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An empirical study of Agile readiness and test-oriented learning competencies in the digital educational environment of Kazakhstan

Zhandos Zulpykhar[1], Dinara Meirgazina[2]
[1]Department of Computer Science, L. N. Gumilyov Eurasian National University, Astana, Kazakhstan
[2]Department of Artificial Intelligence and Information Technology, Sarsen Amanzholov East Kazakhstan State University, Ust-Kamenogorsk, Kazakhstan

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ABSTRACT

The rapid digital transformation of Kazakhstan's higher education system has increased the need for flexible, evaluation-oriented, and technologically supported teaching models. However, the availability of digital platforms does not always lead to teachers' readiness to implement Agile-oriented and test-based learning practices. This study addresses the gap between institutional digital transformation, teachers' Agile readiness, digital assessment competencies, and labor market expectations in Kazakhstan's digital education sector. The study employed a descriptive empirical design based on questionnaire data from university teachers and a complementary analysis of job advertisements in EdTech and digital pedagogy. The study is conceptually informed by constructivist learning theory, the technology acceptance model (TAM), the DeLone and McLean information systems success model, and the DigCompEdu framework. The findings show that teachers recognize the importance of iterative feedback, continuous assessment, adaptive digital courses, and learning analytics, but the actual implementation of these practices remains uneven. The comparison with labor market requirements also indicates a mismatch between teachers' reported competencies and the practical skills expected by employers. The study contributes to digital pedagogy by demonstrating that effective digital transformation requires not only technological infrastructure but also Agile-oriented pedagogical readiness, digital assessment literacy, and competency-based teacher development. The results may support universities, teacher training institutions, and policymakers in designing professional development programs focused on Agile pedagogy, digital assessment, learning analytics, and adaptive instructional planning.

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Corresponding Author:

Dinara Meirgazina
Department of Artificial Intelligence and Information Technology
Sarsen Amanzholov East Kazakhstan State University
55 30th Guards Division Street, Ust-Kamenogorsk, East Kazakhstan Region, Kazakhstan
Email: dinara_ckt@mail.ru

1. INTRODUCTION

From 2010 to 2024, the digital transformation of higher education in Kazakhstan has become one of the key directions of the state educational policy. Universities are actively implementing digital platforms, automated assessment systems, and adaptive learning tools to increase the flexibility, transparency, and effectiveness of the educational process. In this context, particular attention is given to approaches based on

Agile methodologies and test-based learning, as these are increasingly viewed as important mechanisms for shaping contemporary pedagogical professionalism and enhancing the quality of digital learning. However, the digital transformation of higher education in Kazakhstan has created not only technological opportunities but also several practical pedagogical challenges. Many university teachers use learning management systems (LMS), online testing tools, and digital platforms, but their application often remains limited to administrative functions, content delivery, or summative assessment. In practice, teachers may experience difficulties in adapting teaching methods to flexible digital formats, organizing iterative feedback, using assessment data for instructional improvement, and integrating Agile-oriented practices into everyday teaching. As a result, the availability of digital infrastructure does not always lead to meaningful pedagogical transformation.

In the Kazakhstani context, this problem is particularly important because universities are increasingly expected to implement digital learning models while teachers' readiness for Agile-based instruction and digital assessment practices remains uneven. Limited pedagogical adaptation, insufficient experience with continuous assessment, and a lack of confidence in using learning analytics may reduce the effectiveness of digital education. Therefore, the central educational problem addressed in this study is the gap between the institutional promotion of digital transformation and teachers' practical readiness to apply Agile and test-oriented learning practices in higher education. In educational settings, Agile is understood as a flexible and iterative approach to teaching and learning that emphasizes continuous feedback, short-cycle improvement, adaptive course design, and responsiveness to learner needs and performance data. In practical terms, Agile-oriented educational environments involve the use of digital assessment tools, learning analytics, formative feedback systems, and coordinated pedagogical adjustment. Thus, Agile competence in education can be understood as teachers' ability to design, implement, and refine adaptive, feedback-driven, and digitally supported learning processes. Previous empirical research suggests that the implementation of flexible and assessment-oriented learning models is often constrained by pedagogical, organizational, and technological factors. Although digital platforms can support adaptive instruction and ongoing assessment, their presence alone does not guarantee meaningful changes in teaching practice or feedback processes [1], [2]. Moreover, studies on Agile in higher education emphasize that successful implementation depends on broader transformations in institutional culture, assessment methods, and collaboration among participants in the educational process [3].

