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Specifics of the students' critical thinking formation within active learning space

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Critical thinking skills are important for personal development and self-realization in professional activity. Thus, this research was aimed at obtaining data about the formation of students' critical thinking and the professional competencies of the future specialist within hybrid learning. The developed elective course for psychologists and linguists was introduced into the educational system of a higher educational institution. To measure the level of forced critical thinking, the authors used the California Critical Thinking Disposition Inventory (CCTDI), which is specifically designed for undergraduate and graduate students or comparable groups. The findings describe the specifics of the students' critical thinking formation within hybrid learning. The statistical data analysis showed positive dynamics and a significant increase in the experimental group. The practical testing and experimental validity of the developed course effectiveness gives prospects for further studies of this phenomenon and the practical implementation of innovative technologies aimed at the students' critical thinking formation within a blended learning model in higher education institutions. The developed optional course within the blended learning model allows creating and practically implementing new educational programs for university students. The research findings also foresee the need for further study of training competent pedagogical staff for the implementation of blended learning.

KEYWORDS

active learning, critical thinking, hybrid learning, university students, innovative technologies

1. Introduction

Today, the intensive development of ICT and economic opportunities promote the increasing popularity of online education. However, interactive teaching and learning environments lack many advantages of face-to-face education, which led to the concept of blended learning. Sikora and Carroll (2002) reported that students of online universities, as a rule, are less satisfied with fully online courses compared to traditional lessons. Thus, the combination of online learning and the traditional educational environment could be much more useful for solving educational problems and meeting educational needs (Murphy, 2003). The integration of face-to-face and online forms is blended or hybrid learning (Korkmaz and Karakuş, 2002).

Modern researchers agree that today it is not enough to have a large amount of information or knowledge obtained during the educational process. The student's development requires a high level of thinking formation, mobility, and self-organization (Gagarina, 2020). Only a

critically thinking person knows how to build a constructive dialog, formulate a problem and find optimal, non-standard ways to solve it and reflect on the obtained result (Plotnikova, 2008).

1.1. Literature review

Boa et al. (2018) studied the problem of students' critical thinking formation within hybrid learning. Their paper describes the effectiveness of the practical implementation of the program for undergraduate students. Rowley et al. (2015) studied the specifics of critical thinking formation and the introduction of reflective practices within blended learning. They concluded about the high potential of blended learning for developing students' cognitive abilities, motivation, and increasing involvement. Their conclusions are consistent with the opinions of other scientists, who highlighted the possibilities and characteristics of hybrid learning: increased flexibility and personalization due to a variety of learning methods (Özdemir, 2005; Horn and Staker, 2015), expanded opportunities for interactivity (Means et al., 2013), technical advantages (Olapiriyakul and Scher, 2006; Shute, 2008; Picciano, 2014), preserving humanity and spontaneity in face-to-face education, as well as increasing learning time and learning resources (Means et al., 2013).

Changwong et al. (2018) used a hybrid learning model as an educational platform for the students' critical thinking formation. The paper describes positive experimental data that testify to the blended learning effectiveness to achieve a high level of students' critical thinking and their positive attitude to the blended learning model.

The National Council on Critical Thinking (NCECT) states that critical thinking is defined as an intellectually disciplined process of actively conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered or generated through observation, experience, reflection, reasoning, or communication (Changwong et al., 2018). Kraisuth and Panjakajornsak (2017) stated that critical thinking skills are consistently included in all lists of the main factors determining readiness for professional activity and self-realization.

Improving the predisposition for critical thinking to solve engineering problems is one of the challenges of engineering education. The study of Özyurt (2015) aimed at determining computer engineering students' critical thinking disposition and problem-solving skills, as well as the relationships between them. The California Critical Thinking Disposition Inventory (CCTDI) and the Problem Solving Inventory (PSI) were used to collect data. The results showed that students had high critical thinking and problem-solving skills. The level of students' critical thinking disposition did not statistically significantly differ by gender and grade level. Similarly, there were no statistically significant differences in students' problem-solving skills by gender and grade level. It was found out that the computer engineering students generally had a high critical thinking level. The computer engineering students also had generally high problem-solving skills.

Contemporary evidence of the critical thinking skills important for employment was provided by the National Association of Colleges and Employers, which showed that most employers surveyed rated critical thinking skills as the most important. Critical thinking formation has recently been more and more important in higher educational institutions around the world (Changwong et al., 2018). The importance of critical thinking in education, professional activity,

and everyday life was described by Ornstein et al. (2011). Masduki (2011), p. 186 states: "critical thinking skills play an important role not only in the academic achievements of students but also in their dynamic professional activity after graduation."

