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Effectiveness of an author's program for psychopedagogical support in the development of metacognitive abilities

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ABSTRACT

In the context of the updated educational system emphasizing autonomy and critical thinking among students, it is necessary to develop effective approaches to support and enhance students' metacognitive abilities. This research aims to evaluate the effectiveness of a proprietary psychological and pedagogical support program designed to develop metacognitive abilities in schoolchildren. Methods included conducting a quasi-experimental study with control and experimental groups, utilizing the metacognitive awareness assessment questionnaire (MAAQ) to assess outcomes. The study involved 184 students (grades 7-9; M=14.40; SD=0.81) from a school in Kazakhstan, where the experimental group underwent the intervention program. Statistical analysis revealed significant improvements in metacognitive abilities among students in the experimental group compared to the control group, including enhancements in self-awareness, self-regulation, critical thinking, decision-making, and problem-solving. These findings affirm the feasibility of integrating metacognitive approaches into educational programs and suggest further avenues for research in pedagogical support and student development.

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1. INTRODUCTION

In the context of Kazakhstan's continuously evolving educational landscape, the country has embarked on a transformative path aimed at renewing its education system [1]. Embracing the principles of active learning, collaborative environments, differentiated instruction, interdisciplinary connections, and the integration of information and communication technologies (ICT), the nation seeks to equip its students with the skills and competencies necessary for success in the twenty-first century [2]. The shift from a traditional pedagogical approach to one based on updated educational principles signifies a move towards nurturing independent and critically thinking individuals, recognizing that memorization of facts and passive learning is no longer sufficient for preparing students to confront the complexities of the modern world [3]. Instead, the emphasis now lies on active learning, encouraging students to take responsibility for their education, participate in collaborative activities, and explore interdisciplinary connections [4]. This paradigm shift is not merely a reflection of educational trends but a deliberate attempt to empower students with the skills, knowledge, and metacognitive abilities required to thrive in the global knowledge system [5], [6].

Despite the acknowledged importance of metacognitive abilities, significant challenges persist in their development within the current educational system [7]. Modern educational systems emphasizing ICT,

dialogical learning, and student-centered approaches present unique challenges and opportunities. Teachers and students sometimes lack clear action plans or guidance for a smooth and qualitative transformation [8]. Effective technology integration in education, facilitation of constructive dialogue, and understanding of diverse student needs are just a few of the issues confronting this new educational landscape [9]. This highlights the critical need for specialized psycho-pedagogical approaches to support and enhance students' metacognitive abilities. Furthermore, despite the acknowledged importance of metacognitive abilities, there persist significant challenges in their development within the current educational system [10]. Modern educational systems, emphasizing ICT, dialogical learning, and student-centered approaches, present unique challenges and opportunities. Teachers and students sometimes lack clear action plans or guidance for a smooth and qualitative transformation [11]. Effective technology integration in education, facilitation of constructive dialogue, and understanding of diverse student needs are just a few of the issues confronting this new educational landscape [12].

In response to these challenges, this article introduces a developed proprietary program aimed at providing psycho-pedagogical support for the development of metacognitive abilities in school students. This program is specifically designed in consideration of the principles of the updated education system in Kazakhstan. It encompasses a combination of strategies and methods grounded in contemporary educational standards to assist students in acquiring the necessary skills to thrive in this new learning environment. The significance of this research lies in its practical application and potential impact on the education system. By examining the effectiveness of the current program, the research aims to provide valuable information on methodologies that can effectively support the development of metacognitive abilities in middle-level students spanning from the seventh to the ninth grade. This is particularly relevant in the context of the evolving educational landscape in Kazakhstan where a departure from traditional approaches is underway. Overall, the article seeks to shed light on the multifaceted path toward enhancing metacognition in the context of the updated education system in Kazakhstan.

2. LITERATURE REVIEW

Metacognition refers to a wide range of understanding and awareness related to an individual's cognitive, emotional, perceptual, or motor attributes. In the realm of education, it includes a learner's self-awareness, recognizing elements that might impact their performance, knowledge of different strategies, and an understanding of when and how to apply these strategies [13], [14]. Beyond just awareness, metacognitive knowledge involves actively monitoring one's own thinking, which includes planning activities, being aware of comprehension, carrying out tasks, and assessing the effectiveness of monitoring processes and strategies [15], [16].

