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EDITED BY
Diego Gavilán Martín,
University of Alicante, Spain

REVIEWED BY
Ana Raquel Costa Aguiar,
Polytechnic Institute of Viana do Castelo, Portugal
Marthe Berg Andresen Reffhaug,
Øvre Eiker Kommune, Norway

*CORRESPONDENCE
Mariya Kabysheva
✉ Kabysheva.m@qyzpu.edu.kz

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Fostering critical thinking in learning outcomes of Kazakhstan initial teacher education

Mariya Kabysheva*

Curriculum Development Office, Kazakh National Women's Teacher Training University, Almaty, Kazakhstan

The integration of critical thinking into initial teacher education programs is crucial to achieving the United Nations' Sustainable Development Goals, particularly SDG 4, as teachers play a pivotal role in fostering this essential competency. This study employs computer algorithms to analyze how Kazakhstani educational program developers incorporate critical thinking into learning outcomes. The data sources include Russian-language versions of all active bachelor's degree teacher education programs in Kazakhstan. A first-in-kind mapping was constructed linking Russian verbs to Bloom's Taxonomy cognitive skill levels for this analysis. The methodological approach utilizing automated verb frequency analysis offers a practical tool not only for initial evaluation but also for ongoing, repeatable assessments of curricula. The findings indicate that while direct mentions of "critical thinking" are present, and some higher-order thinking skill verbs are utilized, critical thinking remains modestly integrated into learning outcomes.

KEYWORDS

critical thinking, learning outcomes, initial teacher education, curriculum, Bloom's taxonomy, frequency analysis, learning analytics

1 Introduction

The twenty-first century presents unprecedented challenges such as poverty, climate change, and inequality—issues demanding innovative thinking and action toward sustainable development. Education stands out as a pivotal driver in this transformative process by equipping individuals with the skills needed to navigate these complexities and contribute effectively toward achieving the United Nations' Sustainable Development Goals (SDGs).

Specifically, SDG 4 focuses on quality education, aiming to ensure inclusive learning opportunities for all while fostering essential knowledge, skills, values, and attitudes required for global citizenship and sustainable development. Target 4.7 within this goal emphasizes equipping learners with necessary competencies—including critical thinking—to promote sustainable development through various avenues such as Education for Sustainable Development (ESD) and promoting human rights, gender equality, peace, non-violence, and cultural diversity (UNESCO, 2019).

Critical thinking is recognized by UNESCO (2017) as a crucial cross-cutting competency essential to achieving all SDGs. It involves questioning norms, reflecting on values and actions, engaging in sustainability discourse, and fostering active citizenship. Teachers play a key role in nurturing critical thinking capacity within their students, empowering them to become effective agents of change.

An analysis of critical thinking definitions reveals several key approaches to its conceptualization, demonstrating a diversity of interpretations. One group of definitions

focuses on the process of rational inquiry and justification. This includes the concept of "reflective thinking" (Dewey, 1910), defined as "Active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends…", the notion of being "appropriately moved by reasons" (Siegel, 1980).

Another group emphasizes the purpose, outcome, and normative nature of critical thinking. For instance, it is viewed as "reasonable reflective thinking that is focused on deciding what to believe or do" (Ennis, 1964) or as "Critical thinking is effortful, careful, consciously controlled processing that maximizes the use of all available evidence and cognitive strategies and purposefully strives to overcome individual biases" (Riggio and Halpern, 2006). Allied with this is the view of critical thinking as a "normative enterprise in which, to a greater or lesser degree, we apply appropriate criteria and standards to what we or others say, do, or write" (Bailin et al., 1999), and as "skillful, responsible thinking that facilitates good judgment because it (1) relies upon criteria, (2) is self-correcting, and (3) is sensitive to context" (Lipman, 1988). The APA Delphi consensus definition (Facione, 1990) also highlights "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation…". Another approach focuses on the structure, components, and self-improvement of thinking. The model by Paul and Elder describes critical thinking as "the art of analyzing and evaluating thinking with a view to improving it" (Paul and Elder, 2004). An important aspect across many models (Ennis, Siegel, Paul, Halpern, APA Delphi) is the integration of both cognitive skills and affective dispositions. Finally, the fundamental dispute regarding domain-specificity persists defining critical thinking the "propensity and skill to engage in an activity with reflective skepticism" (McPeck, 1981) tied to a particular subject area, contrasting with the more generalist approaches of most other theorists.

