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Enhancing University Teachers' Competencies in Integrating Active Methods and Digital Tools: A Pretest-Posttest Experimental Study

Abstract

The integration of active learning methodologies with digital technologies represents a critical competency for contemporary university teaching, aligning with global trends in pedagogical innovation. Nevertheless, a significant proportion of higher education instructors face challenges in effectively implementing such approaches due to insufficient training and support. This study investigated the effectiveness of a blended professional development course in enhancing university teachers' abilities to integrate Case-Based, Problem-Based, and Team-Based Learning with digital tools. Twenty-one participants completed a pretest and posttest assignment (a digital teaching guide), evaluated using standardized rubrics. Pretest scores averaged 15.6 (SD = 10.2), while posttest scores rose to 84.6 (SD = 9.9), with a statistically significant increase ($t = 35.70$, $p < .001$). Participants showed strong performance in using AI tools and lesson design, though some struggled with complex data tools like Power BI.

The results confirm that structured, hands-on training can significantly improve digital-pedagogical integration, supporting prior findings on teacher self-efficacy and blended learning. Professional development programs that integrate active learning methodologies with digital technologies have demonstrated effectiveness in enhancing instructional competencies in higher education. The findings of this study provide valuable insights for curriculum developers, university administrators, and policy-makers aiming to foster pedagogical innovation and support the digital transformation of teaching practices..

Keywords: digital pedagogy, active learning, professional development, university teachers, educational technology, teaching competencies, blended learning, PBL, CBL, TBL.

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Introduction

Developing teachers' competencies in integrating active learning methods with digital tools is a multifaceted and dynamic process that requires a solid foundation in both pedagogical knowledge and technological proficiency. Effective integration not only enhances student engagement but also improves learning outcomes by leveraging digital environments to foster interaction, creativity, and autonomy. Teachers must possess a range of key competencies to successfully implement such integrative approaches.

One fundamental competency is technological proficiency. Educators need to demonstrate a high level of digital literacy, including the ability to navigate educational platforms, utilize interactive software, and apply various ICT tools. This skill set enables them to design and deliver meaningful digital content while creating interactive and personalized learning experiences (Kiryakova & Kozhuharova, 2024; Yadav, 2024). Equally important is pedagogical knowledge, particularly regarding active learning methodologies such as Case-Based Learning (CBL), Problem-Based Learning (PBL), and Team-Based Learning (TBL). These approaches encourage critical thinking, collaboration, and reflective inquiry, and their effectiveness is significantly enhanced when coupled with appropriate digital tools (Abildinova et al., 2024; Alcántar, 2024).

In addition, content expertise plays a critical role in ensuring the relevance and adaptability of teaching materials. Teachers must be capable of designing electronic resources that address diverse learning styles and support collaborative online learning environments (Kiryakova & Kozhuharova, 2024; Svensson, 2021). To support the development of these competencies, structured professional development is essential. Ongoing training initiatives - especially those that blend workshops, collaborative projects, and self-paced modules - have demonstrated positive effects on educators' confidence and capacity to implement innovative teaching methods (Abildinova et al., 2024; Romero-García et al., 2020).

The use of digital tools such as Moodle, augmented reality applications, and interactive platforms further supports the transformation of pedagogical practices. These technologies can foster the development of soft skills, enhance student motivation, and enable the personalization of instruction (Smawati et al., 2022; Santos et al., 2024). Moreover, inter-professional collaboration within communities of practice provides a platform for exchanging experiences and pedagogical innovations, thereby reinforcing digital and didactic competencies (Svensson, 2021).

Despite these opportunities, several challenges hinder the seamless integration of digital tools and active learning methods. Limited access significant barriers. Overcoming these issues requires strategic planning, adequate funding, and leadership support (Abildinova et al., 2024; Santos et al., 2024). Furthermore, ensuring equitable access to technology and digital training is paramount, especially in contexts where disparities in infrastructure and digital literacy persist (Santos et al., 2024; Yadav, 2024).