From preschool to high school age, the educational system often provides limited opportunities for the development of metacognitive and cognitive skills. Nevertheless, these skills are essential for academic success and real-world applications [17], [18]. The development of metacognitive and cognitive abilities is not innate but can be cultivated, emphasizing the importance of integrating metacognitive learning into educational programs to help students effectively employ cognitive strategies and enhance their learning processes [19], [20]. Further, metacognitive abilities in middle school may include a range of key skills and conscious strategies aimed at improving their learning process. These skills encompass self-awareness, self-regulation, self-evaluation, reflection, task understanding, and control over the learning process [8].

As part of Kazakhstan's reformed education system and in accordance with state-sanctioned instructional and methodological guidelines, the country is striving to improve education across the board [2]. This effort includes the introduction of psycho-pedagogical programs aimed at fostering the development of metacognitive skills [21]. In this context, it is relevant to recall Bloom's "Taxonomy of educational objectives", revised by Anderson, which led to significant changes in the understanding and application of the taxonomy in educational goals. The revised taxonomy includes six categories of cognitive processes: remembering, understanding, applying, analyzing, evaluating, and creating, thereby rendering the categories more dynamic and action-oriented [22]. Unlike the original taxonomy, the revised version replaces nouns with verbs, incorporates a knowledge dimension, and distinguishes knowledge into factual, conceptual, procedural, and metacognitive domains, enabling a more precise assessment and development of various aspects of students' cognitive activities, enhancing their academic success and readiness for the complexities of the modern world [22].

In traditional educational institutions, primary attention is often given to the first two levels of this hierarchy, presupposing mechanical memorization and recall of facts and understanding the meaning of the material being studied. Although these levels are foundational, they do not engage students in deeper and more critical forms of thinking [2], [23]. The philosophy of updated education aims to move students beyond the initial stages. This modern approach also encourages students to reach higher levels of Bloom's

Taxonomy [2]. These levels consist of "application," where students apply knowledge in new contexts; "analysis," which entails dissecting information to grasp its structure; "synthesis," where students combine various elements to create something new; and "evaluation," the highest level, where students assess and make judgments based on established criteria and standards [24].

Currently, in Kazakhstan, updated education represents a comprehensive overhaul of the education model, involving a revision of its structure, content, educational and pedagogical approaches, as well as teaching and assessment methods [2]. Within the scope of educational reform, the emphasis is placed on creating a collaborative and differentiated learning environment that stimulates personal development and the implementation of pedagogical innovations. These innovations are aimed at enhancing student motivation and transforming schools into places of SMART education, where both active learning and the development of moral-spiritual qualities are essential [2], [25].

Furthermore, collaborative learning is another cornerstone of the updated education in Kazakhstan, as within this setting, students work together to solve problems, share ideas, and engage in meaningful discussions, receiving feedback from teachers [26]. Collaboration not only fosters metacognition by encouraging students to articulate their thoughts and reasoning but also contributes to the development of social and communicative skills crucial in the contemporary world [27]. Differentiated instruction is an essential element of modern education, recognizing that students have varying learning needs and abilities. This approach emphasizes the necessity of tailoring teaching methods to address the specific needs of each individual learner [28]. When it comes to metacognition, it is crucial to understand how differentiation can be applied to support the development of metacognitive abilities in a heterogeneous class [29].

Among other things, interdisciplinary connections represent another dimension of updated education in Kazakhstan [2]. Recognizing that real-world problems often require an interdisciplinary approach, this educational model encourages students to explore connections between different subjects, apply their knowledge comprehensively, navigate the complexities of multiple disciplines, establish links between them, and think critically about how their knowledge can be applied in various contexts [30]. Additionally, in the era of ICT, the effective use of digital tools is a fundamental skill. Therefore, within the framework of updated education, they become not just accessories but an integral part of the learning process [3].

Moreover, the dialogue between teachers and students, as well as an understanding of their individual needs, are of particular importance for effective pedagogical support. This begins with how teachers can engage in substantive dialogue with students to understand thinking processes and guide them toward more effective strategies. It also involves how educators can tailor their support to address particular metacognitive needs [31]. These factors create avenues for research, collaboration, and access to information related to metacognitive development, leading to the question of how a psycho-pedagogical support program can leverage modern educational paradigms to improve students' metacognitive skills.

