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Enhancing professional abilities of university students through digital educational interventions: a study in Kazakhstani universities

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This study investigates enhancing professional abilities among university students in Kazakhstan through digital educational interventions. These abilities are increasingly crucial in a labor market shaped by rapid technological advancements. The research included 520 students from Toraighyrov University and L.N. Gumilyov Eurasian National University. The research employed a systematized methodology that involved a literature review of existing studies to identify key themes related to students' professional abilities and rigorous testing and correlation analyses using SPSS software. The educational interventions consisted of interactive online classes, a 12-week MOOC in "Psychology," and a 16-week course on managing learning processes using distance education technologies. The interventions significantly improved students' performance on cognitive ability tests, enhanced creativity-related task outcomes, increased motivation, and strengthened professional orientation. These gains are supported by paired *t*-tests and align with theoretical frameworks such as Cattell's theory and Self-Determination Theory. This study underscores the effectiveness of digital tools and interactive platforms in developing cognitive and non-cognitive skills, which aligns with contemporary educational reforms and studies in Kazakhstan.

KEYWORDS

digitalization, professional competencies, intelligence, creativity, Kazakhstan

1 Introduction

In today's dynamic labor market, the focus has shifted from acquiring knowledge to developing comprehensive professional abilities (Kireyeva et al., 2024). Cognitive and non-cognitive competencies are essential for navigating changing digital environments. As Castells (2009) described, digitalization is "the process that underlies all processes," fundamentally transforming production, distribution, and communication and extending its impact on education. The integration of digital technologies into educational practices has necessitated a reevaluation of the development of professional abilities. Digital integration challenges traditional pedagogical methods and pushes for innovative approaches that cater to the demands of the 21st-century workforce. However, significant challenges persist in implementing digital education. Studies emphasize the digital divide, characterized by disparities in access to digital tools and internet connectivity, particularly in socio-economically disadvantaged communities (Gan and Sun, 2021; Afzal et al., 2023). These barriers limit equitable participation and hinder the effectiveness of digital interventions.

Kazakhstan's alignment with European educational standards under the Bologna Process reflects a strategic initiative to enhance the global competitiveness of its graduates by fostering essential professional competencies (ENIC Kazakhstan, 2024; Anafinova, 2024). However, implementing competency-based education in developing regions has faced significant

challenges, such as inadequate teacher training and resource constraints, as observed in Kenya's primary education reforms (Pale and Amukowa, 2020). Similar issues are noted in technical and vocational education, where alignment with labor market needs is often limited (Obwoge, 2016). Despite these efforts, there is a notable gap between the abilities imparted through formal education and the expectations of employers, particularly in terms of practical skills and real-world application (Bazhenova et al., 2022). This disconnect underscores the need for educational reforms prioritizing the development of universal competencies applicable across various professions and adaptable to different work environments. This need is further emphasized by the rapidly evolving job market, where adaptability, problem-solving, and continuous learning are increasingly valued (Mei et al., 2023).

The rapid economic and societal changes of the 21st Century have presented significant challenges for universities, particularly in ensuring stable employment and career growth for graduates. As traditional career paths become less linear and more complex, professional training has increasingly emphasized the development of competencies and skills that align with contemporary employer requirements (Jackson et al., 2022; Niman and Chagnon, 2023). As defined by Raven (1984), competence includes the knowledge and theoretical understanding of a subject and the practical experience necessary to apply this knowledge effectively. Integrating competence, skills, and abilities in the digital age is critical for professional readiness. This sentiment is echoed by Jackling and Lange (2009) and Umoru et al. (2024), who highlight the importance of incorporating digital skills into the broader framework of professional abilities within educational curricula.

Recent studies have expanded our understanding of professional abilities in higher education, particularly the impact of digital tools on student learning outcomes. The transformative potential of digital education is evident in research that compares online and traditional learning environments, showing that digital tools can significantly enhance both cognitive and non-cognitive skills (Irkha et al., 2024; Sarker et al., 2019; Atuahene et al., 2024; Koay et al., 2021; Stack, 2015). These studies not only highlight the effectiveness of digital tools in fostering skills such as critical thinking, creativity, and self-directed learning but also emphasize the need for systematic reviews to understand the broader implications of MOOCs and other digital platforms in higher education (Mellati and Khademi, 2020; Rugube et al., 2022; Albelbisi and Yusop, 2020; Palacios-Hidalgo et al., 2020; Mukhtarkyzy et al., 2023). Research in Central Asia highlights the increasing integration of digital education tools, such as augmented reality and MOOCs, to foster collaborative and individualized learning experiences (Mukhtarkyzy et al., 2023; Kuanbayeva et al., 2024). MOOCs, for instance, have shown promise in enhancing digital literacy and self-directed learning. Studies such as the IC-Health project highlight their potential to reduce disparities in digital competencies (Perestelo-Perez et al., 2020). Furthermore, combining digital interventions with motivational and cognitive behavioral techniques can improve user engagement and learning outcomes (Serio et al., 2022). Moreover, integrating digital competencies into higher education curricula is challenging. Researchers such as Sánchez-Caballé et al. (2021), Alenezi et al. (2023), and Morgan et al. (2022) discuss the strategies required to overcome these challenges, stressing the importance of digital literacy for workforce readiness and the need for educational institutions to adapt to these new demands. While digital education has democratized access to learning opportunities, global challenges remain. These include infrastructure disparities, ethical concerns, and psychological impacts of over-reliance on technology, as noted in recent analyses (Danmuchikwali and Suleiman, 2020; Bhat, 2023a; Bhat, 2023b).

In response to these challenges, this study integrates advanced technological tools and platforms into educational interventions to enhance university students' professional abilities. Specifically, the study utilizes Zoom for interactive online classes, Coursera for a MOOC in "Psychology," and Google Classroom for managing distance learning technologies. These platforms were selected for their ability to provide a flexible, interactive, and comprehensive learning environment that facilitates real-time engagement, access to diverse learning resources, and timely feedback.

The present study addresses the following research questions: (1) Does the educational intervention significantly improve the general mental abilities of university students? (2) Does the educational intervention enhance students' ability for personal creativity and intelligence? (3) Does the educational intervention positively influence students' motivation and professional orientation? Based on these questions, the study proposes the following hypotheses: (1) The educational intervention will significantly improve the general mental abilities of students; (2) The educational intervention will significantly enhance students' ability for personal creativity and intelligence; (3) The educational intervention will positively influence students' levels of motivation and professional orientation. In this study, 'intelligence' is understood as performance on a standardized cognitive ability test, rather than a fixed, innate trait. Likewise, increases in creativity are interpreted as enhancements in creativity-related task performance, rather than permanent alterations in an individual's inherent creative capacity.