Another critical issue is the alignment of digital tools with existing curricula. Successful integration demands thoughtful adaptation of instructional materials and outcomes to ensure cohesion with institutional goals and educational standards (Abildinova et al., 2024; Alcántar, 2024). Without such alignment, the risk of fragmented or ineffective instructional design increases.

While integrating active learning methods with digital tools holds immense potential for transforming higher education, it simultaneously introduces complex challenges that must be addressed at both the institutional and individual levels. Sustained professional development, equitable resource allocation, and a collaborative culture are essential components for fostering innovation and enhancing digital pedagogy. Addressing these dimensions enables educators to create more inclusive, interactive, and impactful learning experiences in the digital era.

Despite a growing body of literature highlighting the importance of equipping teachers with both pedagogical and technological competencies, there remains a need for empirical evidence on how structured professional development programs translate into measurable improvements in these areas. While various studies have outlined the theoretical underpinnings and strategic frameworks for integrating digital tools with active learning methodologies, fewer have examined the concrete outcomes of such integration in real instructional settings, particularly within higher education contexts.

To address this gap, the present study explores the effectiveness of a blended learning course designed to enhance university teachers' competencies in applying active teaching methods supported by digital technologies. The course was implemented within a national professional development initiative and focused on developing skills related to instructional design, digital tool usage, and case-based learning techniques.

Accordingly, this study is guided by the following research question: How does participation in a professional development course impact university teachers' competencies in integrating active learning methods (CBL, PBL, TBL) with digital tools?

Methods and materials

This study employed a pedagogical experiment aimed at enhancing university teachers' competencies in applying active learning methods.

The intervention was structured as a blended professional development course hosted on the institutional platform of Margulan University's Institute for Continuing Education (https://cabinet.ido.ppu.edu.kz/course/view.php?id=444). The course was conducted over a one-month period from April 22 to May 22, 2025, and included both asynchronous online modules and synchronous interactive components.

A total of 21 university educators voluntarily enrolled in the course. Participants came from various higher education institutions in Kazakhstan and represented diverse academic disciplines. Their participation was voluntary, and informed consent was

obtained from all individuals prior to the start of the study.

The course comprised 72 academic hours and was delivered in Russian. It was designed to improve university teachers' competencies in implementing active learning methodologies, specifically Case-Based Learning (CBL), Team-Based Learning (TBL), and Problem-Based Learning (PBL), through the effective use of digital tools. Structured into five thematic modules, the course addressed instructional design using active methods, integration of educational technologies such as Moodle, Blackboard, Mentimeter, Quizziz, Plickers, TED-Ed, Power BI, ChatGPT, Gamma, and Canva, as well as the development of pedagogical resources including case studies, educational videos, and digital surveys. Additional areas of focus included formative assessment strategies, feedback techniques, and classroom management in digitally enhanced learning environments.

To reinforce these skills, participants were engaged in a series of practical assignments aimed at evaluating their ability to combine pedagogical techniques with appropriate technologies. These included designing lessons using digital tools, developing reflective surveys, creating instructional videos, performing data visualization using Power BI, utilizing artificial intelligence tools for lesson planning, building multimedia presentations, and generating realistic educational visuals. All assignments were submitted via the Moodle platform and assessed by course instructors using standardized rubrics that considered the quality, structure, creativity, and relevance of tool application.

The course included the evaluation of several key assignments: lesson design using active methods and digital tools (task #1), creation of reflective surveys (task #2), development of instructional videos (task #3), data analysis in Power BI (task #4), AI-assisted lesson planning (task #5), ChatGPT & Grammarly Use (task #6), multimedia presentation design (task #7), the generation of realistic educational visuals (task #8), creating a methodological teaching guide that integrated active learning methods with digital tools (task #9).