Purposeful formation of critical thinking prepares students for competitiveness, promotes self-development skills (Taylor, 2012), and the ability to assess the future consequences of their current actions and the actions of others (Hove, 2011). The ability to analyze and creatively adapt to new situations is the basis of critical thinking, which, according to Paul and Elder (2008, 2014), is a means of educating the mind.

Costa and Kallick (2014) investigated what critical thinking is and what prevents its widespread formation in the 21st century education system. Their research showed that critical thinking is a mental process. Based on this, people need to understand, apply, analyze, synthesize, and evaluate information actively and skillfully to come to an answer or a conclusion (Morochenkova, 2004; Costa and Kallick, 2014; Changwong et al., 2018; Gagarina, 2020).

Of course, critical thinking is formed by the logic of life and depends on natural abilities and inclinations, social environment, and social education. However, the teachers play a leading role in critical thinking formation. Preparing students for critical thinking is one of the key goals for many universities (Sulaiman et al., 2008). The study of critical thinking as the basis of educational technologies of the 21st century can certainly be called one of the most priority directions. Among the researchers dealing with the problems of the formation of critical thinking, we can mention Facione (1990), Plotnikova (2008), and others.

Students' critical thinking formation is the result of the interaction between the teacher and the student. Its level depends, first of all, on the correct choice of educational forms. Some researchers point out that the traditional form does not develop the personality to the full extent since it does not allow development of the qualities necessary for working in a team (Plotnikova, 2008). Teachers of universities, based on traditional approaches to critical thinking formation, are faced today with the difficulties of including students in developing thinking in various types of professional and social relationships. In this regard, it is possible to conclude that students' critical thinking formation is inadequate for the reformation of the educational system. Both the content and the forms and methods of forming critical thinking need to be updated. A modern university needs a transition to new effective learning technologies, which allow graduates to flexibly adapt to the social and economic situation in the world (Plotnikova, 2008). Hybrid or blended learning is a thoughtful integration of face-to-face and online learning (Aspden and Helm, 2004; Robison, 2004; Halverson and Graham, 2019). Today, researchers consider hybrid learning as one of the most effective and progressive educational models.

However, along with the positive characteristics of this learning technology, Changwong et al. (2018) describe unpreparedness and insufficient competence of teachers in blended learning: a small percentage (36%) of the surveyed teaching staff is ready to switch to a hybrid model. Bennett et al. (2020) and Lorencová et al. (2019) highlight this issue. At the same time, student respondents (Pescatore, 2007; Lin, 2008; O'Byrne and Pytash, 2015; Karakoc, 2016; Meiramova, 2017; Tuzlukova and Usha-Prabhukanth, 2018; Turk et al., 2019) show interest in blended learning technology. This issue determined the relevance and necessity of additional research aimed at identifying and

confirming the effectiveness of the hybrid learning model for the students' critical thinking formation.

1.2. Comparison of blended learning (hybrid) and online learning

With the advent of e-learning, classes in classrooms and auditoriums began to mix with assignments, tests, and computer courses. Based on the above literature analysis, one can summarize the following:

(1) Blended learning speaks to the high potential of developing students' cognitive abilities, increasing motivation and engagement in learning, achieving high levels of students' critical thinking and their positive attitude toward the blended learning model, maintaining humanity and spontaneity in face-to-face learning, and increasing learning time and learning resources. The formation of students' critical thinking takes place.

(2) Online learning is about acquiring knowledge and skills through a computer or other gadget connected to the Internet in the here-and-now mode. It is also called e-learning. Online learning increases flexibility and personalization through various learning methods, enhanced interactivity, and technical advantages. During online learning, a student watches lectures in video recording or live broadcasting, takes interactive tests, exchanges files with a tutor, communicates with classmates and teachers in chat rooms, goes through quests, etc. The individual pace of learning prevails here. One can study materials according to their own schedule, without reference to the group, time, and place of the class availability. One can learn from any computer at a convenient time. One can also review a lesson or a missed webinar at any time in the record and download training materials.