The conceptual framework for this study is grounded in two interconnected models: the American Philosophical Association's Delphi Report consensus definition and Dwyer (Dwyer et al., 2014) hierarchical model of critical thinking. Dwyer's framework organizes critical thinking development into a clear progression: foundational knowledge, core competencies (analysis, evaluation, inference), and advanced stages like reflective judgment and metacognitive regulation. Importantly, this model explicitly links critical thinking to Bloom's Taxonomy (Bloom, 1956). The latter categorizes cognitive skills into six levels—knowledge, comprehension, application, analysis, synthesis, and evaluation, with critical thinking centered on the higher-order domains (analysis, synthesis, evaluation) known as Higher-Order Thinking Skills or HOTS (Orakci, 2023; Rahman et al., 2017; Williams et al., 1994). Dwyer's framework aligns with Bloom's Taxonomy while also reflecting key principles from the Delphi Report, ensuring a cohesive theoretical basis for analyzing critical thinking in educational contexts. That framework is notable for its explicit hierarchical organization, outlining a progression from foundational knowledge and understanding, through core critical thinking skills (Analysis, Evaluation, Inference), and culminating in higher-level reflective judgment and metacognitive self-regulation.

Within the framework of constructive alignment, educational programs (EPs) must be meticulously designed to cultivate these essential skills through curriculum integration (Biggs, 1996). Learning outcomes (LOs), serving as a roadmap, outline the intended knowledge and abilities that graduates will possess upon completion (Biggs and Tang, 2020). Analyzing the learning outcomes for teacher education programs in Kazakhstan offers insights into how critical thinking is incorporated into their curricula. Despite constructive alignment being a widely adopted practice for developing educational programs in virtually all countries participating in the Bologna Process, it has faced criticism at the institutional level for reportedly leading to excessive bureaucracy in program approval and development (Loughlin et al., 2021).

Nevertheless, a viewpoint exists for instance, maintaining that critical thinking is not always amenable to formalization and measurement within the framework of standard learning outcomes. That indicates that certain desired outcomes of higher education, including aspects of critical thinking, either cannot be clearly articulated or are immeasurable (Erikson and Erikson, 2019).

Learning outcomes in educational programs are verb-centric by design. Categorizing commonly used verbs according to Bloom's Taxonomy levels and comparing their frequencies provides a method for describing the balance of these categories within specific curricula.

Particularly, this study's goal was to understand to what extent do learning outcomes of teacher education programs in Kazakhstan aim to develop future teachers' critical thinking skills, as measured by verb frequency analysis aligned with Bloom's Taxonomy?

1.1 Kazakhstan's modern teacher education context

Kazakhstan has fully committed to achieving the Sustainable Development Goals—in 2018, the country established a dedicated SDG Coordination Council chaired by the First Deputy Prime Minister. This council aims to develop unified policies for effective implementation of the SDGs. In 2021, the government approved an extensive list of national SDG indicators tailored specifically to the local context, including 87 relevant metrics. Regular reports on SDG 4 implementation (including Target 4.7) are issued by the Ministry of Education and the Ministry of Science and Higher Education. Efforts are underway to integrate Education for Sustainable Development into higher education—a crucial endeavor that this study aims to contribute toward furthering: although some research has explored integrating Global Citizenship and Education in Kazakhstan, the existing studies primarily concentrate on training non-teacher education (Abazov, 2021; Bespalyy et al., 2024; Gafu et al., 2024; Yelubayeva et al., 2023); a more comprehensive exploration within teacher education is needed.

In 2010, Kazakhstan became one of the first Central Asian nations fully integrated into Europe's higher education system by signing the Bologna Declaration. This milestone opened new opportunities but also necessitated significant revisions to educational programs. The integration requires adapting to global standards and presents both challenges and benefits for the Republic's higher education landscape.

Kazakhstan has made substantial progress toward implementing competency-based learning in its higher education system, beginning with active development efforts initiated in 2016 (Ismukhanova and Sansyzbayeva, 2016; Kunanbayeva, 2016). These reforms culminated in the implementation of a new core curriculum in 2022 (Moldasan et al., 2023). This comprehensive overhaul replaced the previous educational framework and placed greater emphasis on developing student competencies across various disciplines. This vision is further reinforced by "The Concept for the Development of Higher Education and Science" published in 2023, signaling an important shift in Kazakhstan's educational philosophy. Consequently, elementary teacher education curricula must evolve to align with these changes, necessitating not only updates but also integration of innovative teaching methodologies, assessment strategies, and skill development that meet global demands.