To evaluate the effectiveness of the professional development course, a pretest-posttest design was employed. Participants completed an identical task before and after the course: creating a methodological teaching guide that integrated active learning methods with digital tools (task #9). This integrative task was selected as a measure of teachers' ability to apply both pedagogical and technological competencies in a coherent manner. The collected scores from the pretest and posttest phases were analyzed using a paired samples t-test, as the same group of participants completed both assessments. This statistical method was chosen to determine whether there was a statistically significant improvement in participants' competencies after completing the course, controlling for individual differences by comparing each participant's pre- and post-course performance.

Each task was assessed using standardized rubrics focusing on integration of pedagogy and technology. The assignments were evaluated by course instructors - experts

in digital pedagogy and active learning methods - using standardized assessment rubrics to ensure consistency and objectivity in scoring. Each assignment was scored on a 0–100 scale across several dimensionsи (see Appendix). Evaluation focused on the degree of method integration, appropriateness of tool selection, clarity of instructional design, and the quality of pedagogical artifacts produced. Detailed rubrics were used to ensure consistency and objectivity.

All participants involved in this study provided voluntary and informed consent prior to their inclusion. Full confidentiality, anonymity, and security of the collected data were ensured throughout the pedagogical experiment. Participation in the professional development course and related assessments was entirely voluntary, and participants were informed of their right to withdraw at any time without penalty. The research protocol was reviewed and approved by the Ethics Committee of Margulan University (Approval No. 12–EK) on March 3, 2025, in accordance with national and institutional ethical standards for research involving human participants.

Results and Discussion

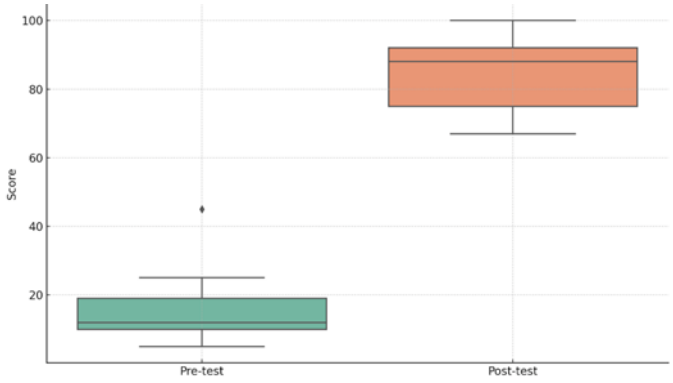
As part of the diagnostic process, participants were asked to complete Assignment 9 both before and after the course. The task required each participant to design a mini-methodological guide focused on a selected topic, explicitly integrating active learning strategies (CBL, PBL, TBL) with digital tools. A standardized template was provided to ensure comparability across responses.

Initial submissions (pre-test) revealed limited familiarity with integrating pedagogical and technological components. Most participants presented fragmented ideas, lacked structured methodology, and demonstrated minimal use of digital instruments. The average score for pre-test submissions was **15.57 out of 100**, with the lowest at **5** and only one case above **40**.

After completing the course, participants were given the **same assignment** as a post-test. The results showed dramatic improvement. Participants demonstrated an enhanced ability to structure lessons using active methods, select appropriate digital tools, and articulate pedagogical rationale. The average post-test score increased to **84.62**, with multiple participants scoring above **90** and several achieving **perfect scores (fig.2)**.