The theoretical framework of this study is grounded in several key concepts: digitalization and its impact on education (Castells, 2009; Wachal, 1971), the development of professional abilities (Gottfredson, 1997; Heckman and Rubinstein, 2001), the integration of competence and skills (Raven, 1984; Jackling and Lange, 2009), and the importance of motivation, intelligence, and personality in shaping these abilities (Cattell, 1987; Carr, 2015). Consistent with Cattell's (1987) theory, improvements in cognitive test performance observed in this study are interpreted as enhancements in fluid intelligence—skills that can be cultivated through appropriate educational interventions—rather than as evidence of a permanent increase in innate intelligence. These studies also emphasize lifelong learning (World Bank, 2003; Carlson, 2016; Kaur, 2017), which underpins the continuous development of professional abilities necessary for adapting to changing labor market demands. Lifelong learning is particularly relevant in digitalization, as it encourages the continuous acquisition of new skills and knowledge, enabling individuals to remain competitive in a rapidly changing job market.

The specialized educational program comprised three key components: interactive online lectures, a Massive Open Online Course (MOOC) in 'Psychology,' and a semester-long course on 'Managing the Learning Process Using Distance Educational Technology.' These components addressed cognitive and non-cognitive skills by fostering critical thinking, creativity, and digital proficiency. The lectures incorporated group discussions, case studies, and problem-solving exercises tailored to students' fields of study. The MOOC focused on psychological principles and self-reflection

activities, while the distance learning course provided hands-on experience with digital tools and collaborative learning techniques. These activities aimed to improve motivation, professional orientation, and adaptability in modern digital workplaces. The intervention was informed by Vygotsky's (1978) and Vygotsky (1984) concept of the zone of proximal development, which emphasizes scaffolding and collaborative learning, and Cattell's (1987) intelligence theory, highlighting the importance of fluid and crystallized intelligence in professional skill development. The MOOC in 'Psychology' included weekly quizzes, peer-reviewed assignments, and interactive discussion forums to encourage reflective thinking and creativity. The distance education course also trained students in self-regulation and time management strategies through digital platforms such as Google Classroom.

This study contributes to the ongoing discourse on integrating digital technologies in higher education by exploring how targeted educational interventions can enhance essential professional abilities. The findings are expected to offer valuable insights for educators, policymakers, and researchers working toward aligning educational outcomes with the evolving needs of the global labor market.

2 Methods and materials

2.1 Methodology

The study utilized a structured and systematized methodology to evaluate educational intervention's impact on professional abilities. This approach began with a literature review to identify relevant constructs and instruments for measuring professional abilities. The review focused on scholarly articles published between 2020 and 2022, highlighting critical cognitive and non-cognitive dimensions, such as creativity, motivation, and general mental abilities. Subsequently, quantitative assessments using validated instruments and statistical analyses performed in SPSS were employed. Data collection was conducted in two stages: pre-intervention (September 2022) and post-intervention (June 2023). Each stage involved administering the three instruments to all participants over 2 weeks to ensure comprehensive data collection.

2.2 Study design and participants

The study involved 520 students equally distributed between two specialties: 260 students from the Mathematics program and 260 from the Philology program. The participants, aged between 18 and 25 years, were enrolled at Toraighyrov University and L.N. Gumilyov Eurasian National University. The selection of two universities was guided by practical considerations, including accessibility and logistical feasibility, as well as the desire to focus on institutions with distinct characteristics to provide a comparative perspective. According to Vygotsky (1984), individuals within this age range are in the early phase of mature development, during which mental and personal abilities expand with professional skills (Glick, 2012; Vygotsky, 1978). Recent studies reinforce this understanding, emphasizing the importance of young adulthood in professional competency development. For instance, Hilger et al. (2018) and Nikoloski and Ajwad (2014) demonstrated that cognitive and non-cognitive skill development during this period significantly influences career success and adaptability.

Furthermore, Galimullina et al. (2020), Weinhardt and Sitzmann (2019), Zhang et al. (2019), and Schmid et al. (2023) underscored the role of targeted educational interventions, such as MOOCs and interactive learning modules, in enhancing creativity, motivation, and professional orientation among university students. Sánchez-Caballé et al. (2021) further emphasized the significance of integrating technology-enhanced learning environments to foster these abilities, noting the advantages of personalized learning experiences and the promotion of self-directed learning. Moreover, Serik et al. (2024) underscored the role of targeted educational interventions in enhancing professional competencies among university students. Collectively, these findings support Vygotsky's early insights, extending them into the context of contemporary educational practices and technological advancements.

Participants were identified through university records of first-year enrollments in Mathematics and Philology programs. Recruitment was conducted via email invitations and classroom announcements, ensuring participants were informed about the study's objectives and requirements. Interested students completed an online screening form to confirm their eligibility based on inclusion and exclusion criteria. Inclusion criteria required students to be willing to participate in the study and commit to the entire duration of the educational intervention. Basic digital literacy skills were also necessary for engaging with the technological tools and platforms used in the study. Students with prior extensive experience using specific digital tools and platforms or those who had participated in similar educational programs were excluded.

A computer-generated random sampling method was applied to the pool of eligible participants to assign students to either the Mathematics or Philology groups. Each participant was assigned a unique identification number, and randomization was conducted using a random number generator to ensure equal representation across groups. The randomization process was monitored to eliminate allocation bias, guaranteeing comparability between the two groups regarding baseline demographics and abilities. Selected students were then contacted and provided detailed information about the study's objectives, procedures, and role in the research. Informed consent was obtained from all participants before the commencement of the study. This rigorous and transparent selection process was implemented to enhance the study's internal validity by minimizing selection bias and ensuring the sample accurately represented the broader student population in the specified specialties.

2.3 Instruments

The study used three primary instruments to assess students' professional abilities. The first instrument was the Motivation and Professional Orientation Questionnaire, a custom-developed tool to evaluate students' motivation and professional orientation levels. The development of this questionnaire followed a rigorous process to ensure its validity and reliability. Initially, items were generated through a comprehensive review of the relevant literature and consultations with subject matter experts in educational psychology and professional development. These experts contributed to creating theoretically grounded and relevant items to the constructs under

investigation. Following item generation, experts thoroughly reviewed them to ensure content validity. They evaluated the items for relevance, clarity, and comprehensiveness, leading to further revisions and refinements.

Subsequently, the questionnaire was pilot-tested with a small sample of students ($n = 50$) not part of the main study. The pilot test aimed to assess the clarity of the items, determine the time required to complete the questionnaire and establish the initial reliability of the instrument. Feedback from this pilot testing phase informed additional modifications to the questionnaire. Cronbach's alpha yielded a coefficient of 0.85, indicating a high internal consistency level. Additionally, an exploratory factor analysis (EFA) was conducted on the pilot test data to examine the underlying factor structure of the questionnaire, identifying distinct dimensions of motivation and professional orientation. This analysis ensured that the questionnaire effectively measured multiple aspects of these constructs. Further, an Item Response Theory (IRT) analysis was performed to refine the instrument by evaluating the performance of individual items and their contribution to the overall measurement. Items that did not perform well were revised or removed, resulting in a more robust and accurate assessment tool.

