing, and reproducing educational material.

Taking into account the number of subjects in Kazakhstan schools, it has been established that the total number of units of special vocabulary is in the thousands. Furthermore, the situation is exacerbated by the implementation of new educational standards in the country, as well as the creation of new educational programs based on them [4, 5]. However, many new terms in school textbooks lack clear, widely accepted content, are unrelated, and frequently contradict established and long-accepted scientific principles. Consequently, the relationship between the terminological density of school textbooks and their effectiveness remains unclear [6]. In some cases, an unreasonable replacement of already established and widely used terms is allowed. In modern textbooks, teaching aids, and dictionaries, there are still incorrect translations of the same term in Kazakh or Russian. In this regard, textbooks use many 'old' and 'new' terms with ambiguous definitions and meanings. Unreasonable synonymy, distorted translations of terms, deviations from approved spelling norms, and rules for writing translated terms are permitted [7]. Unfortunately, the lack of a research base results in ambiguous starting points and the structure of the conceptual and terminological apparatus of school textbooks on natural science and math [8]. All of this suggests that there are certain issues with the use of terminology in natural science and mathematics textbooks [9]. One of them is the conflict between modern requirements for the quality of students' knowledge and the completely insufficient development of pedagogical aspects of teaching terminology in public schools in Kazakhstan. Conceptual gaps and terminological inconsistencies impede scientific communication, limiting the scope of Kazakh educational research and its effectiveness. Unfortunately, the lack of a sufficient research base in the country leads to unclear starting positions and the establishment of the structure of the conceptual and terminological apparatus of school textbooks on natural science and mathematics in public schools in Kazakhstan [10]. All of this necessitates an analysis of the situation, a research study, and, most importantly, an understanding of the problem and the first steps toward a mutually satisfactory solution. The study aims to evaluate the quality of the terminological apparatus in school textbooks covering natural and mathematical subjects.

1.1. Significance of the Study

This study focused on the quality of terminological apparatus in school textbooks covering natural and mathematical subjects. Unfortunately, there is an unclear systematization of terminological units and unified, generally accepted

approaches to both selecting and defining the most important concepts. These and other flaws in the use of terms in textbooks complicate the process of learning natural sciences and math for students. Conceptual gaps and terminological inconsistencies impede scientific communication, limiting the scope of Kazakh educational research and its effectiveness. This article, therefore, argues for the need to evaluate the quality of the terminology in school textbooks on natural science and mathematics in public schools in Kazakhstan. This study adds to the existing literature by examining the quality of terminological apparatus in school textbooks covering natural and mathematical subjects that will affect improved term structuring and systematization, thus contributing to the success of natural science and mathematics learning for students in public schools in Kazakhstan.

2. Materials and Methods

2.1. Research Design

This study employed a cross-sectional survey design to evaluate the quality of the terminological apparatus in school textbooks covering natural and mathematical subjects in Kazakhstan. A quantitative approach was instrumentalized through a structured questionnaire.

2.2. Formation of Research Samples

The criteria for selecting participants were: (a) working as a teacher in public schools at the time of invitation to participate in the study; and (b) teaching natural science and mathematics. According to statistics for 2023, there are currently more than 369,696 subject teachers in secondary schools in the country. There is a significant gender gap among school teachers: 274,310 are women and 66,648 are men.

2.3. Study Population

The study aimed to include all Kazakhstani teachers who teach natural sciences and mathematics subjects. However, due to logistical constraints, the sample was limited to those teachers who received the survey link and password via official communication channels, including email distributions from school administrations and educational authorities. The distribution strategy aimed to reach as broad a population as possible within these logistical constraints. The study sample consisted of teachers from secondary schools from all regions of Kazakhstan. The total number of samples is N = 1763, among them male = 286 (16.2%), female = 1477 (83.8%). The characteristics of the sample are shown in Table 1.

Table 1.
Study population.

Levels	Counts, n	% of Total
Age		
20-30 years	465	26.4 %
31-40 years old	593	33.6 %
41-50 years	372	21.1 %
51-60 years	277	15.7 %
over 60 years	56	3.2 %
Work experience		
1-5 years	430	24.4 %
6-10 years	304	17.2 %
11-15 years	285	16.2 %
16-20 years	200	11.3 %
21-25 years	169	9.6 %
more than 25 years	375	21.3 %
Level of teaching		
Primary School	28	1.6 %
Middle School	531	30.1 %
Secondary School	1204	68.3 %
Subjects of teaching		
Natural science	87	4.9 %
Biology	106	6.0 %
Geography	51	2.9 %
Informatics	248	14.1 %
Mathematics	741	42.0 %
Physics	192	10.9 %
Chemistry	78	4.4 %
More than 2 subjects	260	14.7 %
Language of instruction		
Kazakh	963	54.6 %
Russian	625	35.5 %
Kazakh+Russian	163	9.2 %