Although previous studies have examined digital competence, adaptive learning, Agile approaches in education, and digital assessment separately, the relationship between these dimensions remains insufficiently explored in the context of Kazakhstan's higher education. In particular, limited attention has been paid to how teachers' Agile readiness is connected with their test-oriented learning competencies and how both of these areas correspond to the practical expectations of the digital education labor market. Existing research often focuses either on technological infrastructure, general digital skills, or separate assessment practices, while the combined analysis of Agile readiness, test-based competencies, and employers' requirements remains underdeveloped. This creates a research gap that is especially relevant for Kazakhstan, where universities are actively implementing digital platforms, but the alignment between teachers' pedagogical readiness and labor market expectations is still unclear. Therefore, this study addresses this gap by providing an empirical description of teachers' Agile readiness, test-oriented learning competencies, and labor market expectations in Kazakhstan's digital education sector. The novelty of this study lies in its integrated examination of three interconnected dimensions: teachers' Agile readiness, test-oriented digital assessment competencies, and labor market expectations in Kazakhstan's digital education sector. While previous studies have often considered digital competence, Agile learning, or educational assessment as separate research areas, this study combines these perspectives within one empirical framework. The study contributes by providing an integrated descriptive comparison of teachers' Agile readiness, test-oriented digital assessment competencies, and labor market expectations within Kazakhstan's digital higher education system. In this way, the study provides a context-specific contribution to understanding digital educational transformation in Kazakhstan and offers practical implications for teacher professional development and higher education program design.

The conceptual framework of this study is informed by four complementary perspectives. First, constructivist learning theory explains Agile-oriented teaching as an iterative process based on continuous feedback and learner-centered knowledge construction. Second, the technology acceptance model (TAM) suggests that teachers' implementation of digital practices depends on their perceived usefulness and ease of use. Third, the DeLone and McLean information systems success model emphasizes that effective digital education depends not only on technological infrastructure but also on system quality, information quality, user satisfaction, and actual use. Finally, the European DigCompEdu framework provides a comprehensive model of teachers' digital competence, including digital assessment, learner support, and professional engagement. Together, these theoretical perspectives provide the conceptual foundation for interpreting

teachers' Agile readiness, digital assessment competencies, and labor market expectations. Unlike previous studies that have examined Agile readiness, digital competence, or assessment separately, this study integrates these dimensions with labor market expectations within a single descriptive empirical framework. This integrated perspective contributes to understanding how teacher competencies correspond with the practical demands of Kazakhstan's rapidly developing digital higher education sector.

Based on the identified research gap, the objective of this study is to examine teachers' Agile readiness, test-oriented digital assessment competencies, and labor market expectations in Kazakhstan's digital higher education transformation in order to identify practical gaps relevant to teacher professional development and digital education policy. The study also aims to determine how these dimensions can inform the improvement of teacher professional development and competency-based curriculum design. To guide the empirical analysis, the following research questions were formulated:

- What is the current level of teachers' Agile readiness and engagement in Agile-oriented digital teaching practices in Kazakhstan's higher education institutions? (RQ1)
- How are test-oriented digital assessment competencies represented in teachers' professional practices? (RQ2)
- How do teachers' Agile readiness and test-oriented competencies compare with labor market expectations in Kazakhstan's digital education sector? (RQ3)
- What practical implications do the findings have for teacher professional development, curriculum design, and digital education policy? (RQ4)

2. RESEARCH METHOD

2.1. Research design

This study employed a descriptive empirical research design with elements of comparative analysis. The design was selected because the purpose of the study was not to test the effect of an intervention, but to examine teachers' Agile readiness, test-oriented digital assessment competencies, and their correspondence with labor market expectations in Kazakhstan's digital education sector. The study combined questionnaire-based data from university teachers with a complementary content analysis of job advertisements in the fields of EdTech, digital pedagogy, and educational technologies.