The second instrument, the Wonderlic Short Selection Test, served as a measure of intelligence in this study. It evaluates general mental abilities, including reasoning, problem-solving, and abstract thinking, which are reliable proxies for cognitive intelligence (Wonderlic and Hovland, 1939). The Wonderlic test was chosen for its broad validation across diverse populations, its reliability, and its strong alignment with the study's objective of assessing key cognitive skills. Its focus on reasoning and problem-solving abilities made it particularly suitable for evaluating improvements in cognitive performance within the Kazakhstani student context. This tool provided a robust measure aligned with the study's objective of assessing intelligence improvements through the intervention.

The third instrument, the E.E. Tunik Test Questionnaire, specifically assessed personal creativity, focusing on the ability to generate and implement innovative ideas. This test has been validated in various studies and is considered a reliable measure of creativity (Tunik, 2013). While creativity and intelligence are often related, this instrument was designed to isolate creativity as a distinct construct.

2.4 Procedure

The study employed a multi-method approach to investigate the development of professional abilities among university students. The research process was organized into five stages, beginning with a literature review to identify relevant constructs and instruments. Subsequent stages involved implementing an educational intervention and conducting quantitative assessments to evaluate its impact. Figure 1 depicts a flowchart outlining the research procedure.

In Stage 1, a literature review of research articles was conducted to identify key constructs underlying students' professional abilities. The analysis reviewed 40 scholarly articles published between 2020 and 2022, selected based on relevance to digital education and professional competency development. Two independent researchers analyzed articles to identify recurring themes such as creativity, motivation, and intelligence. Thematic patterns were discussed collaboratively to ensure consistency, achieving an inter-rater reliability of 85%. These themes informed the design of the educational intervention, ensuring it addressed both cognitive and non-cognitive dimensions critical to professional skills development.

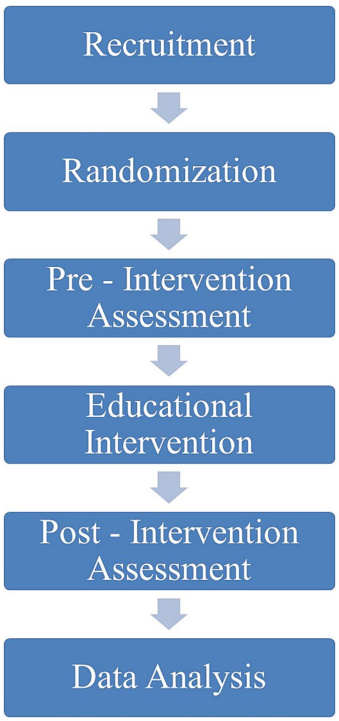

FIGURE 1
Study design flowchart.

Stage 2 involved the Initial Assessment of students' professional abilities, conducted in September 2022. This baseline assessment employed three different methods to gather comprehensive data. The first method used a custom-developed questionnaire to measure the students' motivation and professional orientation level. The second method involved assessing the participants' general mental abilities through the E.F. Wonderlic Short Selection Test (Wonderlic and Hovland, 1939). Finally, the E.E. Tunik Test Questionnaire was used to measure students' creativity (Tunik, 2013). These assessments provided a detailed overview of the student's initial professional abilities, serving as a benchmark for subsequent evaluations.

In Stage 3, the study implemented an Educational Intervention throughout the 2022–2023 academic year. This intervention was structured around a model designed to enhance professional abilities. Orientation sessions were conducted initially to familiarize students with the platforms (Zoom, Coursera, and Google Classroom). Weekly reminders and technical support were provided to ensure active participation. Challenges such as initial resistance to online tools and occasional internet connectivity issues were mitigated through dedicated technical support and flexibility in assignment deadlines. The intervention integrated three key components that were conducted simultaneously. The first component, Interactive Classes, involved online sessions held twice a week, each lasting 2 hours. These classes aimed to stimulate cognitive and non-cognitive skills through group discussions, problem-solving activities, and case studies pertinent to the students' fields of study. The interactive nature of these sessions encouraged active participation and critical thinking.

The second component was a Massive Open Online Course (MOOC) in "Psychology," which spanned 12 weeks and was integrated into the academic schedule. Students were expected to dedicate approximately 4 hours per week to this course, which included video lectures, reading materials, quizzes, and interactive discussion forums. The MOOC was designed to develop students' creativity and deepen their understanding of psychological principles applicable in various professional contexts. The third component, a Special Course titled "Managing the Learning Process Using Distance Educational Technology," lasted for one semester (16 weeks) with weekly 3-hour sessions. This course covered effective online learning strategies, digital tools for managing learning processes, and self-regulation techniques. Teaching methods included live demonstrations, hands-on practice with digital tools, and peer reviews. These activities were strategically designed to enhance cognitive and non-cognitive skills through engaging and practical methods. The simultaneous execution of these components ensured a comprehensive intervention manageable within an academic year's constraints.

Stage 4 involved a Post-Intervention Assessment in June 2023 to evaluate the educational intervention's impact. The follow-up assessment used the same instruments for general mental abilities and personal creativity development. This stage was essential for determining the effectiveness of the educational interventions.

Finally, in Stage 5, the data collected were subjected to thorough analysis. A Comparative Analysis was performed to compare the average values of indicators for professional abilities before and after the intervention. Additionally, a Correlation Analysis was conducted using SPSS to examine the relationships between general mental abilities, personal creativity, motivation levels, and professional orientation indicators. The Statistical Analysis involved several key steps, including calculating descriptive statistics (mean and standard deviation) for all measured variables to provide a comprehensive overview of the data. Additionally, a *t*-test for dependent samples was conducted to compare the average values of indicators before and after the intervention, assessing the statistical significance of any observed changes. *T*-tests and Pearson's correlation coefficient were chosen as they are standard methods for analyzing the relationships between variables in studies with small to medium sample sizes and normally distributed data. These tests are well-suited for examining group differences and variable correlations in the context of digital education research. This rigorous multi-stage procedure ensured that the study's findings were robust, reliable, and grounded in a comprehensive data analysis.

2.5 Educational implementation

The educational intervention was carefully designed to develop students' professional abilities—encompassing both cognitive (e.g., reasoning, problem-solving) and non-cognitive (e.g., motivation, creativity, professional orientation) dimensions—across the 2022–2023 academic year. Grounded in Vygotsky's (1978) Zone of Proximal Development, the intervention aimed to provide scaffolding that supported learners just beyond their current level of competence. Additionally, principles of Self-Determination Theory (Deci and Ryan, 1985) guided the design to foster autonomy, competence, and relatedness, ensuring that students remained engaged and intrinsically motivated.

Drawing on evidence that targeted, digitally enhanced educational experiences can bolster creativity, motivation, and professional readiness (Galimullina et al., 2020; Sánchez-Caballé et al., 2021; Schmid et al., 2023; Weinhardt and Sitzmann, 2019; Zhang et al., 2019), the intervention integrated three complementary components. The first component consisted of interactive online lectures, delivered twice weekly through platforms such as Zoom, which encouraged real-time discussion, collaborative problem-solving, and critical thinking activities. These sessions provided opportunities for immediate feedback and peer interaction, key factors in stimulating cognitive development and professional skill acquisition (Hilger et al., 2018; Nikoloski and Ajwad, 2014).