2.1. Problem statement

The aim of this research is to evaluate the effectiveness of a custom-designed psycho-pedagogical support program in enhancing metacognitive abilities among school students within the framework of updated education. The study aims to identify how this program can contribute to improving the learning process and promoting deeper and more conscious engagement of students in educational activities. The scientific significance of this article lies in providing empirically validated data on the impact of the author-designed psycho-pedagogical support program on the development of students' metacognitive abilities. The article expands the understanding of how innovative educational approaches can be effectively integrated into school learning within the framework of the modern requirements of updated education. It also offers valuable recommendations for teachers and educational institutions on how to enhance educational processes and contribute to the holistic development of students. The research tasks formulated during the study are: i) By comparing the indicators of control and intervention groups, assess the effectiveness of the author-designed psycho-pedagogical support program for the development of metacognitive abilities in school students within the context of updated education, comparing pre-tests and post-tests; ii) Establish the reliability of differences in the obtained results for the intra-group indicators of control and intervention groups to confirm or refute differences between post-tests and pre-tests; and iii) Determine the reliability of differences between pre-tests and post-tests to identify the dynamics of indicators in the control and intervention groups.

3. METHOD

For this research, an author-designed psycho-pedagogical support program for school students was developed to contribute to the development of metacognitive abilities in the context of Kazakhstan's updated education. The program's creation involved a multi-stage approach. The methodology of the present study was based on a comprehensive approach to the development and analysis of the effectiveness of a

pedagogical program. Its development commenced with a thorough analysis of needs and a preliminary review of existing methodologies, thereby facilitating the formulation of clear educational goals and objectives. Building upon these data, the content of instructional modules and methods of their implementation were delineated. To assess the effectiveness of the program, a quasi-experimental design was selected, encompassing pre- and post-testing involving both control and experimental groups. Data were gathered using standardized tests and questionnaires, and their analysis was carried out using statistical methods to ensure a reliable evaluation of changes in students' metacognitive abilities resulting from the intervention. All methodological decisions made during the research were based on current theoretical frameworks in educational psychology and metacognitive studies. This approach not only supported the creation of a well-founded and effective educational program but also allowed for the measurement of its impact on the learning process. In the planning phase, the program's primary goals and objectives were established, with a focus on fostering the development of metacognitive skills, such as the ability to analyze, plan, and evaluate one's own learning activities.

In the process of program development, instructional modules were created, emphasizing active learning through group projects, individual assignments, and the integration of interactive technologies. Before its implementation in this research, the program underwent testing and verification. Preliminary trials in schools allowed for participant feedback collection and subsequent adjustments for improvement. After completing the testing and refinement stage, the program was introduced into educational institutions, with a crucial aspect being the training of teachers responsible for implementing the program in practice.

A series of training sessions and seminars were organized to familiarize teachers with the methods and approaches of the program and to develop practical skills for working with students. Ultimately, the program aimed to enhance metacognitive abilities by promoting active student participation in the educational process and improving academic performance. It provided students with the necessary tools for better understanding and managing their learning processes and strategies, a crucial factor for successful education. In the experimental group, a developed psycho-pedagogical program was implemented, comprising a series of interactive exercises and tasks aimed at fostering metacognitive skills. Instructional activities were organized through modified teaching sessions, wherein students actively applied self-assessment and self-regulation techniques, supported by regular monitoring and feedback from teachers. Due to text limitations and copyright constraints that prohibit providing extensive materials, a description of the program is presented in Table 1.

Each of these elements was incorporated into the educational process to establish a comprehensive and effective learning environment that stimulates the development of metacognitive abilities among students, as well as fostering their academic, personal, and spiritual growth. The integration followed a protocol and the program itself, encompassing all aspects. The primary tool for assessing the program's effectiveness was the specially designed metacognitive abilities assessment questionnaire (MAAQ), comprising five subscales:

- Self-awareness: understanding one's strengths and weaknesses in learning, and awareness of preferred learning styles and strategies.
- Self-regulation: the ability to set learning goals, plan and organize the learning process, as well as control and adjust it according to tasks and requirements.
- Critical thinking: the ability to analyze information, distinguish facts from opinions, and evaluate arguments and evidence.
- Decision-making: the ability to choose optimal strategies and solutions in various learning situations.
- Problem-solving: utilizing logical thinking to find solutions to complex problems, as well as adapting to new and changing conditions.

The metacognitive abilities questionnaire text is presented, which was administered using a 5-point Likert scale, where 1=strongly disagree, and 5=strongly agree, as presented in Table 2. The development, preparation, pilot testing, and validation process of the questionnaire to assess the metacognitive abilities of middle school students was a multi-stage undertaking involving several key phases. The initial development stage encompassed the formulation of the conceptual basis of the questionnaire, entailing a review of scientific literature on metacognitive abilities and educational psychology. Based on the gathered data, five key subscales were identified, and statements reflecting various aspects of metacognitive abilities were devised for each subscale. After developing the initial version of the questionnaire, it was subjected to expert evaluation, where specialists in psychology and education reviewed its content to ensure alignment with the research objectives. The feedback and suggestions provided were used to refine and clarify the statements.