1.3. Problem statement

Even though scientists and practitioners show interest in blended learning (Drysdale et al., 2013; Halverson and Graham, 2019), relatively few authors consider it for investigating the specifics of critical thinking formation in university students within this technology (Drysdale et al., 2013; Halverson and Graham, 2019). Thus, additional research is needed to theoretically substantiate and practically confirm the effectiveness of a blended learning model. This research attempts to fill this gap and describes the specifics of students' critical thinking formation within hybrid education (Halverson and Graham, 2019).

The study's motivation is to obtain new experimental data describing this phenomenon within a blended learning model. Its practical significance consists in the theoretical validity and experimentally confirmed technology of students' critical thinking formation within hybrid education at a university. The theoretical significance lies in revealing the concepts of "hybrid education" and "critical thinking" and describing the specifics of the critical thinking formation within hybrid education in a university.

The purpose of the research is to theoretically substantiate and experimentally verify the conditions for the critical thinking formation of university students within hybrid learning. The objectives of the study are (1): to define "critical thinking" and "hybrid learning"; (2) to evaluate the critical thinking level in the control and experimental groups; (3) to develop and test a model of the students' critical thinking formation within hybrid learning; and (4) to evaluate and analyze the dynamics of the students' critical thinking level in the experimental group using the elective course model as a learning management tool.

2. Methods and materials

2.1. Sample

Institute of Pedagogy and Psychology of Abay Kazakh National Pedagogical University, Institute of Foreign Languages of Moscow Aviation Institute, and Yelabuga Institute of Kazan Federal University were the study sites.

The experiment enrolled fourth-year undergraduate students of psychological and linguistic specialties. Students in the fourth year of study possess enough knowledge, professional competencies, and a stable psycho-emotional state. Future graduates, more than others (e.g., junior students), show a high level of self-organization and interest and focus on results. The control group had an equal number of males and females ($n = 18$ for each gender). The experimental group consisted of 19 females and 17 males. The study sample mostly included students aged 20–21 years. The researchers implemented the developed elective course to the curriculum of the experimental group based on a hybrid learning model to study the specifics of critical thinking formation in university students.

2.2. Research design

To measure the level of critical thinking, the authors used the California Critical Thinking Disposition Inventory (CCTDI), which is specifically designed for undergraduate and graduate students or comparable groups.

2.3. Procedure

The experimental course lasted 1 academic semester with 2 academic hours per week. The purpose of this program was to form a student's critical thinking and the professional competencies of a future specialist and create the conditions for critical thinking development within hybrid learning.

The course objectives were to form:

– Ability to conclude from a variety of facts, analyze, compare results, and make comparative judgments, and interpret the data obtained.
– Ability to diagnose tasks and problems based on observations.
– Ability to prove the decision correctness on a large amount of information.

– Ability to recognize, if necessary, the limitations of own conclusions and correct discrepancies.

The study had three stages: organizational and preparatory, substantive and practical, and generalizing. At the first organizational and preparatory stage, the researchers diagnosed the real state of students' critical thinking, determined the experimental strategy, formed control and experimental groups, and trained teachers for the practical implementation of hybrid learning technology for the experiment. The method used at the organizational and preparatory stage identified the following levels of students' critical thinking: high, medium, and low. Students with a high level of critical thinking have a clear understanding of critical thinking and ways of its formation, have formed skills in basic mental operations, have the ability to reflect, put forward a hypothesis, and argue it, and have cognitive motivation. Students with a low level have a general understanding of critical thinking, low ability to assess, and insufficient formation of mental operations.

In the second stage, the researchers proposed a program for the experimental group. This elective program based on hybrid learning provides for a symbiosis of face-to-face and online learning with the following methods: problematic lectures, thematic discussions, exercises, consultations, presentations, research projects, group training, and situational analysis, solving pedagogical problems, cases, and business games. The substantive and practical stage included the practical implementation of the developed elective course "Critical thinking formation during learning and research activities" into the curriculum of the experimental group within hybrid learning (8 in-class and 8 online lessons).

The authors implemented a personality-oriented approach, which consists of critical thinking in a personal position, self-expression, and lifestyle. There is an affective disposition in the desire for personal development, motivation, lack of prejudice of worldviews, and objectivity in the assessment of arguments and facts (Borisova et al., 2018). The authors performed a control measurement of critical thinking in both groups. Then they draw a conclusion based on the results of statistical processing, analysis, and generalization of findings. The positive dynamics of mean values and the increase in the percentage of high and medium levels of critical thinking within hybrid learning demonstrate the effectiveness and reasonability of blended learning technology in the modern educational environment to form critical thinking. At the third generalizing stage, the researchers analyzed and summarized findings and made theoretical and practical conclusions based on the results.