A key aspect of the modern Kazakhstani approach to teacher training involves incorporating pedagogical disciplines such as didactics and subject-specific instructional methods. Aspiring teachers with initial bachelor's degrees in fields other than education are required to complete specialized courses in these subjects before being eligible to teach in schools.

This study primarily focuses on the integration of critical thinking into EPs designed specifically for prospective preschool teachers, primary school teachers, and secondary school educators pursuing a bachelor's degree in education. The aim is to enhance these programs so that graduates are well-prepared to meet both local educational standards and global competencies demands.

2 Methods

2.1 Data source

All Educational Programs (EPs) in Kazakhstan are listed on a publicly accessible Registry of Educational Programs available at https://epvo.kz (Unified Higher Education Platform). This registry contains essential information about each EP, including objectives, learning outcomes, and specific disciplines. To ensure relevance, the registry includes only currently active programs that have enrolled students for the past two academic years. To ensure data quality and comparability, we adhered to recommendations from the National Center for the Development of Higher Education of Kazakhstan, which suggest 8–15 learning outcomes per program.

According to the regulations governing the maintenance of the relevant Registry, the formulation of learning outcomes (LOs) within educational programs must adhere to specific requirements. A key stipulation is the mandatory inclusion of a verb from Bloom's

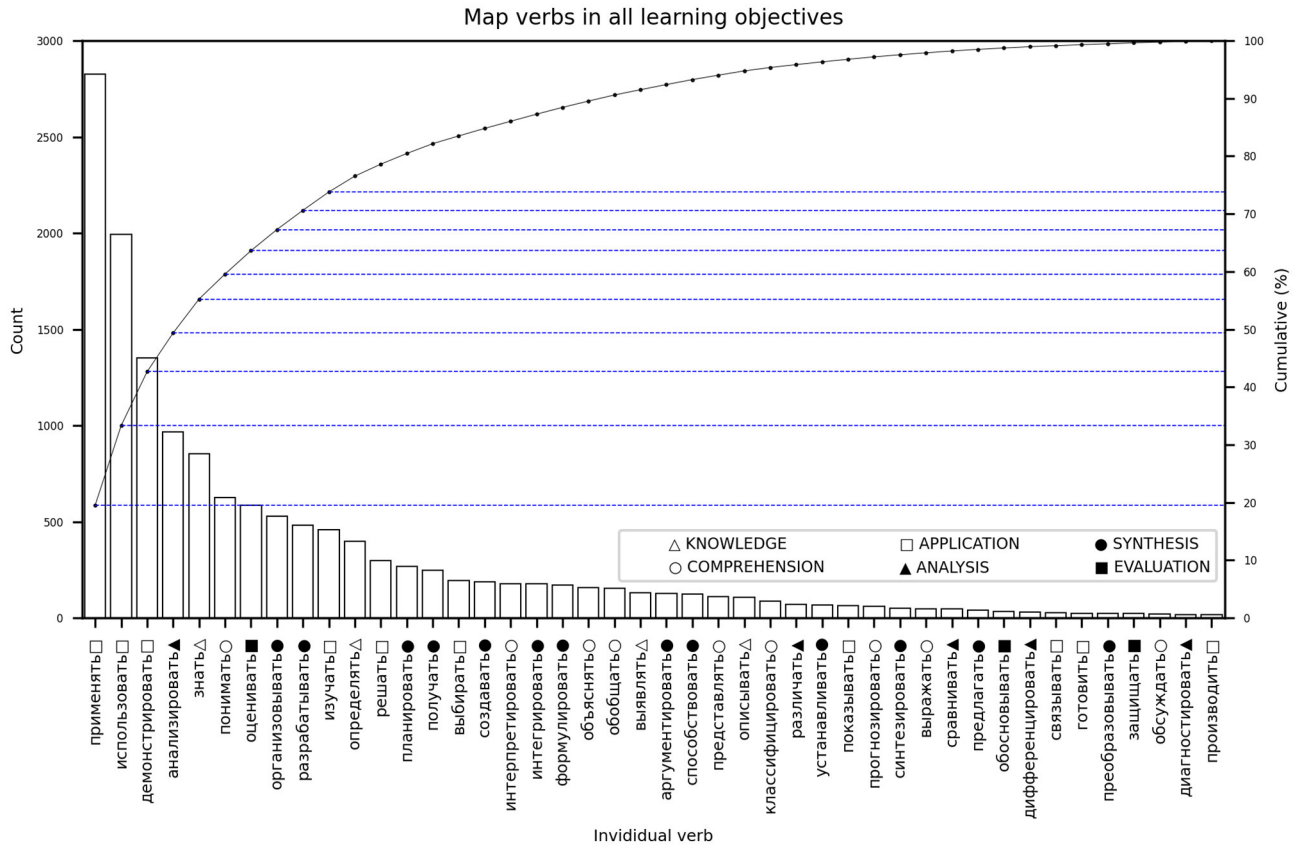

FIGURE 1
Pareto chart showing the frequency of verbs in learning outcomes and their cumulative coverage percentage. Source: author.

Taxonomy, selected from a list provided in the official guidelines for EP development. This requirement, along with other stringent rules (for example, the mandate that Russian-language LO formulations must commence with an active verb), is aimed at the unification of EPs and ensuring their development adheres to a single standard. Non-compliance with these regulations, such as failing to start an LO with the appropriate verb form, results in the program being returned to the developer by the Registry administrator for revision.

It was precisely this emphasis on unification and the strict formalization inherent in the EP development process that served as determining factors in selecting the methodological approach for the present study.

EPs are offered in three languages: Kazakh, Russian, and English. While we prioritized analysis of the Russian-language EPs due to potential quality variations across universities when developing their English versions, our decision to exclude Kazakh was not based on linguistic quality concerns but rather because of limited availability of specialized tools for text processing. Additionally, the author's expertise in contextual text analysis is more extensive with respect to Russian.