Levels	Counts, n	% of Total
Kazakh/Russian + English	12	0.7 %
Qualification category		
Teacher	542	30.7 %
Moderator	463	26.3 %
Expert	473	26.8 %
Researcher	285	16.2 %

The teachers had varying levels of work experience, with the majority having 1-5 years of experience (430, 24.4%) and more than 25 years (375, 21.3%). The levels of teaching among the participants were primarily focused on Secondary Schools (1204, 68.3%). The participants were primarily teachers of mathematics (741, 42.0%), followed by informatics (248, 14.1%), and more than two subjects (260, 14.7%). Teachers mainly taught in Kazakh (963, 54.6%) and Russian (625, 35.5%). The participants held various qualification categories, namely, teacher (542, 30.7%), expert (473, 26.8%), moderator (463, 26.3%), and researcher (285, 16.2%). The analysis of demographic data allowed researchers to determine whether respondents were qualified to participate in the study. The results of this study include information from 1,763 teachers of natural science and math.

2.4. Measures

The questionnaire was developed by the researchers and contains a total of 12 items (see Table 2). The decision to use a 3-point scale (no/partially/yes) was made to simplify the response process and reduce the cognitive load on participants. While this approach has its advantages in terms of ease and clarity, it also limits the ability to capture nuanced opinions.

Table 2.
Survey items and participants' responses.

No	Questions	Response options, n (%)		
		No	Sometimes (#1-11) Partially (#12)	Yes
1.	Does the textbook define terms not previously encountered in all cases?	405 (23.0%)	513 (29.1%)	845 (47.9%)
2.	Does defining a term help you understand its meaning?	128 (7.3%)	397 (22.5%)	1238 (70.2%)
3.	Are there misspelled, vague definitions of the term?	681 (38.6%)	496 (28.1%)	586 (33.2%)
4.	Do textbooks provide examples or illustrations to help you better understand the meaning of the terms?	249 (14.1%)	526 (29.8%)	988 (56.0%)
5.	Do the assignments and practices in the textbook help students understand and use the term?	147 (8.3%)	449 (25.5%)	1167 (66.2%)
6.	Do textbooks explain the meaning and origin of terms (etymology) borrowed from another language?	324 (18.4%)	522 (29.6%)	917 (52.0%)
7.	Are there borrowed terms in the textbook for your discipline that do not correspond to their conceptual meaning and origin?	930 (52.8%)	448 (25.4%)	385 (21.8%)
8.	Are there terms in textbooks that are awkward to pronounce and difficult to use and read?	828 (47.0%)	445 (25.2%)	490 (27.8%)
9.	Are the terms in the textbooks appropriate for the age and level of language development of the students?	240 (13.6%)	359 (20.4%)	1164 (66.0%)
10.	Are the terms appropriate to the curriculum content and educational goals for a particular age group?	148 (8.4%)	329 (18.7%)	1286 (72.9%)
11.	Do the terms meet the didactic learning requirements?	112 (6.4%)	326 (18.5%)	1325 (75.2%)
12.	Is there a problem of terminological illiteracy among students?	471 (26.7%)	639 (36.2%)	653 (37.0%)

Cronbach's alpha coefficient was used to assess the reliability of the questionnaire, which was 0.780, indicating that the questionnaire is reliable [11, 12].

2.5. Data Collection

Data were collected between September 2023 and October 2023 through an online survey using Google Forms. All teachers in Kazakhstan have access to computers and use them daily in their work, making this survey accessible to a large number of potential participants. However, the survey's distribution was reliant on school administrations and educational authorities, who disseminated the survey link. Therefore, not all eligible teachers received the link, which likely introduced self-selection bias as only those with access to the internet and a willingness to participate were included.

2.6. Data Analysis

Descriptive statistics were calculated for the demographic and work-related characteristics of the participants, presented as counts and percentages (n, %). To examine the factors associated with the outcome variables, regression analysis was performed. The regression analysis included appropriate covariates to adjust for potential confounding factors. All statistical analyses were conducted using the Jamovi software and a p-value of <0.05 was considered statistically significant.

3. Results

The study aimed to evaluate the quality of the terminological apparatus in school textbooks covering natural and mathematical subjects. A survey was conducted among teachers to assess various aspects of terminology, definitions, and didactic alignment in these textbooks.

3.1. Analysis of Responses

In this section, we analyze the responses to the survey questions.

3.1.1. Terminological Definition and Clarity

The first question explored whether the textbooks defined new terms adequately. Of the respondents, 405 (23.0%) indicated that new terms were not defined, 513 (29.1%) responded that this happened occasionally, and 845 (47.9%) stated that terms were always defined.

The survey then assessed whether defining a term helped the teachers understand its meaning. The majority, 1238 (70.2%), agreed, while a smaller portion, 397 (22.5%), felt it was only partially true, and 128 (7.3%) disagreed. However, there were reports of vague or misspelled definitions, with 681 (38.6%) indicating this problem, while 496 (28.1%) noted it sometimes occurred, and 586 (33.2%) stated that it did not.