2.4. Data collection

CCTDI is designed for test takers to demonstrate the critical thinking skills needed for problem solving and decision making by forming reasoned judgments. Multiple choice items use everyday scenarios. Test items vary in difficulty levels. Questions include the need to analyze or interpret the information presented in the form of text, diagrams, or images, and draw accurate and reasonable conclusions. CCTDI takes 45–50 min to pass.

The test consists of 34 items and provides a set of scales with reports describing strengths and weaknesses in various skill areas. The CCTDI report provides an overall score for thinking skills (mean

score) and individual scores on a scale of analysis, interpretation, inference, evaluation, explanation, induction, deduction, and numeracy. Mean scores in the range of 40–60 are considered as a low level of critical thinking development, 60–80 as a medium level, and over 80 points as a high level.

2.5. Data analysis

To solve the tasks, the researchers diagnosed the level of students' critical thinking and performed statistical processing using Microsoft Excel and an online calculator https://math.semestr.ru/group/group_manual.php as well as a comparative descriptive analysis of findings. The significance of differences is given at $p < 0.05$ and tested using Student's t-test.

2.6. Research limitations

The limitations are based on the definition that hybrid learning is the integration of traditional (face-to-face), distance, and online learning as well that, after 2020, passing and obtaining CCTDI results is possible only online and it is recommended to use a computer or laptop, and not portable devices. The key condition for the implementation of the practical research is the availability of ICT for all participants. This fact necessitated the preliminary collection of information on the availability of ICT with Internet access from the participants (students and teachers).

3. Results

The baseline test results showed the mean critical thinking level of 66.2 in the experimental group and 66.4 in the control group and indicate approximately the same results in both groups. Quantitative and qualitative data analysis at the first stage showed that the majority of students had medium and low levels (77.8% in each group, 18 and 10 students in the control group and 16 and 12 in the experimental group with medium and low levels, respectively) (Table 1).

To test the effectiveness of the developed elective program and its dynamics within hybrid learning, the researchers performed a control measurement of the critical thinking level in both groups and calculated mean values (Table 2). The mean critical thinking level in the control group remained medium after the experiment. The quantitative values of students with a high level increased, but not significantly, and this did not significantly affect the final mean values. The dynamics in the experimental group are very significant: the baseline values of 66.2 (medium level of critical thinking) increased to 84.6 (+18.4), which corresponds to a high level.

TABLE 1 Table of mean students' critical thinking level.

Levels	Experimental group	Control group
High	22.2%	22.2%
Medium	44.4%	50%
Low	33.4%	27.8%

TABLE 2 Comparative table of mean students' critical thinking levels at baseline and after the experiment.

Scale	Experimental group			Control group		
	Baseline M	End M	Dynamics	Baseline M	End M	Dynamics
Analysis	69	87	+18	71	83	+12
Interpretation	72	90	+18	70	81	+11
Inference	66	86	+20	65	72	+7
Evaluation	63	82	+19	62	71	+9
Explanation	68	85	+17	66	72	+6
Induction	62	80	+18	66	73	+7
Deduction	59	79	+20	58	68	+10
Numeracy	71	88	+17	73	78	+5
Total score	66.2	84.6	+18.4	66.4	74.8	+8.4

M = mean.

FIGURE 1
Dynamics of critical thinking level in the experimental group.
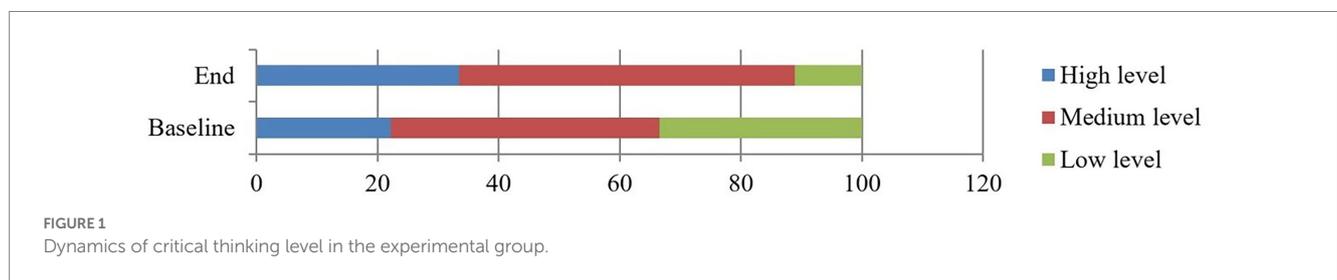
The evaluating stage showed positive dynamics of the critical thinking level in the experimental group. By the experiment's end, the number of students in the experimental group with a low level of critical thinking decreased by 22.3% (Figure 1), while in the control group the change was 11.2 (Figure 2). As for the medium level of critical thinking in the experimental group versus the control group, the increase was 5.6% higher (increase by 11.1% in the experimental group and by 5.5% in the control group) (Figures 1, 2). In the experimental group, the frequency of high critical thinking level increased by 11.2% (Figure 1). In the control group, the frequency of high critical thinking level increased slightly, by 5.5% (Figure 2).