As previously mentioned, this study focuses specifically on bachelor's degree programs in pedagogical sciences. Using the EPVO's built-in filter feature, we identified 950 relevant EPs as of March 28, 2024. This high number of pedagogical programs in Kazakhstan is directly related to the country's parallel teacher training system: unlike sequential systems where students first obtain a specialized degree before pursuing teacher training, Kazakhstani students simultaneously study both subject-specific disciplines and pedagogical content. Educational programs are structured into "groups of educational programs" that align with multiple legal frameworks—such as professional standards and other relevant regulatory acts. This hierarchical structure ensures consistency in program design. For example, the "Teacher Training of Mathematics" group encompasses programs like "Teacher training of Mathematics-Computer science" and "Teacher training of Mathematics-Physics." Graduates receive a "Bachelor of Education" degree specific to their chosen program within the group. Universities typically have 25–30 teacher training educational programs, reflecting the breadth of this system.

2.2 Refinement

To ensure data quality and comparability, we adhered to recommendations from the National Center for the Development of Higher Education of Kazakhstan, which suggest 8–15 learning outcomes per program. This resulted in the exclusion of 13 from initial sample of 950 EPs.

Two programs were removed due to a lack of crucial metadata, likely caused by technical errors.

Additionally, the ongoing teacher education modernization project introduced 41 duplicate programs with identical learning outcomes. To avoid overrepresentation, we removed 25 such educational programs (leaving us with 16 unique sets of LOs).

Further analysis was conducted on the remaining sample of 910 EPs and a total of 10,241 LOs.

2.3 Text preprocessing

To address the complexities of Russian morphology, MyStem computer program (Segalovich and Titov, 2011) was used to lemmatize the LO text. MyStem is a well-established stemming/lemmatization software specifically designed for Russian language.

Lemmatization transforms words to their canonicalized form. For example, original text could include various forms of the verb "to know," such as "знают" (plural: they know), "знает" (singular: he/she knows), or "зная" (while knowing). Converting all these variations to the dictionary form "{знать}" (to know) simplifies the toolset needed to make statistical analysis possible (output lemmas are enclosed in curly brackets by MyStem).

2.4 Literal search

Transforming all learning outcomes into lemmas enables a computer script that searches and counts string literals potentially related to critical thinking. By extracting one word before and after each literal found, it becomes possible to more accurately determine whether the usage is linked specifically to critical thinking or if it belongs to unrelated constructs like "{avoid} {critical} {error}."