3.1.2. Supportive Examples and Practical Application

The provision of examples or illustrations to help comprehend the terms was positively reported by 988 (56.0%) respondents, while 526 (29.8%) indicated partial support, and 249 (14.1%) saw no such examples.

The effectiveness of assignments and practices in the textbooks was evaluated next, with 1167 (66.2%) agreeing that these helped students understand and use the terms, while 449 (25.5%) responded "sometimes," and 147 (8.3%) felt that they did not.

3.1.3. Etymology and Appropriateness of Borrowed Terms

When asked whether textbooks explained the meaning and origin of borrowed terms, 917 (52.0%) answered affirmatively, 522 (29.6%) indicated occasional explanations, and 324 (18.4%) disagreed. Additionally, 930 (52.8%) reported the presence of borrowed terms that did not align with their conceptual meaning, while 448 (25.4%) saw this issue occasionally, and 385 (21.8%) did not.

3.1.4. Pronunciation and Age-Appropriateness

On the matter of awkward terms that are difficult to use and read, 828 (47.0%) identified such terms, 445 (25.2%) encountered them occasionally, and 490 (27.8%) did not. In terms of age-appropriate terminology, 1164 (66.0%) felt the terms were suitable for the student's age and language development level, while 359 (20.4%) noted they were sometimes appropriate, and 240 (13.6%) disagreed.

3.1.5. Curriculum Alignment and Didactic Requirements

Regarding alignment with curriculum content and educational goals, 1286 (72.9%) agreed the terms were appropriate, while 329 (18.7%) saw partial alignment, and 148 (8.4%) disagreed. The majority, 1325 (75.2%), also felt that the terms met didactic learning requirements, with 326 (18.5%) indicating partial compliance, and 112 (6.4%) disagreeing.

3.1.6. Terminological Illiteracy

Finally, the survey assessed the issue of terminological illiteracy among students. The responses were mixed, with 653 (37.0%) acknowledging this problem, 639 (36.2%) reporting partial literacy issues, and 471 (26.7%) indicating no problem.

3.2. Sociodemographic Associations and Questions About Terms

An ordinal regression analysis was conducted to examine the socio-demographic predictors of teachers' responses to various questions regarding the terminological apparatus of school textbooks in natural science and mathematical subjects. The models provided insights into which factors influenced the teachers' perceptions.

3.2.1. Does the Textbook Define Terms Not Previously Encountered in All Cases?

In this model, several significant predictors were identified (Appendix A). Teachers with more experience were less likely to report that terms were defined for new concepts (-0.1439, p=0.007). Teachers teaching in Russian (β=-0.8245, p<0.001) or English (β=-1.1562, p=0.038) were less likely to report that terms were defined for new concepts compared to those teaching in Kazakh. Moreover, older teachers were more likely to report that terms were defined for new concepts (β=0.2591, p=0.002).

3.2.2. Does Defining a Term Help You Understand its Meaning?

The second model investigated whether defining a term helps in understanding its meaning. The key significant predictors were the teachers' category. Thus, teachers with higher qualifications (expert (β=-0.3390, p=0.037) or researcher (β=-0.6994, p<0.001)) were less likely to agree that defining a term helps in understanding it (Appendix B).

3.2.3. Do Textbooks Provide Examples or Illustrations to Help You Better Understand the Meaning of the Terms?

For this model, the key significant predictor was the language of instruction (Appendix D). Teachers teaching in Russian were more likely to report that textbooks provided helpful examples or illustrations compared to those teaching in Kazakh (β=0.2802, p = 0.007).

3.2.4. Do The Assignments and Practices in the Textbook Help Students Understand and Use the Term?

This model showed significant effects for teachers' category and subject of teaching (Appendix E). Teachers with higher qualifications (moderator (β=-0.35397, p=0.011), expert (β=-0.32103, p=0.037), researcher (β=-0.37485, p=0.043)) were less likely to agree that assignments and practices in the textbook helped students understand and use the terms. Teachers of chemistry were more likely to agree that assignments and practices helped students understand and use terms compared to teachers of natural science (β=0.77708, p=0.021).

3.2.5. Are There Borrowed Terms in the Textbook for Your Discipline that Do Not Correspond to Their Conceptual Meaning and Origin?

For this model, the key significant predictors were a category of teacher, level of teaching, language of instruction, and gender (Appendix G). Thus, teacher-researchers were more likely to report issues with borrowed terms compared to teachers without any category (β=-0.3836, p=0.027). Secondary school teachers were more likely to report issues with borrowed terms compared to primary school (β=-0.8918, p = 0.015). Russian-speaking compared to Kazakh-speaking teachers were more likely to report issues with borrowed terms (β=-0.5994, p<0.001). Moreover, females were more likely to report these issues (β=-0.2709, p=0.035).