Following this, the questionnaire was pilot tested with a group of middle school students (n=20). This testing aimed to assess the clarity and relevance of statements for the target audience, and feedback was collected for further improvements. To assess the questionnaire's validity, a factor analysis was conducted,

and its reliability was substantiated through the application of Cronbach's alpha coefficient. The findings revealed a substantial degree of internal consistency among statements within each subscale, with coefficients ranging from 0.85 to 0.91. Through these rigorous processes, a questionnaire was developed capable of effectively assessing the metacognitive abilities of middle school students.

Table 1. Description of the author's program for psychological and pedagogical support of schoolchildren to develop metacognitive abilities

Element of the program	Description	Methods and approaches	Application
Active learning	Stimulating active participation of students in the learning process.	Project-based learning (PBL), role-playing: utilizing interactive educational platforms such as Kahoot! to create quizzes and gamified learning activities. Applying the PBL platform for the development and implementation of educational projects.	Executing projects to solve real-world problems, and conducting educational role-playing games to enhance decision-making skills.
Collaborative environment	Developing teamwork skills.	Group discussions, collaborative research: engaging in group discussions and collaborative research. Using Google Classroom and Microsoft Teams to organize collaborative work on projects and documents.	Organizing discussions on current topics, and group scientific projects where each student contributes.
Differentiated instruction	The individualized approach to teaching.	Individual assignments, adaptive technologies: assigning individual tasks and employing adaptive technologies. Applying adaptive educational platforms like Khan Academy to provide assignments tailored to each student's level of knowledge.	Developing tasks with different levels of complexity, employing adaptive educational programs.
Integration of ICT	Utilizing technology in education.	Electronic resources, educational programs: incorporating educational applications like Duolingo for foreign language learning and Tinkercad for basic 3D modeling education.	Implementing interactive educational materials, utilizing educational applications and platforms.
Dialogic learning	Support for open communication.	Debates, roundtables: engaging in debates and roundtable discussions. Utilizing the TED-Ed platform for discussing and analyzing ideas presented in educational videos.	Facilitating debates on controversial issues, and conducting roundtable discussions with experts and students.
Development of moral and spiritual qualities	Fostering values and personal qualities.	Morality and ethics lessons, extracurricular activities: implementing resources such as character.org for developing lessons and activities aimed at character education and moral values.	Conducting thematic sessions on ethics, and organizing socially significant events and projects.
Formative assessment	Assessment of student progress.	Portfolios, self-assessment: using the Seesaw platform for creating student portfolios, including their works, reflections, and assessments.	Maintaining portfolios by students to track their achievements, enabling self-assessment of progress.
Spiral learning	Gradual deepening of knowledge.	Modular learning, subject integration: utilizing learning programs like Edmodo for organizing modular learning, allows students to progressively deepen and expand their knowledge.	Building the curriculum in a way that knowledge deepens and expands with each learning module.
Cross-cutting themes	Creating interdisciplinary connections.	Thematic projects, interdisciplinary lessons: utilizing interdisciplinary educational platforms, such as discovery education, for creating integrated educational projects and lessons.	Integrating different subjects through common themes and projects contributes to the comprehensive development of students.

3.1. Participants

Students from one of the schools in Kazakhstan, which had implemented updated teaching methods and expressed readiness to incorporate the author's program within its premises, participated in the research. The sample comprised 184 students from grades 7 to 9 (M=14.40; SD=0.81). They were distributed across parallel classes, and randomly, one class from grades 7-9 was designated as the control group, while the other served as the experimental group. To mitigate additional stress, students were not mixed within the classes. More detailed information about the participants is provided in Table 3.

On average, males constitute 45.1% of the sample, while females account for 54.9%. All participants were informed about the current project and the author's program, and that their classes would be randomly assigned to either the influence or control group, provided their voluntary consent to participate in the study. As all participants were minors, written permissions were obtained from their parents or guardians, confirming the child's eligibility to participate. Assurances of data confidentiality and privacy were extended to all participants.