2.5 Verb map

The mapping of Russian language verbs to Bloom's Taxonomy cognitive domain categories was produced by combining two sources: Kazakhstani national experts' recommended list for EP developers (ENIC, 2023) and the "Pragmatic Master List" of 51 verbs (Newton et al., 2020).

The original national list contains 119 non-unique entries, with some verbs appearing in multiple categories—those were condensed to 79 lemmas. Verbs that occurred <10 times across all LOs were removed, resulting in a set of 37 relevant verbs.

The original English-language PML was translated into Russian and expanded or reduced as necessary based on synonyms and lexical nuances. In some cases, one original verb introduced two different Russian verbs. In other cases, multiple verbs were consolidated to a single term. Excluding rarely used verbs (occurring <10 times), this resulted in a set of 28.

A union of these two sets–37 verbs from the national experts' recommended list and 28 verbs from the PML translation—yielded a final comprehensive map of 44 unique Russian verbs (Table 1).

2.6 Frequency analysis

Computer code in Microsoft PowerShell scripting language was created to summarize each educational program to multiple metrics:

- *LO_COUNT* and *LO_TOTAL_WORDS*—the number of LOs and total word count in all LOs combined
- For each of six categories:

- "*count*" (followed by category name)—count of uses of all verbs of that category in the LOs
- "*ratio*" (followed by category name)—the corresponding "*count*" divided by *LO_TOTAL_WORDS* and multiplied by 100, providing a normalized measure

TABLE 1 Russian-language verbs categorized by Bloom's taxonomy.

Category	Verbs	English translation
KNOWLEDGE	выявлять, знать, описывать, определять	Identify, know, describe, define
COMPREHENSION	выражать, интерпретировать, классифицировать, обобщать, обсуждать, объяснять, понимать, представлять, прогнозировать	Express, interpret, classify, summarize, discuss, explain, understand, present, predict
APPLICATION	выбирать, готовить, демонстрировать, изучать, использовать, показывать, применять, производить, решать, связывать	Select, prepare, demonstrate, study, use, show, apply, produce, solve, link
ANALYSIS	анализировать, диагностировать, дифференцировать, различать, сравнивать	Analyze, examinate, differentiate, distinguish, compare
SYNTHESIS	аргументировать, интегрировать, организовывать, планировать, получать, предлагать, преобразовывать, разрабатывать, синтезировать, создавать, способствовать, устанавливать, формулировать	Argue, integrate, organize, plan, receive, propose, transform, develop, synthesize, create, promote, establish, formulate
EVALUATION	защищать, обосновывать, оценивать	Defend, justify, evaluate

Source: Author.

The data for this study was naturally sourced from dozens of organizations. Since different institutions may formulate LOs in various ways, normalizing the results using ratios is crucial to enable meaningful comparisons between programs with differing lengths or verbosity levels. These ratios effectively reflect the "concentration" of verbs within each category per 100 words in EP.

These metrics were combined with three metadata fields carried from EPVO into a single table in CSV format. Basic statistical analysis was performed using Microsoft Excel.

The same PowerShell script also counts individual usages for each verb within LOs. Additionally, two Python scripts were used to generate graphs that visually represent the frequency analysis results.

2.7 Known limitations

Natural language processing tasks involve inherent uncertainties. Several risks must be considered when interpreting our findings:

- LOs might contain grammatical errors or typos, which can affect the accuracy of text processing
- There may be verbs used in LOs that are not included in the verb map. These omissions could result in certain words being excluded from statistical analysis
- The manual review process is subject to human bias and interpretation errors, potentially leading to inconsistent exclusions or inclusions.

3 Results

3.1 Literal usages of "critical"

A total of 62 triplets containing the word "critical" were identified, with this term being used 319 times across all learning outcomes. The top three most frequent usages included "{навык} {критический} {мышление}" ("the skill of critical thinking"),

TABLE 2 Ten most used verbs across all Los.

Rank	Verb	English translation	Count	Category
1	применять	Apply	2,826	APPLICATION
2	использовать	Use	1,993	APPLICATION
3	демонстрировать	Demonstrate	1,352	APPLICATION
4	анализировать	Analyze	968	ANALYSIS
5	знать	Know	852	KNOWLEDGE
6	понимать	Understand	626	COMPREHENSION
7	оценивать	Evaluate	586	EVALUATION
8	организовывать	Organize	530	SYNTHESIS
9	разрабатывать	Develop	482	SYNTHESIS
10	изучать	Study	460	APPLICATION

Source: Author.