A purposive sampling strategy was used because the study focused on teachers who had experience with digitally supported teaching practices. A total of 235 questionnaires were distributed to university teachers from three Kazakhstani universities involved in digital transformation initiatives during the 2025–2026 academic period: L.N. Gumilyov Eurasian National University, Sarsen Amanzholov East Kazakhstan University, and Kh. Dosmukhamedov Atyrau University. Of these, 124 valid responses were received, yielding a response rate of 52.7% [4], [5].

2.2. Instrument validity and reliability

The questionnaire consisted of 20 items distributed across two constructs: Agile readiness (11 items) and test-oriented digital assessment competencies (9 items). To ensure the content validity of the questionnaire, the instrument was reviewed by three experts in digital pedagogy, educational assessment, and teacher professional development. The experts independently evaluated each item according to three criteria: clarity, relevance, and alignment with the intended construct. Each criterion was rated using a 4-point relevance scale. Based on their feedback, several items were revised to improve wording, relevance, and construct alignment. All items were retained after revision because the experts agreed that they adequately represented the intended constructs.

The reliability analysis showed acceptable internal consistency. Cronbach's alpha was 0.86 for Agile readiness, 0.83 for test-oriented digital assessment competencies, and 0.85 for the overall instrument. Since all Cronbach's alpha coefficients exceeded the commonly accepted threshold of 0.70, the questionnaire demonstrated adequate measurement quality for descriptive empirical research. The content validity and reliability characteristics of the questionnaire, including the number of items, validation procedure, and Cronbach's alpha coefficients for each construct, are summarized in Table 1.

Table 1. Instrument validity and reliability

Construct	Number of items	Validation method	Cronbach's alpha
Agile readiness	11	Expert review (3 experts)	0.86
Test-oriented digital assessment competencies	9	Expert review (3 experts)	0.83
Overall instrument	20	Content validation	0.85

2.3. The survey was conducted using Google Forms

The questionnaire included two main sections: i) assessment of teachers' Agile readiness, including perceptions of flexible approaches, willingness to work iteratively, acceptance of continuous feedback, and self-reported digital skills; and ii) assessment of test-based learning competencies, including experience in using digital assessment tools, the ability to work with learning analytics, and involvement in testing and self-verification cycles [6], [7]. The questionnaire was designed to capture key components of Agile professionalism in digital learning, including motivation to adopt flexible approaches, preferred feedback models, factors influencing digital readiness, perceptions of test-oriented strategies, frequency of use of LMS functions such as quizzes, assignment submission, gradebooks, discussion forums, and feedback tools, experience with digital forms of assessment, and expectations regarding the digital educational environment. The questionnaire included items covering teachers' demographic and professional background, patterns of engagement in digitally supported teaching, and perceptions of Agile and test-oriented practices. Questions 7–20 focused specifically on evaluative dimensions, including the expected role of Agile, the importance of continuous assessment, the requirements of digital platforms, the need for practice-oriented digital courses, and perceptions of the effectiveness of test-based learning. The instrument included five multiple-choice questions, four open-ended questions, and 11 Likert-scale items rated on a 5-point scale.

To strengthen the practical relevance of the study, a complementary analysis of labor market demands was undertaken. Specifically, 70 job advertisements in the fields of EdTech, digital pedagogy, and educational technologies were collected from major Kazakhstani platforms, including hh.kz, LinkedIn, Zerocoder, Digital Nation, and university career centers. Employers' requirements included competence in digital tools, knowledge of LMS, basic skills in learning analytics, the ability to design and manage flexible educational processes [8]–[10], and skills in formative assessment and digital communication. The questionnaire responses and job advertisements were categorized according to recurring competency themes, which enabled a comparative analysis of university training and labor market expectations.