3.2.6. Are There Terms in Textbooks that are Awkward to Pronounce and Difficult to use and Read?

Significant predictors for this model were the level and subject of teaching (Appendix H). Middle (β=-0.86973, p=0.019) and secondary (β=-1.00153, p=0.017) school teachers were more likely to report terms that were awkward to pronounce or use compared to primary school teachers. Teachers of biology (β= p=0.035) and mathematics (β=0.57077, p=0.015) compared to natural science teachers were more likely to report terms that were awkward to pronounce or use.

3.2.7. Are the Terms in the Textbooks Appropriate for the Age and Level of Language Development of the Students?

Secondary school teachers were more likely to report that terms were appropriate for age and language development compared to primary school teachers (β=0.8206, p=0.033). Teachers of geography were less likely to report that terms were appropriate for age and language development compared to teachers of natural science (β=-0.8988, p=0.008). Female participants were more likely to report that terms were appropriate (β=0.3046, p = 0.028), Appendix I.

3.2.8. Are the Terms Appropriate to the Curriculum Content and Educational Goals for a Particular Age Group?

In this model, the significant predictor was the language of instruction (Appendix J). Russian-speaking compared to Kazakh-speaking teachers were more likely to report that terms were appropriate for the curriculum content and educational goals (β=0.28404, p = 0.018).

3.2.9. Do the Terms Meet the Didactic Learning Requirements?

For this model, significant predictors included subject and language of instruction (Appendix K). Those teaching more than two subjects were more likely to report that terms met the didactic learning requirements compared to natural science teachers (β=0.5711, p=0.043). Russian-speaking compared to Kazakh-speaking teachers were more likely to report that terms met the didactic learning requirements (β=0.2669, p=0.030).

For models "Are there misspelled or vague definitions of the term?" and "Do textbooks explain the meaning and origin of terms (etymology) borrowed from another language?" significant socio-demographic predictors were not identified (Appendix C and F).

4. Discussion

The aim of this study was to evaluate the quality of the terminological apparatus in school textbooks for natural and mathematical subjects, focusing on the perspectives of teachers in Kazakhstan. The findings provide valuable insights into how well these textbooks serve their purpose in terms of terminological clarity, relevance, and didactic effectiveness.

4.1. Terminological Definition and Clarity

The responses suggest that while the majority of teachers believe textbooks define new terms adequately, a notable portion feel otherwise. Defining a term greatly aids understanding, with over 70% of teachers agreeing with this assertion. This aligns with research indicating the importance of clear definitions in educational materials for enhancing comprehension and learning. However, the presence of vague or misspelled definitions remains an issue for a significant proportion of respondents, highlighting a potential area for improvement [13].

4.2. Supportive Examples and Practical Application

Over half of the teachers reported that textbooks provide examples or illustrations to aid comprehension, which is consistent with educational best practices that advocate for contextual examples to enhance learning [14]. Furthermore, the majority of teachers agreed that assignments and practices in the textbooks help students understand and use the terms, reinforcing the importance of practical application in learning [15]. However, the variations in responses suggest that this is not consistently achieved across all textbooks or subjects, indicating a need for more uniform quality.

4.3. Etymology and Appropriateness of Borrowed Terms

More than half of the teachers noted that textbooks explain the origin of borrowed terms, which is essential for understanding their contextual meaning and origin. However, a notable portion of teachers identified borrowed terms that do not align with their conceptual meaning, indicating potential issues with translation or adaptation. This finding is in line with previous studies that highlight the challenges of accurately translating and contextualizing scientific terminology [16].

4.4. Pronunciation and Age-Appropriateness

The study also found that many teachers encounter terms that are awkward to pronounce or use, and while the majority find the terminology age-appropriate, there are still concerns in this area. Age-appropriate terminology is crucial for effective learning, as it aligns with students' cognitive and linguistic development [17].

4.5. Curriculum Alignment and Didactic Requirements

The majority of teachers believe that the terms in the textbooks align with curriculum content and educational goals, and meet didactic learning requirements. This indicates that, overall, the textbooks are well-designed for their educational purpose, aligning with the principles of constructive alignment [18, 19]. However, the variations in responses suggest that this is not uniformly achieved, highlighting the need for continuous review and improvement.

4.6. Sociodemographic Associations

The regression analysis revealed several significant predictors of teachers' responses. For example, teachers with more experience were less likely to report that terms were defined for new concepts, while older teachers were more likely to report that terms were defined for new concepts. This could reflect differences in pedagogical expectations or familiarity with terminology over time. Language of instruction also influenced responses, with Russian-speaking teachers more likely to report issues with terminology compared to Kazakh-speaking teachers. This underscores the importance of considering language and cultural factors in textbook design [20-23]. Thus, the study demonstrates the importance of thinking about the quality of the terminological apparatus in school textbooks covering natural and mathematical subjects. The findings highlight the strengths and weaknesses of the terminological apparatus in these textbooks, emphasizing the need for continuous improvement to enhance educational quality.