Table 2. Metacognitive abilities assessment questionnaire (MAAQ)

	Item
Self-awareness	I know which subjects I excel in and where I need additional help.
	I am aware of which learning strategies suit me best.
	I can easily identify parts of a lesson or topic that I find challenging.
	I am conscious of my learning style.
	I understand when to seek help or use additional resources to comprehend a topic.
Self-regulation	I set specific goals that I want to achieve in my studies.
	I create a plan for approaching my studies and adhere to it.
	I regularly assess my progress to see if I am achieving my learning goals.
	I can adjust my learning methods if they are ineffective.
	I efficiently manage my time to cover all learning topics.
Critical thinking	I question the information I receive in classes and do not accept everything as fact without evidence.
	I can distinguish between main points and additional details in what I read or hear.
	I enjoy discussing various perspectives on a given topic.
	I can differentiate between facts and opinions in texts or discussions.
	I critically evaluate the arguments and evidence presented in my study materials.
Decision making	I can choose the most effective learning strategies for different types of assignments or tests.
	I make decisions about my learning based on what has worked well for me in the past.
	I am confident in selecting resources (books, websites, people) that will help me learn.
	I can decide how best to approach a new or challenging topic.
	Faced with a complex problem, I can choose the best course of action to solve it.
Problem-solving	I enjoy solving complex problems in my studies.
	I can break down complex tasks into smaller, manageable parts.
	I am skilled at finding different ways to solve a problem when it seems to be at an impasse.
	I adapt well to new methods and changes in my learning environment.
	When encountering obstacles in learning, I can usually find effective solutions.

Table 3. Data on middle school students (grades 7-9) participating in the current study

Group		Total	Male	Female	Average age (M)	SD
A (control)	7 grades	32	13	19	14.42	.84
	8 grades	29	13	16		
	9 grades	31	15	16		
B (experimental)	7 grades	30	12	18	14.38	.79
	8 grades	31	16	15		
	9 grades	31	14	17		
Total/mean		184	83	101	14.40	.81

3.2. Study design

The research itself spanned the academic year 2022-2023, from September to the end of May, coinciding with the period of influence. At the outset of the study, students from all six classes (two parallel classes from each of the three grades) completed the MAAQ in computer labs using online forms. Subsequently, as mentioned earlier, one of the parallel classes served as the control group, while the other class assumed the role of the influence group. The control group attended regular classes as per their curriculum, while the influence group underwent the implementation of the author's program with the involvement of four psychologists and twelve specially trained teachers across various subjects. All subjects were taught to children by the principles embedded in the psychological and pedagogical support program aimed at developing students' metacognitive abilities. Upon the conclusion of the intervention, participants again completed the MAAQ.

3.3. Data analysis

All collected MAAQ results were automatically stored on a server for further analysis. Data analysis was conducted using statistical package for the social sciences (SPSS), ensuring high accuracy and reliability in data processing. Non-parametric tests were employed during the analysis, both for dependent and independent samples. These tests included the Wilcoxon signed-rank test to assess within-group differences and the Mann-Whitney U test to compare scores between the control and experimental groups.

3.4. Ethical issues

Before initiating the study, permission was obtained from the educational authorities of Kazakhstan and the ethics committee, which provided its resolution for the research. All organizational expenses related to the study were covered by the researchers and the institution; participants and their parents did not incur any additional costs from their resources. All children participated voluntarily, were assured of the confidentiality and anonymity of their data, and were granted the right to discontinue their participation in the study at any point if they wished to do so.

4. RESULTS AND DISCUSSION

The first and second tasks involved assessing the effectiveness of the author's program for psychological and pedagogical support in developing metacognitive abilities among students in the context of updated education. This was achieved by comparing the indicators of the control and influence groups and examining pre-tests and post-tests. Additionally, using the Wilcoxon criterion for the control and influence groups, the significance of intra-group differences was determined. For simplicity and ease of comprehension, the five subscales of the MAAQ are presented separately across five tables.

Table 4 presents the mean values of self-awareness indicators in the pre-test and post-test for the control and influence groups. In the control group, the mean value remained virtually unchanged, while in the influence group, a significant increase of 3.8 points in the mean value was observed. According to the Wilcoxon criterion, the changes in the control group were negligible and statistically insignificant, whereas in the influence group, a substantial and statistically significant increase in self-awareness indicators occurred.