2.4. Data analysis techniques

The quantitative data from the questionnaire were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. Comparative analysis was used to identify differences between expected and actual engagement in Agile-oriented practices. The responses to open-ended questions were examined through thematic categorization to identify recurring patterns related to teachers' challenges, digital assessment practices, and professional development needs.

The labor market data were analyzed using content analysis. A total of 70 job advertisements were manually screened to remove duplicate and irrelevant postings. The remaining requirements were coded according to recurring competency categories, including digital assessment, learning analytics, LMS management, Agile-oriented instructional planning, and digital communication. The coded categories were descriptively compared with teachers' survey responses to identify apparent areas of alignment and mismatch.

To support the descriptive interpretation of the findings, differences between expected and actual levels of Agile-oriented practices were calculated in percentage points. The labor market data were analyzed using qualitative content analysis and descriptive frequency comparisons. Differences between teachers' responses and competency requirements identified in job advertisements were interpreted descriptively in percentage terms without inferential statistical testing.

3. RESULTS

3.1. Teachers' Agile readiness and engagement in digital teaching practices

In the modern digital educational environment, increasing attention is being paid to the development of Agile approaches and test-based learning competencies, as these practices support flexibility, continuous feedback, adaptive instruction, and more effective use of digital assessment tools [10]–[12]. To examine teachers' expectations and their actual level of engagement, the questionnaire included two specific items: "what level of Agile practices did you expect to see in the learning process?" and "what level of Agile practices is actually used in your teaching practice?" The results are presented in Table 2.

Table 2. Expected versus actual engagement in Agile practices among teachers

Agile practice category	Expected level (%)	Actual level (%)	Gap, percentage points (%)
Iterative feedback	54.8	28.2	26.6
Continuous assessment and testing	61.3	37.1	24.2
Adaptive digital courses	48.4	22.6	25.8
Other digital practices	23.4	42.1	-18.7

The comparison between expected and actual engagement showed notable percentage-point gaps across key Agile-oriented practices. The largest gap was observed in adaptive digital courses, where the expected level was 48.4%, while the actual level was 22.6%, resulting in a gap of 25.8 percentage points. Iterative feedback showed a gap of 26.6 percentage points, and continuous assessment and testing showed a gap of 24.2 percentage points. These results indicate that teachers' expectations regarding Agile-oriented practices are considerably higher than their reported implementation in teaching practice.

The analysis of Table 2 reveals several important trends. First, there is a substantial gap between the expected and actual implementation of Agile practices in teaching. For example, 54.8% of teachers expected the active use of iterative feedback, whereas only 28.2% reported that it was implemented in teaching practice [13]–[15]. Second, although teachers recognize the importance of test-based learning competencies, this is not fully reflected in practice. For example, 61.3% of teachers expected the active use of continuous assessment and testing, whereas only 37.1% reported that it was implemented. Third, the actual use of "other digital practices," including LMS reporting functions, automated scoring, and video-based instructional materials, exceeded teachers' expectations: 42.1% reported their actual use, compared with an expected level of 23.4%. This may indicate that some digital tools are more commonly integrated into practice than teachers initially anticipated [16].

3.2. Agile-related and test-based competencies in teachers' digital practice

The requirements of the digital education sector increasingly challenge traditional approaches to teaching and professional development. As Caena and Redecker [17] emphasize, digital competence in teaching extends beyond the technical use of digital platforms and encompasses broader pedagogical and professional capabilities, including adaptability, digital assessment, and the effective integration of technology into teaching and learning. Preparing teachers for AI-supported digital education therefore requires several complementary competencies. Schmidt *et al.* [18] propose structured prompt patterns for improving interactions with generative AI systems, while Zarivna [19] highlights the importance of communicative and pedagogical strategies in AI-enhanced educational environments. In addition, teachers should be prepared to critically evaluate AI-generated content because such systems may produce distorted or inaccurate information, commonly referred to as AI hallucinations [20]. Against this background, an important question arises: Which professional competencies are most relevant for university teachers seeking to meet the expectations of Kazakhstan's digital education sector?