The second component was a 12-week MOOC in Psychology, selected to deepen students' theoretical understanding of cognitive and affective processes relevant to professional growth. This MOOC included structured video lectures, readings, quizzes, and online discussion forums that promoted reflection, creativity, and adaptive thinking. The content was strategically integrated into the curriculum to bridge theoretical knowledge with practical applications, thereby enhancing problem-solving abilities and professional orientation (Vygotsky 1984).

The third component, a 16-week course on managing the learning process using distance educational technology, focused on digital literacy, self-regulation strategies, and time management skills. By providing hands-on practice with online platforms, guided demonstrations, and peer review exercises, this course ensured that students developed the necessary competencies to navigate digital learning environments effectively (Sánchez-Caballé et al., 2021). Through exposure to diverse tools and strategies, learners were better positioned to adapt to evolving professional contexts.

Throughout the intervention, orientation sessions and ongoing technical support helped mitigate common barriers such as initial resistance to online tools and variability in internet connectivity. Regular reminders, flexible deadlines, and accessible support services facilitated student engagement and consistent participation. This comprehensive and flexible approach aligned with current research advocating for interactive, technology-driven, and student-centered learning experiences (Galimullina et al., 2020; Sánchez-Caballé et al., 2021).

Taken together, these three components created a cohesive learning ecosystem that simultaneously fostered cognitive and non-cognitive skill enhancement. By situating the intervention within established educational theories (Deci and Ryan, 1985; Vygotsky, 1978) and informed by contemporary empirical evidence, this integrated model effectively supported students' professional ability development, as confirmed by pre- and post-intervention assessments.

3 Results

3.1 Hypothesis 1

The educational intervention was hypothesized to significantly improve students' general mental abilities. Before the intervention, the general mental abilities of both Mathematics and Philology students were assessed using the E.F. Wonderlic Short Selection Test, which revealed that both groups had similar baseline scores. Following the intervention, a follow-up assessment using the same test indicated a

significant improvement in general mental abilities across both student groups.

The pre-test and post-test scores, detailed in Table 1, show marked increases in various indicators of professional ability. For example, the ability to generalize and analyze material showed improvement. The mean score increased from 4.40 to 5.51 for Mathematics students and 4.45 to 5.71 for Philology students. Similarly, the flexibility of thinking increased from a mean of 5.38 to 7.05 for Mathematics students and from 5.58 to 7.32 for Philology students. Other components, such as speed and accuracy of perception, language use literacy, and risk inclination, also showed significant improvements in post-test scores compared to pre-test results.

To statistically validate these findings, a paired *t*-test was conducted, comparing the pre-test and post-test scores across all measured components of general mental abilities. The results, summarized in Table 2, demonstrate significant increases in the average scores for both groups. For instance, the *t*-criteria for the ability to generalize and analyze material were 13.52 for Mathematics students and 11.04 for Philology students. Similar significant *t*-values were observed across other indicators, such as flexibility of thinking (16.35 for Mathematics students and 12.41 for Philology students) and emotional components of thinking and distractibility (16.78 for Mathematics students and 12.18 for Philology students).

These findings confirm Hypothesis 1, indicating that the educational intervention effectively enhanced the general mental abilities of students in both Mathematics and Philology disciplines. These abilities are essential for professional success and underscore the intervention's efficacy.

3.2 Hypothesis 2

The second hypothesis proposed that the educational intervention will significantly enhance students' ability for personal creativity (measured by the E.E. Tunik Test) and intelligence (measured by the Wonderlic Short Selection Test). Before the intervention, the average scores and standard deviations for various components of personal creativity and intelligence were recorded for both Mathematics and Philology students. A follow-up assessment was conducted following the educational intervention.

The data, as summarized in Table 3, show a substantial increase in the scores for personal creativity and intelligence after the intervention. For Mathematics students, the ability for personal creativity improved from a mean of 52.45 with a standard deviation of 12.99 to a mean of 96.18 with a standard deviation of 2.64. Similarly, the average creativity scores for Philology students increased from 53.43, with a standard deviation of 14.41, to 96.60, with a standard deviation of 2.44. The intelligence scores also showed significant gains, with Mathematics students improving from a mean of 30.24 to 46.36 and Philology students from a mean of 32.87 to 45.83.

A paired *t*-test was conducted to compare the pre-test and post-test scores for both personal creativity and intelligence, and the results are presented in Table 4. The analysis confirmed significant improvements in both areas, with *t*-values for personal creativity being 33.87 for Mathematics students and 30.02 for Philology students, and for intelligence, *t*-values were 25.34 and 19.98, respectively. The *p*-values for all comparisons were less than 0.001, indicating that the improvements were statistically significant.

These results confirm Hypothesis 2, demonstrating that the educational intervention significantly impacted students'

TABLE 1 Comparison of pre-test and post-test scores for professional ability indicators, showing significant improvements post-intervention.

Indicators of professional ability	Pre-test						Post-test	
	Mathematics		Philology		Mathematics		Philology	
	Avg	SD	Avg	SD	Avg	SD	Avg	SD
Ability to generalize and analyze material	4.40	1.286	4.45	1.431	5.51	0.560	5.71	0. 45
Flexibility of thinking	5.38	1.654	5.58	1.813	7.05	0.975	7.32	0.77
Inertia of thinking	3.97	0.880	3.98	0.96	4.75	0.432	4.67	0.48
Emotional components of thinking and distractibility	4.30	2.067	4.85	2.44	7.53	0.625	7.40	0.68
Speed and accuracy of perception, distribution, and concentration of attention	2.77	1.297	3.12	1.61	4.67	0.472	4.77	0.51
Language use literacy	4.31	1.451	4.80	1.73	7.48	0.638	6.93	0.89
Orientation	2.69	1.842	3.12	1.967	5.65	0.496	5.46	0.58
Spatial imagination	1.42	0.905	2.86	1.237	2.72	0.449	3.54	0.49
Risk inclination	9.98	4.29	11.94	4.64	21.17	1.26	23.08	0.94
Curiosity	15.34	4.00	15.47	4.55	25.65	0.70	25.10	1.49
Complexity	13.40	4.13	12.75	5.00	24.99	1.26	25.30	1.19
Imagination	12.74	4.86	13.27	4.92	22.37	1.83	23.10	1.40

TABLE 2 Comparison of *t*-criterion ($p > 0.05$).

Indicators of professional ability	*t* – Student's criteria for mathematics	*t* – Student's criteria for philology
Ability to generalize and analyze material	13.52	11.04
Flexibility of thinking	16.35	12.41
Inertia of thinking	11.65	8.33
Emotional components of thinking and distractibility	16.78	12.18
Speed and accuracy of perception, distribution, and concentration of attention	16.60	12.13
Language use, literacy	24.25	18.52
Orientation	18.20	13.81
Spatial imagination	16.31	6.53
Risk inclination	31.08	27.60
Curiosity	30.02	22.83
Complexity	32.57	27.90
Imagination	21.40	22.31

TABLE 3 Comparison of pre-test and post-test scores for personal creativity and intelligence.