The investigation of the MAAQ self-regulation subscale in Table 5 revealed that, following the intervention, the mean value in the influence group increased by 4.02 compared to the pre-test, signifying a statistically significant difference. In contrast, the control group exhibited a modest increase of 0.72 in the mean value, and the differences in this group were found to be statistically insignificant. The results of the analysis of the MAAQ critical thinking subscale in Table 6 indicate that, following the intervention, the mean value of critical thinking in the influence group increased by 3.49 compared to the pre-test, and this difference proved to be statistically significant ($p<.05$). Meanwhile, in the control group, the differences in mean values between the pre-test and post-test were negligible and did not reach statistical significance.

Table 7 presents the results of the pre-test and post-test for the decision-making subscale of the MAAQ in two groups (control and influence). The control group exhibited an increase in the mean value by 1.11, while the influence group demonstrated a more substantial increase of 4.35. Both changes are statistically significant, as evidenced by the p-values approaching zero.

Table 4. Pre-test and post-test values of the MAAQ self-awareness subscale

		Pre-test	Post-test
Control group	Mean	12.45	12.49
	Standard deviation	1.706	1.738
	Standard error of the mean	.178	.181
	Variance	2.909	3.022
	Excess	-1.252	-1.295
	Standard error of excess	.498	.498
	Skewness	.075	.070
	Z	-.062	
	p-value	.951	
Experimental group	Mean	12.66	16.46
	Standard deviation	1.705	1.094
	Standard error of the mean	.178	.114
	Variance	2.907	1.196
	Excess	-1.295	-1.268
	Standard error of excess	.498	.498
	Skewness	-.109	.191
	Z	-8.216	
	p-value	.000	

Table 5. Pre-test and post-test values of the MAAQ self-regulation subscale

		Pre-test	Post-test
Control group	Mean	8.83	9.55
	Standard deviation	1.450	1.103
	Standard error of the mean	.151	.115
	Variance	-1.378	-1.319
	Excess	.498	.498
	Standard error of excess	.112	-.040
	Skewness	-1.677	
	Z	.104	
Experimental group	Mean	8.98	13.00
	Standard deviation	1.467	1.453
	Standard error of the mean	.153	.151
	Variance	-1.424	-1.361
	Excess	.498	.498
	Standard error of excess	-.026	-.022
	Skewness	-8.038	
	Z	.000	

Table 6. Pre-test and post-test values of the MAAQ critical thinking subscale

		Pre-test	Post-test
Control group	Mean	11.14	11.22
	Standard deviation	1.442	1.357
	Standard error of the mean	.150	.142
	Variance	2.079	1.842
	Excess	-1.320	-1.253
	Standard error of excess	.498	.498
	Skewness	-.208	-.136
	Z	-.340	
	p-value	.734	
Experimental group	Mean	10.92	14.41
	Standard deviation	1.303	1.081
	Standard error of the mean	.136	.113
	Variance	1.697	1.168
	Excess	-1.076	-1.282
	Standard error of excess	.498	.498
	Skewness	-.009	.016
	Z	-8.233	
	p-value	.000	

Table 7. Pre-test and post-test values of the MAAQ decision-making subscale

		Pre-test	Post-test
Control group	Mean	12.89	14.00
	Standard deviation	1.433	1.468
	Standard error of the mean	.149	.153
	Variance	2.054	2.154
	Excess	-1.262	-1.391
	Standard error of excess	.498	.498
	Skewness	.057	.000
	Z	-4.699	
	p-value	.000	
Experimental group	Mean	12.82	17.17
	Standard deviation	1.406	1.434
	Standard error of the mean	.147	.150
	Variance	1.976	2.057
	Excess	-1.237	-1.337
	Standard error of excess	.498	.498
	Skewness	.167	-.199
	Z	-8.271	
	p-value	.000	

Table 8 presents the results of the pre-test and post-test for the problem-solving subscale of the MAAQ in the control and influence groups. The control group exhibited a statistically insignificant increase in the mean value. Meanwhile, the influence group demonstrated a statistically significant increase of 3.25. The third task was to establish the significance of the differences between pre-tests and post-tests to identify the dynamics of indicators in the control and influence groups in an intergroup aspect. The results are presented in Table 9.

Table 9 displays the results of evaluating the statistical significance of differences between pre-test and post-test scores across the five MAAQ subscales in both the control and influence groups. The pre-test results show homogeneity across all five subscales (self-awareness, self-regulation, critical thinking, decision-making, and problem-solving), confirming that the samples were comparable at the start of the study. However, the post-test results reveal significant differences, with the influence group showing notably higher scores than the control group. This contrast in post-test results highlights the effectiveness of the program, as the influence group demonstrated marked improvement following the intervention.