Most of the respondents noted that textbooks provide definitions of terms that have not been encountered; respondents positively assessed that an accurate definition of a term helps to understand its meaning. Teachers deny that textbooks contain incorrect and vague definitions of the term. The survey found that (1) textbooks provide examples and illustrations to better understand the meaning of terms; (2) assignments and practice exercises help students understand and use the term; (3) explain the meaning and origin of terms borrowed from other languages; and (4) the terms correspond to the age and level of language development of the students. Most of the participants responded that the textbook does not contain borrowed terms that do not correspond to the conceptual meaning and origin or terms that are awkward to pronounce and difficult to use and read. The terms correspond to the content of the curriculum, educational goals, and didactic requirements. However, survey participants noted that there is a problem of terminological illiteracy among students. The study of the dynamic nature of the term and the formation of the term based on the analysis 'from content to form' allowed us to understand the abundance of contradictions of terms in the educational literature of classes. In this sense, the consideration of the term 'from content to form' seems to be the most promising in the theory and methodology of term formation. However, this process is not provided for in the development of domestic educational literature and educational and methodological complexes. This is not realized even when developing educational literature. These results are consistent with those of other researchers [24-26].

5. Conclusion

The study provides valuable insights into the strengths and weaknesses of the terminological apparatus in school textbooks for natural and mathematical subjects. While the overall quality is high in certain aspects, such as the provision of definitions and examples, there are areas for improvement, particularly in terms of clarity, appropriateness, and alignment.

The findings indicate that despite some strengths, there are significant issues with vague definitions, inappropriate borrowed terms, and awkward pronunciation that need to be addressed. These conceptual gaps and terminological inconsistencies can impede scientific communication and limit the effectiveness of educational materials in Kazakhstan. Therefore, the authors recommend continuous review and improvement of the terminological apparatus in these textbooks to enhance educational quality and support effective learning.

Future research should focus on psychological and pedagogical patterns of students' assimilation of terms and the language of science in general in public school terminological work in the learning process as a factor in students' professional orientation. Additionally, ways to improve the terminological literacy of future teachers should be explored to address these ongoing challenges.

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Appendix A.

Q1. Does the textbook define terms not previously encountered in all cases?

Model fit measures.

Overall model test						
Model	**Deviance**	**AIC**	**R^2_{McF}**	**χ^2**	**df**	**p**
1	3607	3647	0.025	93.6	18	< 0.001

Predictor	**Estimate**	**SE**	**Z**	**p**
Category:				
Moderator – teacher	-0.123	0.124	-0.993	0.321
Expert – teacher	-0.017	0.137	-0.125	0.901
Researcher – teacher	0.094	0.168	0.557	0.577
Level of teaching:				
Middle school – primary school	0.295	0.365	0.808	0.419
Secondary school – primary school	0.226	0.361	0.626	0.531
Work experience:	-0.144	0.054	-2.681	0.007
Subjects of teaching:				
Biology - natural science	0.179	0.279	0.640	0.522
Geography - natural science	0.445	0.354	1.256	0.209
Computer science - natural science	-0.079	0.236	-0.336	0.737
Mathematics - natural science	-0.339	0.217	-1.562	0.118
Physics - natural science	-0.257	0.248	-1.033	0.302
Chemistry - natural science	0.020	0.298	0.068	0.946
More than 2 subjects – natural science	-0.156	0.237	-0.658	0.511
Language of instruction:				
Russian – kazakh	-0.824	0.101	-8.181	< 0.001
Kazakh+russian – kazakh	-0.267	0.163	-1.631	0.103
+ English – kazakh	-1.156	0.558	-2.072	0.038
Gender:				
Female – male	-0.028	0.128	-0.217	0.828
Age:	0.259	0.082	3.145	0.002

Appendix B.

Q2. Does defining a term help you understand its meaning?

Overall model test						
Model	**Deviance**	**AIC**	**R^2_{McF}**	**χ^2**	**df**	**p**
1	2705	2745	0.009	27.8	18	0.106

Predictor	**Estimate**	**SE**	**Z**	**p**
Category:				
Moderator – Teacher	-0.268	0.144	-1.860	0.063
Expert – Teacher	-0.339	0.163	-2.085	0.037
Researcher – Teacher	-0.699	0.192	-3.648	< .001
Level of teaching:				
Middle school – Primary school	0.296	0.422	0.700	0.484
Secondary school – Primary school	0.238	0.418	0.570	0.569
Work experience:	0.106	0.061	1.727	0.084
Subjects of teaching:				

Biology - natural science	-0.480	0.311	-1.542	0.123
Geography - natural science	-0.533	0.375	-1.423	0.155
Computer science - natural science	-0.090	0.276	-0.326	0.744
Mathematics - natural science	-0.215	0.253	-0.850	0.396
Physics - natural science	-0.098	0.289	-0.340	0.734
Chemistry - natural science	0.145	0.359	0.405	0.686
More than 2 subjects – natural science	-0.030	0.279	-0.106	0.916
Language of instruction:				
Russian – Kazakh	-0.079	0.114	-0.699	0.485
Kazakh+Russian – Kazakh	0.142	0.194	0.733	0.464
+ English – Kazakh	0.304	0.670	0.454	0.650
Gender:				
Female – male	0.136	0.145	0.934	0.350
Age:	-0.085	0.092	-0.920	0.358

Appendix C.