Indicators	Pre-test						Post-test	
	Mathematics		Philology		Mathematics		Philology	
	Avg	SD	Avg	SD	Avg	SD	Avg	SD
Ability for personal creativity	52.45	12.99	53.43	14.41	96.18	2.64	96.60	2.44
Intelligence	30.24	6.49	32.87	8.97	46.36	1.94	45.83	1.98

TABLE 4 Paired *t*-test results for personal creativity and intelligence.

Indicators	Mathematics				Philology			
	Mean difference	SD	*t*-value	*p*-value	Mean difference	SD	*t*-value	*p*-value
Ability for Personal Creativity	43.73	10.35	33.87	<0.001	43.17	11.97	30.02	< 0.001
Intelligence	16.12	4.56	25.34	<0.001	12.96	6.53	19.98	< 0.001

TABLE 5 Pre and post-test scores for motivation and professional orientation.

Indicators	Pre-test				Post-test			
Motivation and professional orientation	Mathematics		Philology		Mathematics		Philology	
	Avg	SD	Avg	SD	Avg	SD	Avg	SD
	67.48	2.36	65.28	2.10	75.60	1.89	73.47	1.76

personal creativity and intelligence in both Mathematics and Philology specialties. The high *t*-values and extremely low *p*-values ($p < 0.001$) suggest that the observed improvements are robust and not due to chance. The statistical tests confirm the educational programs' effectiveness in enhancing students' abilities.

3.3 Hypothesis 3

The third hypothesis proposed that educational intervention positively influences students' motivation and professional orientation. A questionnaire was administered to both Mathematics and Philology students before and after the intervention.

As presented in Table 5, the post-test scores indicated a significant increase in motivation and professional orientation levels among Mathematics and Philology students. Specifically, the mean score for motivation and professional orientation increased from 67.48 to 75.60 in the Mathematics group and from 65.28 to 73.47 in the Philology group, with corresponding improvements in standard deviations.

A paired *t*-test was conducted to statistically validate these findings, with the results summarized in Table 6. The analysis revealed that the *t*-values for motivation and professional

TABLE 6 Paired *t*-test results for motivation and professional orientation.

Indicators	Mathematics				Philology			
	Mean difference	SD	*t*-value	*p*-value	Mean difference	SD	*t*-value	*p*-value
Ability for personal creativity	8.12	2.17	34.67	< 0.001	8.19	2.01	36.92	< 0.001

TABLE 7 Correlation analysis of interrelations of indicators.

Indicators	Correlation coefficient	*p*-value
Ability to generalize and analyze material	0.363	0.000
Flexibility of thinking	0.381	0.000
Inertia of thinking	0.347	0.000
Emotional components of thinking and distractibility	0.565	0.000
Speed and accuracy of perception, distribution, and concentration of attention	0.508	0.000
Language use, literacy	0.582	0.000
Orientation	0.616	0.000
Spatial Imagination	0.447	0.000
Risk inclination	0.692	0.000
Curiosity	0.653	0.000
Complexity	0.687	0.000
Imagination	0.700	0.000

$p < 0.01$.

orientation were 34.67 for Mathematics students and 36.92 for Philology students, with *p*-values of less than 0.001. These results confirm that the observed improvements are statistically significant, supporting Hypothesis 3.

Further analysis through Pearson's correlation coefficient was conducted to explore the relationships between various indicators of general mental abilities, personal creativity, motivation, and professional orientation levels. The results in Table 7 show significant positive correlations between these variables. For instance, the ability to generalize and analyze material had a moderate positive correlation ($r = 0.363$, $p < 0.01$), while the flexibility of thinking showed a similar correlation ($r = 0.381$, $p < 0.01$). Other indicators, such as emotional components of thinking and distractibility and speed and accuracy of perception, demonstrated strong positive correlations with motivation and professional orientation, with *R*-values of 0.565 and 0.508, respectively. Risk inclination, curiosity, complexity, and imagination showed strong positive correlations, with *R*-values ranging from 0.653 to 0.700. The *R*-values indicate that these creativity-related indicators are closely associated with higher motivation levels and professional orientation.

The paired *t*-test and correlation analysis results confirm that the educational intervention significantly enhanced students' motivation and professional orientation in both Mathematics and Philology specialties. The high *t*-values and low *p*-values ($p < 0.001$), combined with the strong positive correlations, underscore the effectiveness of the educational programs in achieving the intended outcomes. This comprehensive analysis validates Hypothesis 3, demonstrating the significant impact of the intervention on students' motivational and professional development.

4 Discussion

The findings of this study are discussed below, organized by each hypothesis and interpreted within the theoretical frameworks previously discussed. Recent research underscores the importance of digital and interactive learning environments, providing a relevant context for the study's results. For instance, studies by Fleischer et al. (2023), Desel and Fleischer (2024), Schmid et al. (2022), and Schmid et al. (2023) demonstrate that digital tools and interactive platforms can significantly enhance cognitive, creative, and motivational outcomes in students. These studies show that digital interventions engage students and provide the scaffolding for deeper learning and skill development. Integrating digital technologies in education aligns with current trends and meets the evolving demands of the labor market. Digital Technology is critical in today's education landscape, equipping students with the skills to face future professional challenges.

4.1 Hypothesis 1

The initial assessment revealed that students from the Mathematics and Philology specialties had similar baseline scores for general mental abilities. Specifically, the average pre-test score for the ability to generalize and analyze material was 4.40 for Mathematics students and 4.45 for Philology students, with standard deviations of 1.29 and 1.43, respectively. Following the educational intervention, post-intervention assessments indicated significant improvements, with average scores increasing to 5.51 (SD = 0.56) for Mathematics students and 5.71 (SD = 0.45) for Philology students. These

improvements are visually represented in Figure 2, which compares pre-test and post-test scores across cognitive abilities for both student groups.

These results suggest that the educational intervention effectively enhanced cognitive abilities, which are crucial for academic and professional success. This improvement is consistent with Cattell's theory of intelligence, which emphasizes the roles of fluid and crystallized intelligence in problem-solving and acquiring new information (Cattell, 1987). Digital interventions enhance fluid intelligence. It involves the capacity to think logically and solve problems in novel situations. Fluid intelligence is particularly relevant to cognitive tasks. The findings align with studies by Diamond and Ling (2016) and Diamond and Lee (2011). These two studies highlight that structured interventions improve cognitive functions, including executive functions such as working memory and cognitive flexibility. The significant gains in general mental abilities observed in this study underscore the value of integrating interactive and engaging educational methods to foster cognitive development. The statistical significance of these improvements, confirmed through *t*-test analyses with *p*-values less than 0.05, further validates the effectiveness of the intervention, echoing the importance of rigorous experimental designs in educational research.