The findings of this study confirm the effectiveness of the proprietary psycho-pedagogical support program in enhancing metacognitive abilities among students within the updated education system in Kazakhstan. Analysis of the data across various MAAQ subscales-self-awareness, self-regulation, critical thinking, decision-making, and problem-solving-leads to several key conclusions and insights. The notable improvement observed in the influence group can be attributed to the specialized methodologies and approaches of the proprietary program, which likely emphasized self-reflection, self-analysis, and critical thinking more than traditional educational methods. This focus contributed to advancements in self-awareness, self-regulation, decision-making, and problem-solving.

Table 8. Pre-test and post-test values of the MAAQ problem-solving subscale

		Pre-test	Post-test
Control group	Mean	13.40	13.96
	Standard deviation	1.070	.824
	Standard error of the mean	.112	.086
	Variance	1.144	.679
	Excess	-1.219	-1.525
	Standard error of excess	.498	.498
	Skewness	.123	.082
	Z	-.257	
	p-value	.821	
Experimental group	Mean	13.39	16..64
	Standard deviation	1.129	1.105
	Standard error of the mean	.118	.115
	Variance	1.274	1.222
	Excess	-1.374	-1.315
	Standard error of excess	.498	.498
	Skewness	.113	-.143
	Z	-8.151	
	p-value	.000	

Table 9. Assessment of the statistical significance of differences between pre-test and post-test indicators

	Pre-test self-awareness	Post-test self-awareness	Pre-test self-regulation	Post-test self-regulation	Pre-test critical thinking	Post-test critical thinking	Pre-test decision-making	Post-test decision-making	Pre-test problem-solving	Post-test problem-solving
U Mann-Whitney	3925.500	170.000	3979.500	240.000	3828.000	262.500	4106.000	644.000	4199.500	1140.000
W Wilcoxon	8203.500	4448.000	8257.500	4518.000	8106.000	4540.500	8384.000	4922.000	8477.500	5418.000
Z	-.861	-11.355	-.715	-11.181	-1.143	-11.135	-.357	-10.044	-.093	-8.794
p-value	.389	.000	.475	.000	.253	.000	.721	.000	.926	.000

Overall, the study indicates that the psycho-pedagogical program plays a significant role in enhancing students' metacognitive abilities. Nevertheless, a critical analysis of the data indicates certain aspects that require further consideration. Specifically, although the overall effectiveness of the program is confirmed, results may vary depending on individual student characteristics such as initial level of preparedness and motivation. It is also important to consider that the influence of external factors, such as family support and educational environment, may have affected the outcomes. These considerations underscore the importance of an individualized approach in the educational process and the need for further research to examine the long-term effects of implementing such programs in various educational contexts.

Furthermore, the minor changes in the control group, evident in four out of five subscales, may reflect limitations in the efficacy of updated educational methods in fostering metacognitive abilities, although improvements were noted in “decision-making.” This underscores that educational programs lacking specific focus may fail to address aspects of metacognitive development necessary for enhancing self-awareness and critical thinking in the modern educational context. The context of the updated education system in which the research was conducted might have also played a role in the obtained results. However, the proprietary program likely demonstrated better adaptation to these requirements, being meticulously integrated and resulting in more significant outcomes in the influence group. Additionally, it is plausible that the proprietary program employed a more individualized approach, considering the unique characteristics and needs of each student in the influence group.

One study by Teng and Zhang [6] investigated the dynamics of children's metacognitive knowledge, as well as their reading and writing skills, throughout their developmental stages. These three variables exhibited high stability and increasing variability over time, indicating individual differences in the development of metacognitive knowledge in children. The metacognitive knowledge of students tends to grow more rapidly among those who enter elementary school with already well-established metacognitive skills [6]. Therefore, this aspect also needs to be considered when interpreting results.

Another study by Smortchkova and Shea [14] argued that changes in procedural metacognition, aimed at mitigating overall excessive self-confidence and moving toward better calibration, are crucial for allowing a child to lose balance and, thus, open up to new concepts in areas where they already possess functioning concepts. This example suggests that there could be various ways through which the metacognitive development of children leads to comprehensive changes in how they can assimilate new concepts [14]. These findings could be incorporated into intervention programs as well.

Another scholarly article by Chen *et al*. [16] examined a metacognition improvement program titled "circular course metacognition training program" (CCMT) based on Anji Play. The results indicated that the experimental group demonstrated better metacognitive abilities than the control group across most metacognitive parameters in the post-test. Moreover, the indicators of metacognitive ability improvement in the experimental group were significantly higher than those in the control group [16]. These findings resonate with the current data, suggesting that proprietary programs can indeed have their effects.