Q3. Are there misspelled, vague definitions of the term?

Model fit measures

Overall model test

Model	Deviance	AIC	R^2_{McF}	χ^2	df	p
1	3831	3871	0.004	13.7	18	0.747

Predictor	Estimate	SE	Z	p
Category:				
Moderator – Teacher	-0.087	0.121	-0.724	0.469
Expert – Teacher	0.007	0.134	0.051	0.959
Researcher – Teacher	-0.057	0.163	-0.350	0.726
Level of teaching:				
Middle school – Primary school	-0.454	0.364	-1.248	0.212
Secondary school – Primary school	-0.396	0.360	-1.099	0.272
Work experience:	0.057	0.051	1.118	0.264
Subjects of teaching:				
Biology - natural science	0.276	0.267	1.032	0.302
Geography - natural science	0.022	0.332	0.068	0.946
Computer science - natural science	-0.080	0.226	-0.352	0.724
Mathematics - natural science	-0.120	0.207	-0.581	0.561
Physics - natural science	0.089	0.237	0.376	0.707
Chemistry - natural science	-0.127	0.282	-0.450	0.652
More than 2 subjects – natural science	-0.080	0.229	-0.350	0.726
Language of instruction:				
Russian – Kazakh	-0.021	0.097	-0.218	0.828
Kazakh+Russian – Kazakh	-0.140	0.158	-0.884	0.376
+ English – Kazakh	0.500	0.573	0.871	0.383
Gender:				
female– male	-0.047	0.126	-0.374	0.708
Age:	-0.013	0.077	-0.168	0.867

Appendix D.

Q4. Do textbooks provide examples or illustrations to help you better understand the meaning of the terms?

Model fit measures

Overall model test

Model	Deviance	AIC	R^2_{McF}	χ^2	df	p
1	3358	3398	0.010	33.0	18	0.017

Predictor	Estimate	SE	Z	p
Category:				
Moderator – Teacher	-0.122	0.127	-0.956	0.339
Expert – Teacher	-0.209	0.143	-1.463	0.143
Researcher – Teacher	-0.158	0.172	-0.923	0.356
Level of teaching:				
Middle school – Primary school	-0.386	0.390	-0.990	0.322
Secondary school – Primary school	-0.406	0.386	-1.052	0.293

Work experience:	0.068	0.054	1.255	0.209
Subjects of teaching:				
Biology - natural science	-0.406	0.273	-1.488	0.137
Geography - natural science	0.223	0.351	0.637	0.524
Computer science - natural science	0.097	0.238	0.409	0.683
Mathematics - natural science	0.052	0.217	0.240	0.811
Physics - natural science	0.348	0.252	1.382	0.167
Chemistry - natural science	-0.029	0.299	-0.096	0.923
More than 2 subjects – natural science	0.379	0.242	1.563	0.118
Language of instruction:				
Russian – Kazakh	0.280	0.104	2.700	0.007
Kazakh+Russian – Kazakh	0.238	0.168	1.410	0.158
+ English – Kazakh	0.140	0.546	0.257	0.797
Gender:				
female– male	0.094	0.131	0.717	0.473
Age:	-0.044	0.083	-0.523	0.601

Appendix E.

Q5. Do the assignments and practices in the textbook help students understand and use the term?

Model fit measures

Overall model test

Model	Deviance	AIC	R^2_{McF}	χ^2	df	p
1	2890	2930	0.011	31.5	18	0.025

Predictor	Estimate	SE	Z	p
Category:				
Moderator – Teacher	-0.354	0.138	-2.556	0.011
Expert – Teacher	-0.321	0.154	-2.087	0.037
Researcher – Teacher	-0.375	0.185	-2.020	0.043
Level of teaching:				
Middle school – Primary school	0.042	0.428	0.097	0.923
Secondary school – Primary school	0.099	0.424	0.233	0.815
Work experience:	-0.062	0.059	-1.044	0.296
Subjects of teaching:				
Biology - natural science	-0.156	0.287	-0.542	0.588
Geography - natural science	-0.140	0.351	-0.399	0.690
Computer science - natural science	0.314	0.250	1.256	0.209
Mathematics - natural science	0.308	0.227	1.361	0.174
Physics - natural science	0.413	0.264	1.563	0.118
Chemistry - natural science	0.777	0.337	2.306	0.021
More than 2 subjects – natural science	0.498	0.253	1.968	0.049
Language of instruction:				
Russian – Kazakh	0.038	0.110	0.343	0.731
Kazakh+Russian – Kazakh	0.002	0.181	0.011	0.991
+ English – Kazakh	-0.793	0.566	-1.401	0.161
Gender:				
Female– male	0.085	0.143	0.597	0.551
Age:	0.086	0.090	0.955	0.340

Appendix F.