To address this question, the questionnaire included the following multiple-choice item: "which elements of digital courses and practices have most contributed to the development of your professional competencies?" In parallel, a complementary analysis of labor market demand was conducted. Specifically, 70 job advertisements in the fields of EdTech, digital pedagogy, and educational technologies were collected from major Kazakhstani platforms, including hh.kz, LinkedIn, Zerocoder, Digital Nation, and university career centers. After manual filtering to remove duplicate and irrelevant postings, the requirements mentioned in the vacancies were coded and grouped into recurring competency categories. Based on the teachers' survey responses and the job advertisement data, several high-frequency competency areas were identified. The integrated results are presented in Figure 1.

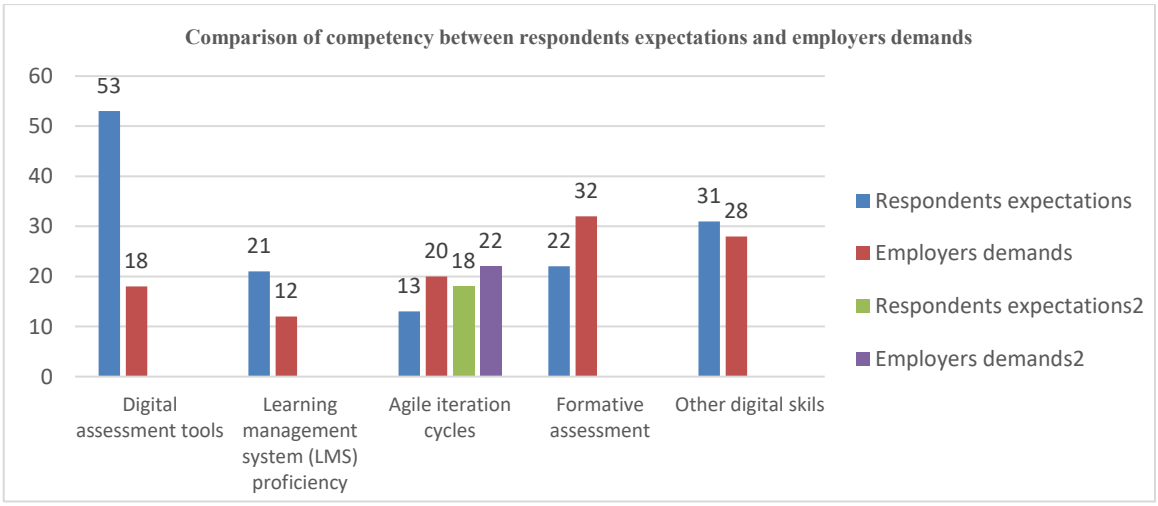


Figure 1. Comparison of teachers' reported competencies and employers' demands

The analysis revealed several important patterns. First, both teachers and employers placed considerable emphasis on digital assessment competencies, although the reported levels differed. Employers mentioned these competencies in 14% of the analyzed vacancies, whereas 52% of teachers identified digital testing and analytics as important for their professional development [21], [22]. The results show that digital assessment is viewed by teachers as a highly relevant area of professional growth. Second, the demand for practical experience with digital platforms and Agile-oriented work cycles was higher in the labor market than in teachers' reported training experience. For example, practical experience of this kind appeared in 28% of the analyzed vacancies, whereas only 19% of teachers reported sufficient preparation in this area. The results show the difference between university-based professional preparation and the practical expectations of the digital education sector [23]–[25]. Third, both teachers and employers recognized the importance of Agile-related competencies, such as feedback cycles and short-cycle instructional planning [26], [27]. These competencies appeared in 22% of the vacancies, while only 11% of teachers identified their own level of preparation in this area as sufficient. The results show that Agile-related competencies are increasingly relevant in digital education but remain underdeveloped in current teaching practice [28], [29]. The comparison revealed that teachers' professional development in digital education increasingly requires competencies related to Agile-oriented instruction, digital assessment, and learning analytics. At the same time, the comparison with labor market data suggests that these competencies are not yet being developed at a level fully aligned with the expectations of Kazakhstan's digital education sector.