Yet another study by Chernyavskaya and Sidorova [21] explored a psychological and pedagogical program for developing metacognitive abilities in school children. The results showed that the development of metacognitive skills in students contributes to their ability to understand themselves and use their resources, foster self-reflection, set goals, organize time, adapt to uncertain situations, manage emotions, and acquire specific practical skills. This, in turn, helps them learn more effectively and build relationships with themselves and others [21]. These outcomes align with the success and results of the current program.

Additionally, another research paper by Korsinszki and Turda [20] aimed to develop a creativity-based educational intervention program for the development of metacognitive skills in elementary school students. The obtained results demonstrated the effectiveness of the program by enhancing children's creativity from low to high levels. This example suggests considering the integration of the creative thinking development process into psycho-pedagogical support programs.

Additionally, one article highlights the positive impact of metacognitive strategies on students' performance in creative writing, indicating that such interventions can significantly improve students' skills [32]. This also echoes the findings of the current study, where the intervention group demonstrated significant gains in self-awareness, self-regulation, critical thinking, problem solving, and decision making, highlighting the effectiveness of the program. Another study by Sercenia and Prudente [33] found that metacognitive pedagogical interventions significantly improved students' performance in mathematics. The overall weighted effect size measured in this study indicated a strong positive impact, which parallels the significant improvements observed in the current study. Both studies suggest that metacognitive interventions can lead to significant academic gains in a variety of subjects.

Metacognitive competencies are important in higher education, especially through reflective thinking and structured learning environments [34]. The focus group results highlight the need for effective teaching strategies to develop metacognitive skills, which is consistent with the findings of the current study, where targeted psychoeducational interventions improved students' cognitive processes and learning outcomes. However, study by Jones *et al.* [35] found that combining working memory training with metacognitive strategies resulted in greater and more sustained improvements in mathematical reasoning and working memory, which is consistent with the findings of the current study, where metacognitive strategies resulted in significant improvements across multiple cognitive domains. Finally, another study by Poll and Petru [36] found that metacognition for social communication improved with age, while metacognition for learning did not. The current study supports the idea that targeted interventions can improve specific cognitive skills, but the uniqueness and characteristics of each individual case must be taken into account.

5. CONCLUSION

The research findings demonstrate a significant impact of the proprietary psycho-pedagogical support program on the development of students' metacognitive abilities. In the intervention group, statistically significant improvements are observed in all investigated aspects compared to the control group, underscoring the effectiveness of the program. Specifically, in the domain of self-awareness, the mean score increased by 3.8 points, students exhibited a gain of 4.02 points in the self-regulation subscale, critical thinking analysis revealed an increase of 3.49 points, in the problem-solving subscale, students demonstrated improvement by 3.25 points, and in the decision-making domain, the intervention group showcased an increase of 4.35 points, while the control group showed an increase of 1.11 points, which was the sole statistically significant gain for the latter. The homogeneity of the sample at the beginning of the study and substantial differences in the post-test between the groups emphasize that improvements in the intervention group result from the program's intervention rather than random fluctuations. This suggests that targeted psycho-pedagogical intervention can significantly enhance students' metacognitive abilities, preparing them for more effective learning and interaction in the educational environment.

The scientific significance of the study lies in its confirmation of the effectiveness of targeted psycho-pedagogical intervention in the development of students' metacognitive abilities. The results contribute to theoretical knowledge in the fields of educational psychology and metacognitive research, illustrating how specialized educational programs can influence students' cognitive processes. Additionally, it enhances methodological approaches to measuring and analyzing metacognitive abilities, especially in the context of updated education.

The practical significance is evident in providing educators and educational institutions with effective tools and methods for fostering metacognitive abilities. This, in turn, can contribute to a more qualitative educational process, improved academic achievements, and the socio-emotional well-being of students. The program can be integrated into curricula, educational modules, and extracurricular activities to enhance students' self-awareness, self-regulation, critical thinking, decision-making, and problem-solving. The application of research findings extends to a wide range of educational contexts, including general education schools and specialized educational institutions.

ETHICS APPROVAL

The authors declare that the work is written with due consideration of ethical standards. The study was conducted in accordance with the ethical principles approved by the Ethics Committee of Toraighyrov University (Protocol No 3 of 1.09.2022).

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