Figure 1

Comparison of Pre-test and Post-test scores



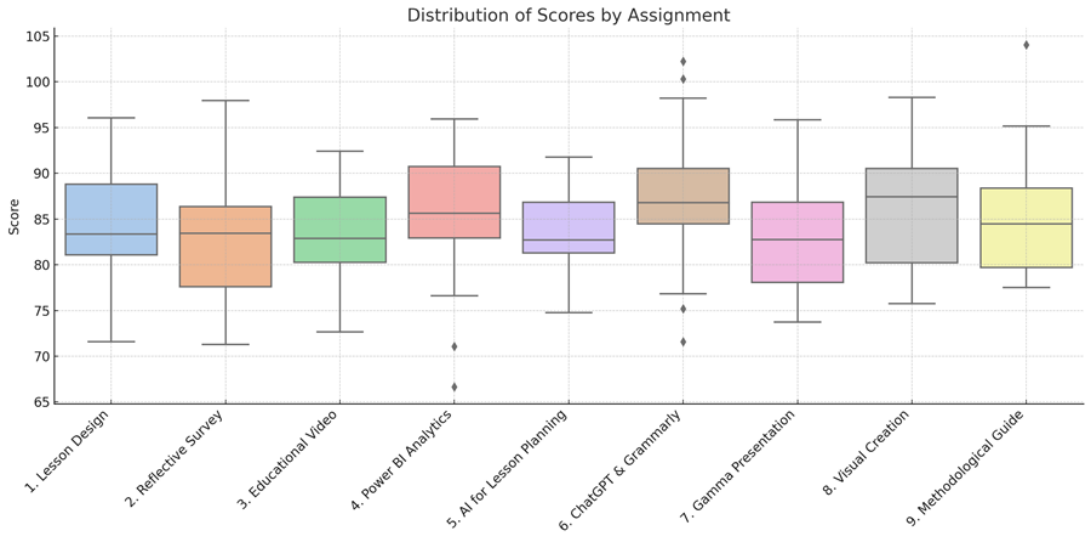
The comparison of pretest and posttest scores using a paired t-test revealed a statistically significant improvement in participants' performance. The mean score increased from 14.3 (SD = 7.2) on the pretest to 85.3 (SD = 9.9) on the posttest. The t-statistic was 35.70, and the result was highly significant ($p < .001$), indicating a strong positive effect of the course on participants' ability to integrate digital tools and active learning methods into instructional materials. This confirms the effectiveness of the professional development program in enhancing the targeted teaching competencies.

The analysis of the participants' scores across all nine assignments revealed consistently high and stable performance (fig.2). The average scores ranged from 82.2 (Task 1: lesson planning with active methodology and digital tool) to 89.3 (Task 5: using AI for lesson planning), while median scores ranged from 82.5 to 90, indicating that most participants developed strong competencies in integrating active learning methods with digital tools.

The highest performance was recorded in Tasks 5 and 9, which focused on the use of artificial intelligence and the creation of a teaching guide. These tasks not only showed the highest mean scores but also had low standard deviations (Task 5: SD = 9.37, Task 9: SD = 9.91), suggesting a relatively consistent understanding and application of these competencies across participants.

Figure 2

Distribution of Participants' Scores Across Nine Integration Assignments



Conversely, Task 4 (data analytics in Power BI) showed more variability, with a standard deviation of 15.32, indicating that while some participants excelled, others faced difficulties—likely due to the technical complexity of the tool. Despite this, the distribution of scores in most assignments was relatively symmetrical and without extreme outliers, indicating an even level of mastery across the cohort. Mode values clustered around 90 points for many tasks, with Tasks 5, 6, and 9 demonstrating the highest concentration of top performers. These findings confirm that the course was effective in developing essential skills and highlight specific areas—such as data analytics - where additional support or differentiated instruction might enhance future outcomes.

The observed patterns in performance across the assignments provide a foundation for further interpretation. The findings of this study demonstrate a significant improvement in university teachers' competencies in integrating active learning methods with digital tools following participation in a structured professional development course. The statistically significant difference between pre-test and post-test results ($t = 35.70$, $p < 0.001$) provides compelling evidence of the course's effectiveness. These results indicate not only growth in individual digital skills but also a deeper pedagogical understanding of how to embed technologies meaningfully into active instructional strategies such as CBL, PBL, and TBL.

This aligns with previous research by Abildinova et al. (2024), who emphasized the importance of blended training formats in improving teachers' digital-pedagogical integration. The marked increase in performance on integrative tasks, particularly the development of teaching materials using multiple tools, supports the view that combining

digital literacy with methodological training can have a transformative effect on instructional practice (Santos et al., 2024).

Furthermore, the variance in scores across assignments highlights the complexity of mastering multiple competencies simultaneously. While tasks such as creating surveys or working with Power BI posed initial difficulties, the final assignment - designing a teaching guide that combined all learned elements - showed that participants were able to synthesize and apply the knowledge gained. This is in line with findings by Romero-García et al. (2020), who argue that integrated, practice-based learning fosters deeper competency acquisition.