Q6. Do textbooks explain the meaning and origin of terms (etymology) borrowed from another language?

Model fit measures

Overall model test

Model	Deviance	AIC	R^2_{McF}	χ^2	df	p
1	3536	3576	0.009	31.0	18	0.029

Predictor	Estimate	SE	Z	p
Category:				
Moderator – Teacher	-0.226	0.125	-1.799	0.072
Expert – Teacher	-0.088	0.140	-0.631	0.528
Researcher – Teacher	-0.259	0.167	-1.556	0.120
Level of teaching:				

Middle school – Primary school	-0.225	0.406	-0.554	0.579
Secondary school – Primary school	-0.307	0.403	-0.763	0.446
Work experience:	-0.084	0.053	-1.573	0.116
Subjects of teaching:				
Biology - natural science	-0.436	0.281	-1.552	0.121
Geography - natural science	-0.053	0.342	-0.155	0.877
Computer science - natural science	0.001	0.245	0.006	0.996
Mathematics - natural science	-0.224	0.224	-0.999	0.318
Physics - natural science	-0.168	0.254	-0.662	0.508
Chemistry - natural science	-0.260	0.302	-0.861	0.389
More than 2 subjects – natural science	0.091	0.244	0.374	0.709
Language of instruction:				
Russian – Kazakh	-0.178	0.100	-1.772	0.076
Kazakh+Russian – Kazakh	-0.071	0.166	-0.429	0.668
+ English – Kazakh	-0.774	0.516	-1.500	0.134
Gender:				
Female– male	0.118	0.128	0.921	0.357
Age:	0.073	0.081	0.908	0.364

Appendix G.

Q7. Are there borrowed terms in the textbook for your discipline that do not correspond to their conceptual meaning and origin?

Model fit measures						
Overall model test						
Model	**Deviance**	**AIC**	**R^2_{McF}**	**χ^2**	**df**	**p**
1	3518	3558	0.020	70.3	18	< 0.001

Predictor	**Estimate**	**SE**	**Z**	**p**
Category:				
Moderator – Teacher	-0.220	0.125	-1.757	0.079
Expert – Teacher	-0.134	0.139	-0.964	0.335
Researcher – Teacher	-0.384	0.173	-2.219	0.027
Level of teaching:				
Middle school – Primary school	-0.674	0.371	-1.817	0.069
Secondary school – Primary school	-0.892	0.367	-2.429	0.015
Work experience:	0.069	0.054	1.294	0.196
Subjects of teaching:				
Biology - natural science	-0.069	0.280	-0.246	0.805
Geography - natural science	0.241	0.333	0.724	0.469
Computer science - natural science	0.058	0.236	0.245	0.806
Mathematics - natural science	-0.174	0.218	-0.800	0.424
Physics - natural science	-0.159	0.249	-0.641	0.521
Chemistry - natural science	-0.186	0.300	-0.620	0.535
More than 2 subjects – natural science	0.053	0.239	0.220	0.826
Language of instruction:				
Russian – Kazakh	-0.599	0.104	-5.780	< .001
Kazakh+Russian – Kazakh	-0.047	0.161	-0.293	0.770
+ English – Kazakh	-0.912	0.603	-1.512	0.131
Gender:				
Female– male	-0.271	0.129	-2.106	0.035
Age:	-0.101	0.083	-1.218	0.223

Appendix H.

Q8. Are there terms in textbooks that are awkward to pronounce and difficult to use and read?

Model fit measures						
Overall model test						
Model	**Deviance**	**AIC**	**R^2_{McF}**	**χ^2**	**df**	**p**
1	3670	3710	0.016	61.2	18	< 0.001

Predictor	**Estimate**	**SE**	**Z**	**p**
Category:				
Moderator – Teacher	-0.100	0.122	-0.819	0.413

Expert – Teacher	-0.113	0.138	-0.820	0.412
Researcher – Teacher	-0.145	0.167	-0.871	0.384
Level of teaching:				
Middle school – Primary school	-0.870	0.371	-2.342	0.019
Secondary school – Primary school	-1.002	0.368	-2.719	0.007
Work experience:	-0.037	0.053	-0.701	0.483
Subjects of teaching:				
Biology - natural science	0.571	0.271	2.107	0.035
Geography - natural science	0.409	0.332	1.232	0.218
Computer science - natural science	-0.273	0.229	-1.189	0.234
Mathematics - natural science	-0.512	0.210	-2.434	0.015
Physics - natural science	-0.391	0.240	-1.627	0.104
Chemistry - natural science	-0.251	0.290	-0.867	0.386
More than 2 subjects – natural science	-0.180	0.231	-0.779	0.436
Language of instruction:				
Russian – Kazakh	0.152	0.099	1.528	0.126
Kazakh+Russian – Kazakh	-0.085	0.161	-0.529	0.597
+ English – Kazakh	0.392	0.566	0.691	0.489
Gender:				
Female– male	-0.002	0.127	-0.017	0.987
Age:	0.034	0.080	0.430	0.667

Appendix I.