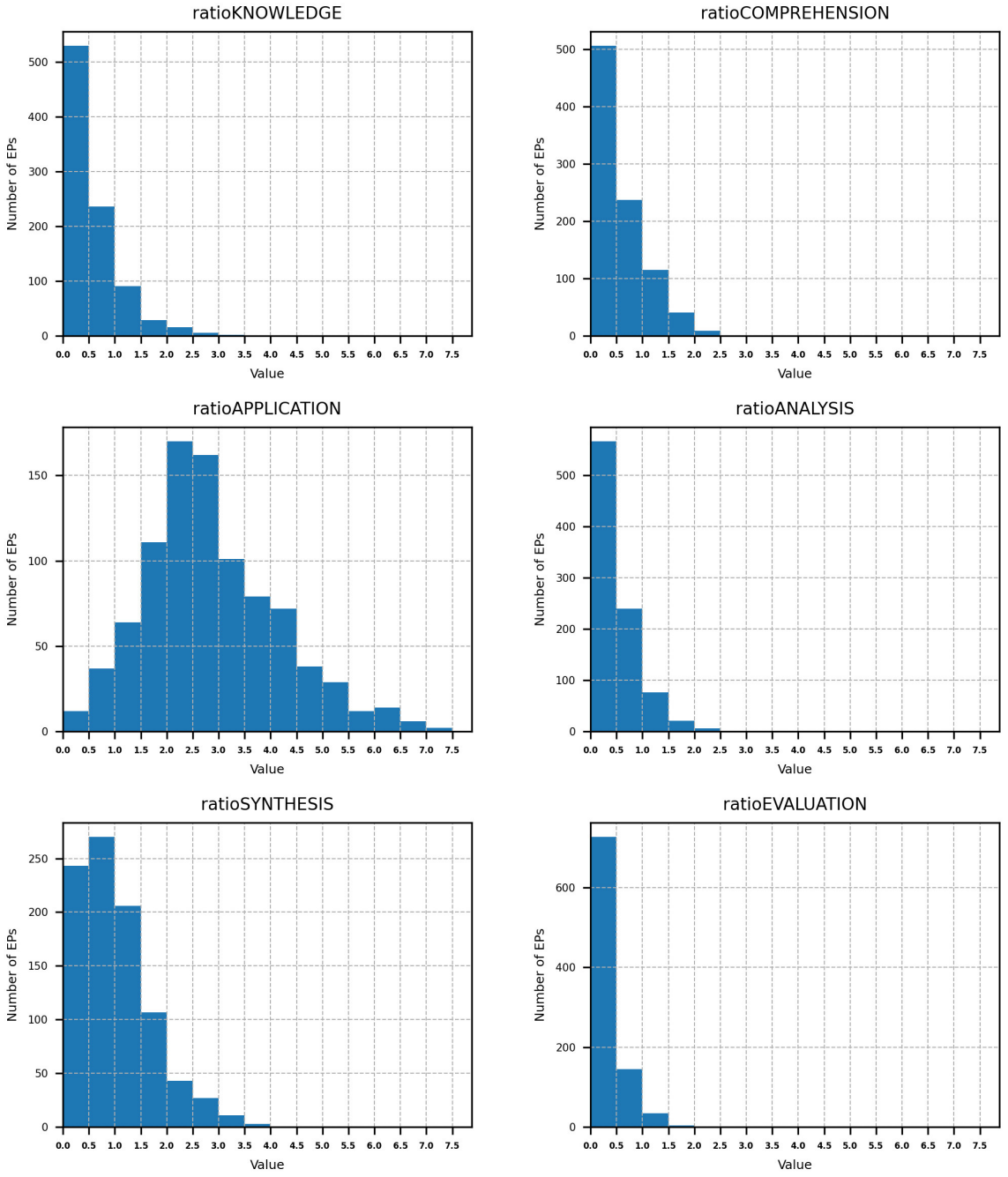

FIGURE 2
Distribution of verb frequency by categories in educational programs. Source: author.

"{и} {критический} {мышление}" ("and critical thinking"), "{навык} {критический} {и}" ("the skill of critical and").

After manual review, 37 instances that did not directly relate to critical thinking (such as phrases like "critical situation," "critical maintenance") were excluded.