3.3. Labor market requirements

The expansion of the EdTech sector and the increasing complexity of digital teaching tasks have made practical experience in real digital projects an important component of teachers' professional competence. As Stanja *et al.* [6] note, effective digitally supported teaching requires practical skills in the use of platforms, learning analytics, and formative assessment. To examine this trend, 70 job advertisements in the fields of digital learning, educational technologies, and EdTech projects were analyzed using data from major platforms, including hh.kz, LinkedIn, EdTech.kz, and related career sources. After screening the vacancies for relevance, employers' requirements related to practical experience were grouped into recurring categories, including participation in the development of online courses, implementation of digital assessment, use of learning analytics, and management of Agile-oriented micro-projects. These high-frequency requirements are presented in Figure 2.

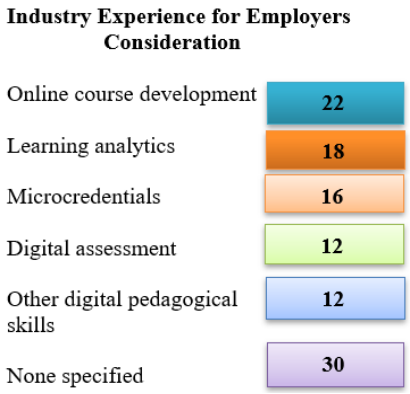


Figure 2. Employers' practical experience requirements in the digital education sector

The analysis revealed several important patterns. First, most employers require practical experience in digital projects. Depending on the category of vacancy, such requirements appeared in approximately 68%–72% of the analyzed postings. The results show that professional competence in the digital education sector is increasingly associated not only with theoretical knowledge, but also with applied experience in digital environments. Second, the most frequently mentioned areas of practical experience were the development and delivery of test-oriented modules (22%), work with learning analytics (18%), the design of short instructional cycles and Agile-related micro-processes (16%), and the management of LMS-based courses (12%). These findings indicate that employers expect teachers to possess not only digital literacy, but also the ability to apply digital tools in structured pedagogical practice. The comparison between teachers' survey responses and labor market requirements should be interpreted cautiously because the two datasets were derived from different sources and employed different measurement approaches. The teacher

survey reflects self-reported perceptions, whereas the job advertisement analysis represents employer expectations extracted through qualitative content analysis. Therefore, the comparison is intended to provide exploratory practical insights rather than direct statistical equivalence between the two populations.

4. DISCUSSION

The findings indicate that teachers in Kazakhstan's higher education system generally recognize the importance of Agile-oriented digital teaching, but the practical implementation of these approaches remains limited. The present findings are comparable with those reported by Martin *et al.* [5], who also observed that technological infrastructure alone is insufficient to transform teaching practices. However, unlike their multinational review, this study demonstrates that this gap remains particularly pronounced in Kazakhstan's higher education institutions [1], [5]. The first major finding concerns the gap between teachers expected and actual use of Agile-oriented practices. Teachers reported high expectations regarding iterative feedback, continuous assessment, and adaptive digital courses, but their actual use was considerably lower. This finding supports the view that Agile learning in education should be understood not only as a technical method, but as a pedagogical culture based on flexibility, short-cycle improvement, collaboration, and responsiveness to learner needs [1], [3]. From the perspective of constructivist learning theory, this gap is meaningful because effective digital learning should support active participation, feedback, and gradual knowledge construction rather than simple content delivery. The results also show that continuous assessment and test-oriented learning practices are valued by teachers, but they are not yet fully integrated into everyday teaching. This finding is in line with Redecker and Johannessen [10], who argued that information and communication technology (ICT)-supported assessment should move beyond traditional summative testing and support formative, continuous, and learner-centered assessment. Similarly, Stanja *et al.* [6] found that formative assessment supported by learning analytics can improve teachers' understanding of students' learning progress. Therefore, the limited use of continuous assessment in the present study indicates that teachers may need more practical training in designing digital tests, feedback cycles, and assessment-based instructional decisions. The findings are also consistent with the DigCompEdu framework [30], which conceptualizes educators' digital competence as a combination of technological, pedagogical, assessment, and learner-support capabilities. The observed gaps suggest that several competence areas proposed by DigCompEdu remain insufficiently developed among the participating teachers. This indicates that future professional development initiatives should address these competence domains more systematically to support effective digital transformation in higher education.