This finding aligns well with Vygotsky's cognitive developmental theories, emphasizing the importance of social interaction and scaffolding in cognitive development (Vygotsky, 1978). Vygotsky's concept of the "zone of proximal development" suggests that students can achieve higher levels of cognitive function when guided through challenging tasks by a knowledgeable other, such as a teacher or digital platform. Contemporary studies also support the role of scaffolding and interactive learning in enhancing cognitive outcomes (De Pol et al., 2010). Moreover, digital platforms can provide the necessary scaffolding through features like immediate feedback, adaptive learning paths, and interactive content, which collectively support cognitive development. Research by Wang (2023), Wang and Li (2024), Wang and Shen (2023), Wang et al. (2018), Wang et al. (2020), and Kwangmuang et al. (2021) further corroborate these findings, demonstrating that digital tools and interactive learning platforms significantly enhance students' cognitive skills. These studies illustrate how digitalization, as a broader trend, contributes to creating more engaging and effective learning experiences, further supporting the findings of this study.

In Kazakhstan, where educational reforms are increasingly focused on active and student-centered learning environments, these findings highlight the potential for digital tools to enhance educational outcomes. The impact of digital interventions aligns with national goals for modernizing education, as articulated in recent educational policies and initiatives (Zhang and Zhou, 2023; Xiaona, 2021; Wu et al., 2021; Yan and Yang, 2021). These reforms aim to equip students with the skills necessary to compete in a globalized labor market, where cognitive agility and problem-solving abilities are highly valued. The results of this study suggest that educational reforms supported by effective educational interventions improve students' cognitive abilities. Educational innovation prepares students for the demands of the modern labor market.

4.2 Hypothesis 2

While creativity and intelligence are interrelated in some theoretical frameworks, this study treated them as distinct constructs measured by separate instruments to ensure a clear assessment of the intervention's effects on both domains. The study assessed personal creativity and intelligence before and after the educational intervention. The Wonderlic Short Selection Test measured intelligence, and the E.E. Tunik Test measured creativity. While the Wonderlic Short Selection Test assesses reasoning and problem-solving abilities, improvements observed here should be understood as gains in testable cognitive skills rather than evidence of a fundamental increase in innate intelligence. Initially, the pre-test scores for personal creativity were 52.45 (SD = 12.99) for Mathematics students and 53.43 (SD = 14.41) for Philology students. Following the intervention, these scores significantly increased to 96.18 (SD = 2.64) for Mathematics students and 96.60 (SD = 2.44) for Philology students. Similarly, intelligence scores saw notable gains, with pre-test averages of 30.24 (SD = 6.49) for Mathematics students and 32.87 (SD = 8.97) for Philology students, rising to 46.36 (SD = 1.94) and

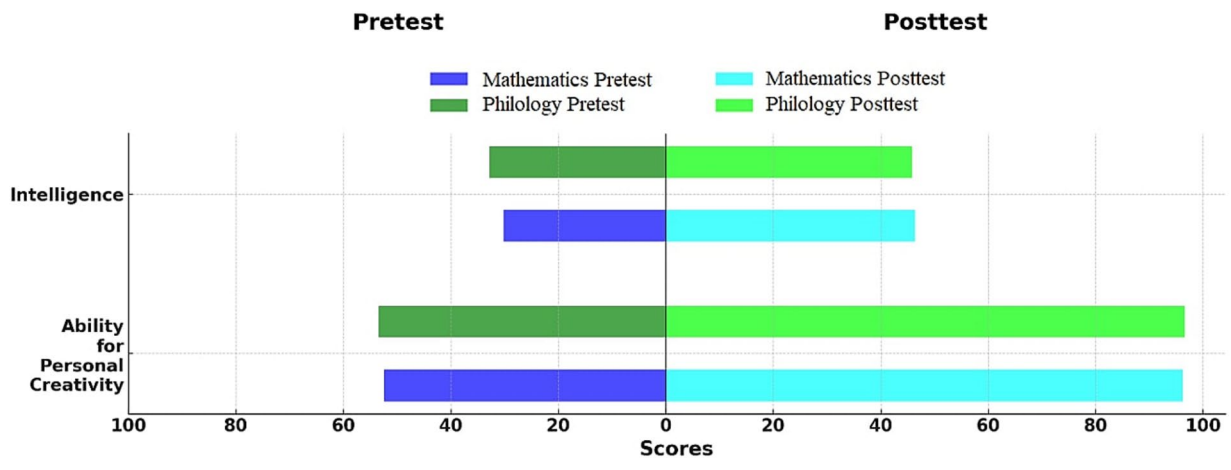

FIGURE 2
Comparison of pre and post test scores for mathematics and philology.

45.83 (SD = 1.98), respectively, after the intervention. These changes are depicted in Figure 3, which compares pre-test and post-test scores for personal creativity and intelligence.

These results underscore innovative educational practices' effectiveness in enhancing creativity and intelligence. Gardner's theory of multiple intelligences, which posits that intelligence is multifaceted and can be cultivated through suitable educational environments, supports these findings (Gardner, 1983). Gardner's framework suggests that creativity and intelligence are not monolithic constructs but are composed of various domains that can be nurtured and developed through targeted educational interventions. The educational intervention engaged students in creative problem-solving and critical thinking activities. The courses likely contributed to the observed improvements by providing opportunities for students to explore new ideas, engage in reflective thinking, and apply knowledge in novel contexts. The *t*-test results, which indicated significant improvements ($p < 0.05$) in creativity and intelligence, further corroborate the hypothesis.

These findings are consistent with recent research demonstrating that digital tools and innovative teaching methods can significantly enhance creative thinking and problem-solving skills (Henriksen et al., 2016). Findings align with Amabile's Componential Theory of Creativity, which suggests creativity can be nurtured through supportive educational and environmental factors (Amabile, 1983). Amabile's theory emphasizes the importance of intrinsic motivation, domain-relevant skills, and creativity-relevant processes, all of which can be cultivated in educational settings that encourage experimentation and risk-taking. Current studies also emphasize the importance of supportive educational environments in fostering creativity (Beghetto and Kaufman, 2010), highlighting how environments that provide intellectual stimulation and emotional support can produce greater creative output.

Moreover, integrating digital technologies in education promotes creative thinking and innovation. Lai and Hwang (2016) point out that digital platforms encouraging interactive learning and collaboration can significantly enhance students' creative capacities. Collaborative platforms and virtual simulations allow students to experiment with new ideas and approaches. Digital learning tools foster an environment where creativity can thrive. In the context of Kazakhstan, where educational reforms are increasingly focused on fostering creativity and innovation, these results highlight the critical importance of integrating digital tools into the curriculum to enhance students' creative and cognitive abilities (Bridges, 2014; Duman, 2024; Sarmurzin et al., 2021). These reforms are part of a broader strategy to align Kazakhstan's education system with the needs of a global economy, where creativity and innovation are increasingly seen as key drivers of competitive advantage.

The study's findings strongly support the hypothesis that targeted educational interventions, particularly those incorporating digital tools and innovative teaching methods, can significantly enhance students' creativity and intelligence. However, it is important to clarify that these improvements reflect enhancements in the skills and performances measured by our instruments, rather than a fundamental alteration of innate intelligence or creativity. In other words, educational intervention created an environment in which students could better apply reasoning abilities and engage in creative thinking tasks, thereby improving their test performance.