Following exclusions, the word "critical" was found in 282 instances across a total of 10,241 learning outcomes. This represents ~2.75% of LOs.

3.2 Verbs

A total of 14,466 occurrences of 44 verbs were identified across all 10,241 learning outcomes (averaging ~1.41 verbs per LO). As shown in (Figure 1), the distribution of verb usage is **highly skewed**: the top three verbs account for 42.7% of all verb usages (the right vertical axis displays the cumulative percentage, left axis is count of verbs). The top 10 verbs span across all six categories

and collectively represent 73.8% of all verb usages, as detailed in Table 2.

The statistics reveal a similarly skewed distribution among categories, where the most popular one significantly outpaces others: APPLICATION (50.15%), SYNTHESIS (17.28%), KNOWLEDGE (10.29%), COMPREHENSION (9.98%), ANALYSIS (7.85%), EVALUATION (4.45%). Note that the so-called HOTS categories are responsible for less than a third of verb usages.

EP developers' preferred category also shows distinctively different distribution pattern when plotted in a histogram based on "ratio" metrics (Figure 2).

Interestingly, there were educational programs not utilizing verbs from each category: APPLICATION was unused in one program (0.11%), SYNTHESIS in 96 (10.55%), COMPREHENSION in 304 (33.41%), KNOWLEDGE in 308 (33.85%), ANALYSIS in 337 (37.03%), and EVALUATION in 496 (54.51%).

4 Conclusion

While critical thinking is essential, it receives only modest attention in the learning outcomes. Both direct mentions of "critical thinking" in text and indirect references through verbs associated with higher-order thinking skills suggest area needs improvement.

The number of occurrences of ANALYSIS and COMPREHENSION verbs shows that these categories are underrepresented. Although some researchers (Anderson Lorin and Krathwohl David, 2001) highlight that critical thinking skills are often categorized under COMPREHENSION, this limited presence suggests there might be a lack of emphasis on both these vital competencies among curriculum developers. Strong analytical and comprehension skills form important foundations for developing robust critical thinking abilities.

The EVALUATION category is notably underrepresented as well—over half of EPs fail to include any verbs from this category. Despite its essential role for teachers' ability to assess student achievements, progression, and the overall quality of their teaching process for continuous improvement. Effective evaluation skills are crucial components of critical thinking because they enable educators to critically analyze the effectiveness of various strategies used during instruction.

The SYNTHESIS category shows a relatively better representation compared to other HOTS. Fostering the ability to develop unique perspectives and integrate knowledge from different sources enhances problem-solving skills, a key component of critical thinking.

The domination of the APPLICATION category may reflect an overly narrow interpretation of practice-oriented learning, equating it solely with practical skill application. While official documents emphasize its role in deepening disciplinary knowledge through real-world engagement, educators might need to broaden their understanding beyond mere procedural skills.

5 Recommendations for curriculum developers

This analysis provides new insights into teacher training in Kazakhstan and offers recommendations for educational program developers:

- Encourage a more balanced integration of all Bloom's Taxonomy categories within learning outcomes.
- Increase focus on evaluation verbs to enhance teachers' abilities to continuously assess student progress, teaching methods, and governance structures critically.
- Promote an expanded view of practice-oriented methodologies that go beyond mere skill application.

The methodological approach, employing a computer algorithm to analyze verb frequencies, facilitates ongoing evaluation of educational programs based on the impact of changes, ensuring continuous improvement in initial teacher education.

Author's note

The author's affiliation with Kazakh National Women's Teacher Training University which offers some of the educational programs included in the analysis, raises the possibility of an institutional perspective influencing the study findings. To ensure objective analysis, the program code used in this study does not classify or identify educational programs based on their originating universities. This methodology minimizes the potential for bias introduced during data processing.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/Supplementary material.

Author contributions

MK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships

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Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1554713/full#supplementary-material

DATA SHEET 1
A zip archive containing the code.

DATA SHEET 2
Results of the count of "critical thinking" mentions in learning outcomes.

DATA SHEET 3
Verb map.

DATA SHEET 4
Results of verb frequency from the verb map, sorted in descending order (from highest to lowest).

DATA SHEET 5
A summary table of the final verb usage frequency results, with calculated metrics: ratio (frequency per 100 words) and count (direct number of mentions), categorized by Bloom's Taxonomy levels.

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