The success of the course also resonates with the concept of teacher self-efficacy in digital environments, as noted by Hamid (2020) and Blonder et al. (2013). Many participants initially lacked confidence in using AI and data visualization tools, but their ability to complete tasks involving ChatGPT, Grammarly, and Power BI by the end of the course suggests a meaningful increase in their perceived and actual capabilities.

Nevertheless, the data also reveal persistent challenges. Some participants continued to underperform on assignments requiring creative or technical synthesis, echoing concerns raised in Svensson (2021) about the variability in digital competence development in adult learners. Moreover, the success of the intervention depends on sustained institutional support and opportunities for continuous professional learning, as suggested by Yadav (2024) and Tondeur et al. (2017).

In sum, this study contributes to a growing body of evidence that strategic, hands-on professional development can foster the integration of active learning and digital tools in higher education. It underscores the importance of designing training programs that not only teach how to use technology, but also embed it within pedagogical frameworks that promote engagement, reflection, and collaboration.

This study has several limitations that should be acknowledged. First, the sample size was relatively small (n = 21), and all participants were affiliated with a single university, which may limit the generalizability of the findings to broader contexts. Second, the assessment relied primarily on performance-based tasks evaluated through standardized rubrics, which, although informative, may not fully capture participants' long-term retention or transfer of the skills acquired. Third, the absence of a control group limits the ability to attribute improvements solely to the intervention, as other contextual or motivational factors could have contributed to the observed gains. Additionally, although the assignments were designed to evaluate the integration of active methods with digital tools, variations in participants' prior experience with technology may have influenced their outcomes. Finally, the study focused on short-term gains; follow-up assessments would be needed to evaluate the sustainability of the achieved competencies over time.

Despite these limitations, the study offers valuable insights into the development of university teachers' competencies in integrating active learning methods with digital

tools. The findings highlight not only statistically significant improvements, but also practical implications for designing professional development programs in higher education. These results underscore the importance of structured, practice-oriented training that addresses both pedagogical and technological dimensions.

Conclusion

This study demonstrates that targeted professional development can significantly enhance university teachers' competencies in integrating active learning methods with digital tools. The results of the pedagogical intervention revealed substantial growth in participants' ability to design and implement instruction that combines Case-Based Learning (CBL), Problem-Based Learning (PBL), and Team-Based Learning (TBL) with digital technologies. The statistically significant improvements observed between the pretest and posttest scores support the effectiveness of the training course in fostering practical, applicable skills among educators.

The study contributes to the broader understanding of how blended, hands-on professional development can be structured to yield measurable outcomes in digital pedagogy. By emphasizing real-world assignments and providing structured feedback, the course helped participants translate theoretical knowledge into educational practice. Furthermore, the findings align with prior research that highlights the need for pedagogically grounded approaches to digital integration in higher education.

These outcomes not only validate the chosen instructional design of the course but also suggest directions for future training programs. Continuing to invest in teacher development that focuses on both digital fluency and pedagogical innovation is essential for preparing educators to meet the demands of contemporary classrooms. Future studies may explore longitudinal impacts, disciplinary differences, and the role of institutional support in sustaining these competencies over time.

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Appendix

Assessment Checklist

Assignment for Module 1: Lesson Design Using an Active Method and a Digital Tool

1. Task Execution

0 - 20 points: The method was not applied or was applied incorrectly.

21 - 40 points: The method was partially applied, but key aspects were missing.

41 - 60 points: The method was applied correctly, but lacked a clear connection to the lesson.

61 - 80 points: The method was applied appropriately with good connection to the instructional process, though minor flaws were present.

81 - 100 points: The method was fully and correctly integrated into the lesson with

effective use of digital tools.

Experience Description

0 - 20 points: Description is missing or highly unstructured.

21 - 40 points: The description is incomplete or lacks sufficient detail.