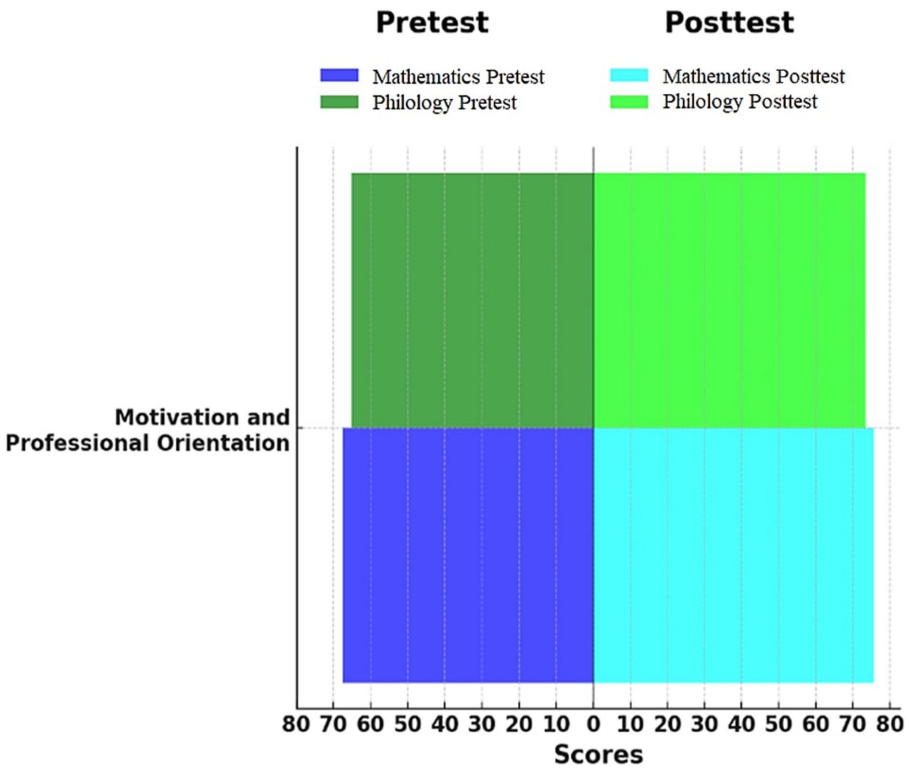

FIGURE 3
Comparison of pretest and post test scores for personal creativity and intelligence.

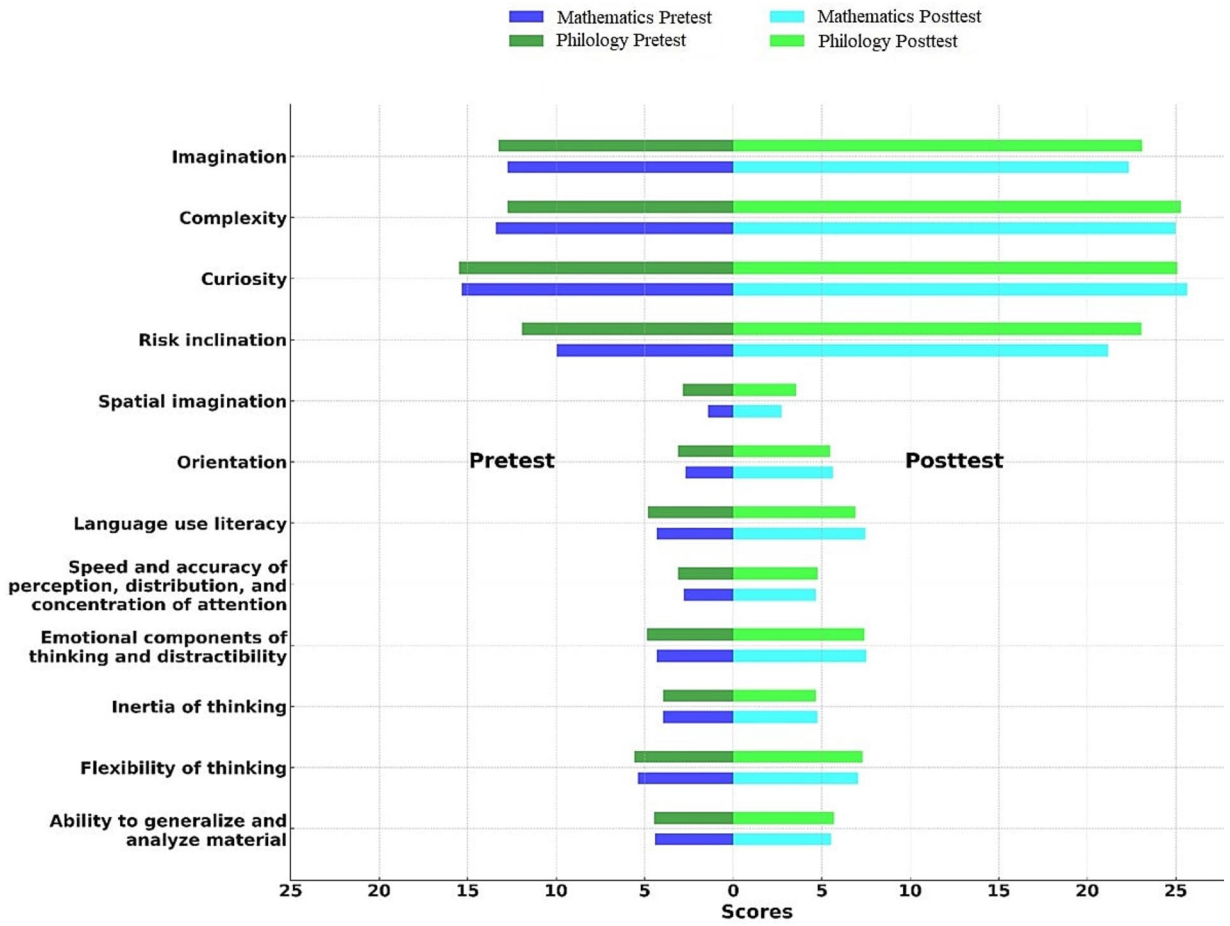

FIGURE 4
Pre and post-test scores for motivation and professional orientation.

These results are particularly relevant in the context of ongoing educational reforms in Kazakhstan, which aim to align the education system with the demands of a rapidly evolving global labor market. As Kazakhstan modernizes its educational infrastructure, integrating digital tools and innovative pedagogies will be essential in cultivating the creative and cognitive skills needed for future success (Kuanbayeva et al., 2024).

4.3 Hypothesis 3

The study observed a significant improvement in students' motivation and professional orientation following the educational intervention. Pre-test scores for motivation and professional orientation were 67.48 (SD = 2.36) for Mathematics students and 65.28 (SD = 2.24) for Philology students. Post-intervention, these scores increased to 75.60 (SD = 1.89) for Mathematics students and 73.42 (SD = 2.12) for Philology students. These improvements are visually depicted in Figure 4, which compares the pre-test and post-test scores for both Mathematics and Philology students.