These results show the effectiveness of the developed elective program aimed at the critical thinking formation in university students within hybrid learning.

4. Discussion

The most important condition for individual development in modern society is critical thinking skills, which have a professional and personal significant value. Critical thinking formation affects the level of students' realization in teaching and research activities and social and personal development. In the context of modern education technologies, the hybrid learning model is considered the most effective and integrates the advantages of traditional, distance, and online learning.

The research findings show the intensive dynamics of students' critical thinking formation within hybrid learning. Such conclusions are consistent with the paper by Boa et al. (2018) describing the practical implementation of a blended learning program aimed at developing critical thinking among Thai undergraduate students. They

described the specifics of the critical thinking formation within hybrid learning and gave the statistical data, which confirm the technology's effectiveness to develop students' critical thinking (Boa et al., 2018).

Korkmaz and Karakuş (2002) show that the use of a blended learning model in geography courses had a positive effect on students' critical thinking. The experimental data describe the positive dynamics of the critical thinking level. Conclusions about the effectiveness of hybrid learning technology for the formation and development of critical thinking are consistent with the current research.

The study by Rowley et al. (2015) on the potential of students employed in hybrid learning spaces to implement reflective practices shows the positive properties of the hybrid learning model. By embedding a reflective tool as a personal learning space, students demonstrated positive dynamics in the development of critical thinking abilities, motivation, and self-organization. In addition, hybrid learning spaces can take into account the interaction between the student, teacher, and researcher to expand learning optimization opportunities. In this context, the student is an active participant and a "researcher" simultaneously (Facione, 1990; Clark and Mayer, 2007; Bennett et al., 2020).

Changwong et al. (2018) concluded about the powerful potential of a hybrid learning model as an educational platform for the formation and development of students' critical thinking. The paper presents the results of a study by the Thailand Science Foundation in 2015, which assessed the logical thinking and analytical skills of 6,235 students from various educational institutions. The mean value was 36.5%, which corresponds to the low level of critical thinking in university students. A focus group (2017) developed a strategy and a new five-step PUSCU Model for managing critical thinking training. Experimental technology based on blended learning was tested for

FIGURE 2
Dynamics of critical thinking level in the control group.
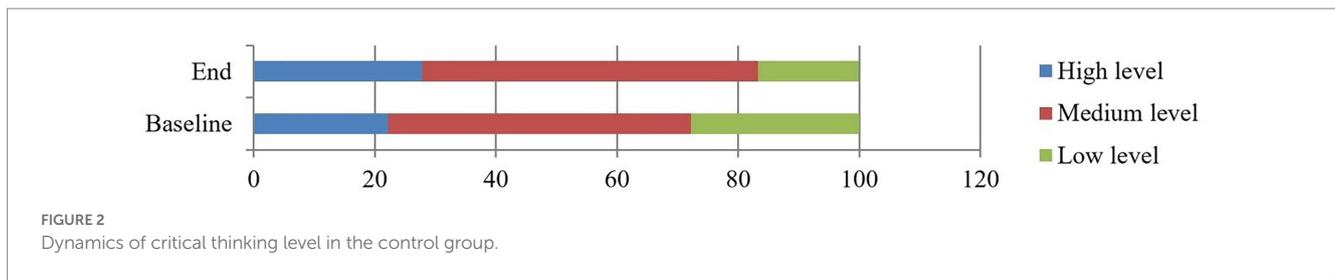
16 weeks. The results showed that, at the end of the study, the experimental group had higher mean scores for critical thinking ability and academic performance and the participants were satisfied with the high level of model performance.