Q9. Are the terms in the textbooks appropriate for the age and level of language development of the students?

Model fit measures

Overall model test

Model	Deviance	AIC	R^2_{McF}	χ^2	df	p
1	3014	3054	0.017	52.0	18	< 0.001

Predictor	Estimate	SE	Z	p
Category:				
Moderator – Teacher	0.088	0.140	0.631	0.528
Expert – Teacher	-0.129	0.151	-0.859	0.390
Researcher – Teacher	-0.096	0.183	-0.528	0.598
Level of teaching:				
Middle School – Primary school	0.732	0.389	1.881	0.060
Secondary School – Primary school	0.821	0.385	2.131	0.033
Work experience:	0.028	0.058	0.492	0.623
Subjects of teaching:				
Biology - natural science	-0.493	0.291	-1.692	0.091
Geography - natural science	-0.899	0.338	-2.659	0.008
Computer science - natural science	-0.149	0.254	-0.586	0.558
Mathematics - natural science	0.231	0.236	0.977	0.328
Physics - natural science	0.355	0.275	1.291	0.197
Chemistry - natural science	0.198	0.331	0.600	0.549
More than 2 subjects – natural science	0.105	0.259	0.403	0.687
Language of instruction:				
Russian – Kazakh	-0.078	0.109	-0.712	0.476
Kazakh+Russian – Kazakh	0.199	0.184	1.080	0.280
+ English – Kazakh	-0.325	0.577	-0.563	0.574
Gender:				
Female– male	0.305	0.139	2.191	0.028
Age:	-0.137	0.088	-1.554	0.120

Appendix J.

Q10. Are the terms appropriate to the curriculum content and educational goals for a particular age group?

Model fit measures						
Overall model test						
Model	**Deviance**	**AIC**	**R^2_{McF}**	**χ^2**	**df**	**p**
1	2610	2650	0.015	39.3	18	0.003

Predictor	**Estimate**	**SE**	**Z**	**p**
Category:				
Moderator – Teacher	0.178	0.150	1.181	0.237
Expert – Teacher	-0.086	0.162	-0.533	0.594
Researcher – Teacher	0.115	0.198	0.581	0.561
Level of teaching:				
Middle school – Primary school	0.393	0.389	1.012	0.312
Secondary school – Primary school	0.436	0.384	1.134	0.257
Work experience:	0.003	0.062	0.051	0.959
Subjects of teaching:				
Biology - natural science	-0.412	0.310	-1.328	0.184
Geography - natural science	-0.353	0.372	-0.948	0.343
Computer science - natural science	-0.066	0.270	-0.244	0.807
Mathematics - natural science	0.308	0.252	1.223	0.221
Physics - natural science	0.483	0.295	1.639	0.101
Chemistry - natural science	0.329	0.355	0.926	0.354
More than 2 subjects – natural science	0.330	0.279	1.183	0.237
Language of instruction:				
Russian – Kazakh	0.284	0.120	2.361	0.018
Kazakh+Russian – Kazakh	0.131	0.192	0.680	0.497
+ English – Kazakh	0.745	0.782	0.953	0.341
Gender:				
Female– male	0.209	0.150	1.396	0.163
Age:	-0.151	0.094	-1.600	0.110

Appendix K.

Q11. Do the terms meet the didactic learning requirements?

Model fit measures						
Overall model test						
Model	**Deviance**	**AIC**	**R^2_{McF}**	**χ^2**	**df**	**p**
1	2437	2477	0.015	37.4	18	0.005

Predictor	**Estimate**	**SE**	**Z**	**p**
Category:				
Moderator – Teacher	-0.081	0.153	-0.531	0.595
Expert – Teacher	-0.280	0.169	-1.654	0.098
Researcher – Teacher	-0.140	0.207	-0.676	0.499
Level of teaching:				
Middle school – Primary school	0.296	0.411	0.720	0.472
Secondary school – Primary school	0.265	0.406	0.653	0.513
Work experience:	0.030	0.065	0.472	0.637
Subjects of teaching:				
Biology - natural science	-0.151	0.310	-0.488	0.626
Geography - natural science	-0.366	0.374	-0.978	0.328
Computer science - natural science	-0.047	0.267	-0.178	0.859
Mathematics - natural science	0.383	0.248	1.543	0.123
Physics - natural science	0.437	0.291	1.500	0.134
Chemistry - natural science	0.742	0.378	1.962	0.050
More than 2 subjects – natural science	0.571	0.282	2.028	0.043
Language of instruction:				
Russian – Kazakh	0.2670	0.123	2.164	0.030
Kazakh+Russian – Kazakh	0.414	0.211	1.963	0.050
+ English – Kazakh	-0.305	0.611	-0.499	0.618
Gender:				
Female– male	0.101	0.155	0.651	0.515
Age:	-0.086	0.098	-0.883	0.377