Motivation and professional orientation are essential components of professional abilities, driving engagement, persistence, and overall success in educational and professional contexts (Carr, 2015). The observed increase in these levels can be attributed to the interactive and student-centered approach of the educational intervention, which likely made learning more relevant and engaging. Self-Determination Theory, proposed by Deci and Ryan (1985), provides a theoretical framework for understanding these results. The theory suggests that environments supporting autonomy, competence, and relatedness enhance intrinsic motivation and engagement. Similarly, in the present study, students' motivation and professional orientation improved significantly post-intervention. Recent studies indicate that educational settings promoting autonomy and competence boost student motivation and engagement (Ryan and Deci, 2000a, 2000b, 2017). The observed improvements align with the principles of Self-Determination Theory, which posits that when students perceive their learning environment as supportive of their autonomy and competence, their intrinsic motivation is likely to increase.

The *t*-test values were significant ($p < 0.05$), confirming the positive impact of the intervention. This finding aligns with Cattell's theoretical framework, highlighting the interplay of motivation, personality, and intelligence in developing professional abilities (Cattell, 1957). Cattell's theory suggests that motivation and intelligence are deeply intertwined. Motivated individuals are more likely to engage in behaviors that enhance their cognitive and professional skills. Current research also emphasizes the role of self-determined motivation in achieving academic and professional success (Vansteenkiste et al., 2010; Vansteenkiste et al., 2008). The

increase in motivation and professional orientation observed in this study result from aligning the educational intervention with students' personal goals and values.

Additionally, recent studies underscore the role of digital learning environments in enhancing student motivation. Schmid et al. (2014) found that digital tools offering immediate feedback and personalized learning paths increase students' motivation and engagement. Immediate feedback helps students understand their progress and areas for improvement, fostering a sense of competence, which is a key driver of intrinsic motivation according to Self-Determination Theory. On the other hand, personalized learning paths cater to individual student needs and preferences. They further enhance motivation by making learning more relevant and tailored to each student. The finding aligns with this study's observed improvements in motivation and professional orientation. The results highlight that the digital components of the educational intervention were crucial. In Kazakhstan, where digitalization is essential to educational reform, these findings highlight the potential for digital tools to boost student motivation and professional orientation (Cavero and Nuria, 2018). The national push toward digitalization in education aims to create more adaptive and responsive learning environments essential for fostering student motivation and professional engagement.

4.3.1 Correlation analysis

The correlation analysis revealed significant relationships between general mental abilities, personal creativity, and the level of motivation and professional orientation. The correlation coefficient between the ability to generalize and analyze material and the level of motivation and professional orientation was 0.363 ($p < 0.01$). The values suggest cognitive skills are closely linked to students' motivation and professional development. Other significant correlations were observed with flexibility of thinking (0.381, $p < 0.01$), emotional components of thinking (0.565, $p < 0.01$), and curiosity (0.653, $p < 0.01$).

These findings support the theoretical framework that posits cognitive abilities, creativity, and motivation are interrelated and collectively contribute to developing professional competencies (Mynbayeva and Sadvakassova, 2017). The strong correlations between these variables indicate that improvements in cognitive and creative abilities are closely linked to higher motivation levels and professional orientation. This comprehensive analysis demonstrates the importance of a holistic approach to education that addresses multiple dimensions of student development. For example, the positive correlation between flexibility of thinking and professional orientation (0.381) suggests that students who think flexibly can better adapt to professional demands. The findings support that educational interventions should foster cognitive flexibility to prepare students for complex and dynamic work environments. Cognitive flexibility is particularly relevant in rapid technological change, where adaptability and cognitive flexibility are critical for professional success.

Recent studies also highlight the interconnectedness of these abilities, suggesting that enhancing one aspect can positively influence others, creating a synergistic effect on overall student development (Cerasoli et al., 2014). For example, Cerasoli and colleagues' meta-analysis found that intrinsic motivation significantly enhances performance when combined with external incentives. The meta-analysis suggests that educational interventions should consider internal and external motivators to maximize student outcomes. The conclusion aligns with the current study's findings, where improvements in creativity, cognitive abilities, and motivation were found to be interrelated. The interrelatedness mandates a comprehensive approach to education that addresses multiple aspects of student development and professional competencies.

In summary, the findings confirm the significant impact of the educational intervention on enhancing university students' general mental abilities, personal creativity, intelligence, motivation, and professional orientation. These improvements align with theoretical frameworks that emphasize the role of cognitive and non-cognitive skills in professional success. The study underscores the need for innovative and interactive educational practices to develop well-rounded professionals equipped for the challenges of the digital age. The results suggest that targeted educational programs can effectively enhance critical professional abilities, thereby better-preparing students for the evolving demands of the modern workforce in Kazakhstan. As the country modernizes its educational infrastructure, integrating digital tools and innovative pedagogies will be essential in cultivating the creative, cognitive, and motivational skills needed for future success.

5 Conclusion

The study confirmed all three hypotheses, demonstrating that the educational intervention significantly improved the general mental abilities, personal creativity, intelligence, motivation, and professional orientation of university students. The quantitative data and statistical analyses provided robust evidence for these improvements, validating the effectiveness of the intervention. These improvements are consistent with the theoretical frameworks that emphasize the role of cognitive and non-cognitive skills in professional success. The findings underscore the need for innovative and interactive educational practices to develop well-rounded professionals equipped for the challenges of the digital age. These results suggest that targeted educational programs can effectively enhance critical professional abilities, contributing to better preparation of students for the evolving demands of the modern workforce.

6 Future directions

Future research should investigate the impact of educational interventions on specific skills, such as critical thinking, problem-solving, teamwork, and communication. These aspects were not covered in this study but are crucial for a comprehensive understanding of how different components of professional abilities develop. Additionally, examining the long-term effects of these interventions would provide insights into the sustainability of the improvements observed. Future studies could also explore the role of different teaching methods and digital tools in enhancing specific professional abilities, allowing for a more nuanced understanding of effective educational practices. Subsequent research will incorporate a broader range of universities, enabling a more comprehensive understanding of the intervention's applicability across diverse settings.

7 Limitations

The study has several limitations. The relatively small sample size, consisting of students from only two universities, limits the

generalizability of the findings to other contexts and populations. Although this study focuses on two universities, which limits generalizability, the findings provide an essential foundation for future multi-university investigations. The reliance on self-reported data for assessing motivation and professional orientation introduces potential biases, as participants might have provided socially desirable responses. Moreover, the absence of a control group that did not receive the educational intervention means that the authors can not definitively attribute the observed improvements solely to the intervention. Including a control group in future studies would provide a more robust comparison and help isolate the specific effects of the intervention.

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 humans were approved by Ethics Commission of Toraighyrov University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

AK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft. SX: Funding acquisition, Project administration, Supervision, Writing – review & editing.

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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.2024.1478622/full#supplementary-material

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