The conclusions of the current research about a positive trend in the critical thinking formation within hybrid learning are also consistent with the paper by Thaiposri and Wannapiroon (2015). Experimental data show that Learning Management System (LMS) based on the hybrid model update is a powerful tool for developing critical thinking skills. The paper "Critical thinking and problem solving skills: English for science foundation program students' perspectives" (Tuzlukova and Usha-Prabhukanth, 2018) describes how different approaches, models, and teaching methods influence the formation of critical thinking. It highlights the results of a study examining the extent to which ESP courses (based on a hybrid learning model) at Sultan Qaboos University in Oman promote critical thinking and address student empowerment issues. The researchers concluded that the results of the practical course stimulate independent learning, interaction, and communication inside and outside the university and develop self-discipline and student motivation (Tuzlukova and Usha-Prabhukanth, 2018).

Robison (2004) examined the experience of 10 educators in developing and teaching blended learning courses at Brigham Young University. The results showed that participating educators experienced three main benefits of blended learning: first, more efficient use of study time; second, increased flexibility in meeting both student and professor time limits; and third, greater ability to meet the needs of individual learners. Consequently, the study highlighted the effectiveness of blended learning and recommended its widespread use in undergraduate courses. A study by Korkmaz and Karakuş (2002) was mainly aimed at comparing the effectiveness of a blended and face-to-face learning environment in terms of student achievement, motivation, and development of cognitive abilities. It investigated a course designed to study achievements and evaluate behavior. The results did not reveal a significant difference between blended and face-to-face learning. These conclusions are not consistent with the current findings that the hybrid form of education is an effective platform for critical thinking formation in students.

Woods et al. (2004) found that hybrid learning helped balance learning, learn at an individual pace and progressively develop critical thinking skills. However, it is important to note that not all students benefit equally from hybrid learning. A small percentage of students noted a decrease in the importance of interpersonal relationships between students of the same group, which affects their psycho-emotional state. The study also highlights the importance of the competence and readiness of teachers for the additional workload associated with the development and implementation of hybrid courses.

Lin (2008) and Riffell and Sibley (2005) presented the practical design and implementation of a hybrid course aimed at developing students' cognitive abilities. The paper describes the advantages of this technology and compares it with other learning models. The researchers point out that the hybrid course model achieves the goal of teaching and developing critical thinking more successfully than the online or traditional one. In addition, at the end of the experiment, students showed an increased interest in the phenomenon of critical thinking and self-exploration.

5. Conclusion

In the 21st century, the ability to intensively, continuously progress, and transform critical thinking is a prerequisite for personal development and realization. Critical thinking reflects the student's level in teaching and research activities and has a direct impact on professional development, self-realization, and personally significant value. The formation of the studied phenomenon is necessary for a modern student of any university, regardless of specialty. Today, one of the priority tasks of education is the development of constructive criticism and self-criticism as a means of effective thinking, self-knowledge, and an objective and adequate assessment of reality. This paper presents the results of a theoretical generalization of scientific and methodological literature, which was the basis for explaining the concepts of critical thinking and hybrid learning and considers the specifics of the students' critical thinking formation in a blended learning model.

The findings from all stages demonstrate that at baseline the differences between the critical thinking levels in the control and experimental groups are insignificant, as evidenced by the mean values (66.2 for the experimental group and 66.4 for the control group). At the research end, the total mean value increased by 22.9 and 8.4 in the control and experimental groups, respectively. The high level of critical thinking in the experimental group increased by 11.2%, the medium–by 11.1%, and the low level decreased by 22.3%. In the control group, the high level increased by 5.5, the medium–by 5.5%, and the low level decreased by 11.2%.

Thus, it can be argued that the critical thinking level in the experimental group has increased significantly versus the control group. The findings indicate the feasibility and effectiveness of the developed course on critical thinking formation within hybrid learning. Based on the new experimental data, analysis of modern research, and scientific literature, we can conclude that the introduction of hybrid learning technology is effective to study the

phenomenon of critical thinking, its formation, and development. These findings and conclusions make it possible to develop innovative programs, adjust the educational process under the goal to form students' critical thinking, and expand scientific understanding of the reflection role in activities.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The research was approved by the local ethics committees of Institute of Pedagogy and Psychology of Abay Kazakh National Pedagogical University, Institute of Foreign Languages of Moscow Aviation Institute, and Elabuga Institute of Kazan Federal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

NS, OT, and SS contributed equally to the experimentation, wrote and edited the article, and equally designed and conducted the

experiment. OT and SS studied scientific literature about the topic. All authors have read and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1132525/full#supplementary-material

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