41 - 60 points: The experience is described well, but some aspects are not fully explained.

61 - 80 points: Detailed and coherent description, with minor flaws.

81 - 100 points: Comprehensive, logical, and clear explanation with analysis of all experience aspects.

Practical Assignment 2.2.1: Reflective Survey Based on an Active Learning Method

2. Survey Quality

0 - 20 points: Survey does not meet requirements or has serious errors.

21 - 40 points: Survey has structural issues or lacks alignment with the method.

41 - 60 points: Survey is mostly correct but needs improvement.

61 - 80 points: Well-developed survey meeting basic standards.

81 - 100 points: Excellent survey, fully aligned with CBL/PBL/TBL and thoughtfully designed questions.

Use of Digital Tool

0 - 20 points: Tool not used or used incorrectly.

21 - 40 points: Tool used with configuration issues.

41 - 60 points: Tool used appropriately with minor problems.

61 - 80 points: Good use of tool with minimal errors.

81 - 100 points: Excellent tool usage with proper configuration and application.

3 Practical Assignment 2.2.3: Creation of an Educational Video in TED-Ed or YouTube

3.1. Video Quality

0 - 20 points: No video or very poor quality.

21 - 40 points: Video contains content or format errors.

41 - 60 points: Good video with some presentation flaws.

61 - 80 points: Clear and effective video.

81 - 100 points: High-quality video with excellent presentation and tool use.

Questions and Feedback

0 - 20 points: Questions missing or irrelevant.

21 - 40 points: Questions poorly structured.

41 - 60 points: Well-written but could be more diverse.

61 - 80 points: Thought-provoking and well-selected questions.

81 - 100 points: Logical, diverse, and fully aligned with learning objectives.

Practical Assignment 2.2.6: Data Analytics in Power BI

4.1. Analytics Structure and Content

0 - 20 points: Analytics missing or seriously flawed.
21 - 40 points: Present but needs major improvement.
41 - 60 points: Adequate but underdeveloped.
61 - 80 points: Well-structured with minor issues.
81 - 100 points: Excellent analytics with in-depth data analysis.
Use of Power BI
0 - 20 points: Not used or used incorrectly.
21 - 40 points: Tool used with setup errors.
41 - 60 points: Correct use with small issues.
61 - 80 points: Good use with proper visuals.
81 - 100 points: Excellent use with clear and informative visualizations.
Practical Assignment 2.2.7: Use of AI for Lesson Planning
5.1. AI Application
0 - 20 points: AI not used or misused.
21 - 40 points: Used with setup errors.
41 - 60 points: Applied correctly but needs refinement.
61 - 80 points: Good application with useful results.
81 - 100 points: Excellent application with relevant outcomes.
Assignment 4.4: Working with ChatGPT and Grammarly
6.1. ChatGPT Usage
0 - 20 points: Not used or used incorrectly.
21 - 40 points: Used but with unsatisfactory results.
41 - 60 points: Used appropriately with room for improvement.
61 - 80 points: Good usage with relevant outcomes.
81 - 100 points: Excellent use of ChatGPT with high-quality results.
Grammarly Usage
0 - 20 points: Not used or misused.
21 - 40 points: Used with many errors.
41 - 60 points: Used properly but some flaws.
61 - 80 points: Good use with minor issues.
81 - 100 points: Excellent analysis and error detection.
Assignment 4.5: Presentation Design in Gamma
7.1. Presentation Quality
0 - 20 points: Missing or poorly done.
21 - 40 points: Completed but with flaws.
41 - 60 points: Good but needs improvements.
61 - 80 points: Clear and effective presentation.
81 - 100 points: Excellent presentation with professional design.
Assignment 4.6: Creation of Realistic Visuals

8.1. Visual Quality
0 - 20 points: Missing or poorly created.
21 - 40 points: Completed but needs refinement.
41 - 60 points: Acceptable but can be improved.
61 - 80 points: Good visuals with detail.
81 - 100 points: Realistic and high-quality visuals.

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