Another important finding is the relatively low level of teachers' engagement with learning analytics. Although learning analytics is increasingly viewed as a key component of digital education, many teachers still lack sufficient confidence and experience in using data for pedagogical decision-making. This result corresponds with the findings of Gašević *et al.* [11], who emphasized that learning analytics should be used to improve learning rather than merely to collect data. Ferguson [12] also noted that the development of learning analytics depends on teachers' ability to interpret digital traces and transform them into meaningful instructional actions. In this sense, the findings of the present study suggest that learning analytics literacy should become a core component of teacher professional development in Kazakhstan. The comparison with labor market requirements revealed a mismatch between teachers' reported competencies and employers' expectations in the digital education sector. Employers increasingly require practical skills in LMS management, digital assessment, learning analytics, Agile instructional planning, and digital communication. This result supports previous studies indicating that contemporary digital competence is broader than basic technical literacy and includes the ability to design, manage, evaluate, and improve digital learning processes [1], [17]. In practical terms, this means that university teachers should be trained not only to use platforms, but also to apply digital tools in real pedagogical and organizational contexts. The findings may also be interpreted through the TAM. Consistent with the TAM developed by Davis [31], the use of technology is influenced by perceived usefulness and perceived ease of use. In the present study, teachers generally recognized the usefulness of Agile-oriented and test-based digital practices, but their actual implementation remained limited. This suggests that positive attitudes toward digital tools are not sufficient for sustainable adoption if teachers lack practical experience, institutional support, or methodological confidence. Similar patterns have been observed in studies of digital competence and adaptive learning systems, where technological acceptance depends on both individual readiness and organizational conditions [3], [14].

The results are also consistent with the information systems success perspective, which emphasizes that successful digital systems depend on system quality, information quality, service quality, user satisfaction, and actual use. In the context of this study, the presence of LMS platforms, online testing tools, and digital resources does not guarantee effective educational outcomes unless teachers use these tools for feedback, assessment, and course adaptation. This supports the argument that digital transformation should be evaluated not only by the availability of infrastructure but also by the quality of pedagogical use and its

alignment with teachers' competencies [5], [10], [11]. The finding that "other digital practices" were used more frequently than expected is also meaningful. It suggests that teachers may be more familiar with routine digital functions such as LMS reporting, automated scoring, and video-based materials than with more complex Agile-oriented practices such as adaptive course redesign and iterative feedback. This is consistent with previous research showing that teachers often adopt surface-level digital tools before developing deeper forms of digital pedagogy [14], [24]. Therefore, professional development should help teachers move from basic platform use to more advanced forms of digital instructional design.

The study also confirms the importance of aligning teacher education with the changing demands of the EdTech and digital education labor market. The analysis of job advertisements showed that employers expect applied competencies in digital assessment, learning analytics, LMS-based course management, and Agile project-oriented work. This finding is consistent with studies showing that digital education increasingly requires interdisciplinary competencies that combine pedagogy, technology, analytics, and communication [6], [11], [29]. Therefore, universities should revise teacher training programs and professional development courses to include practice-oriented modules related to Agile pedagogy and test-based digital assessment [30]–[33]. Overall, the findings contribute to the literature by showing that Kazakhstan's digital higher education transformation requires a shift from infrastructure-based digitalization to competency-based pedagogical transformation. The results support previous studies emphasizing that digital education is effective only when teachers are prepared to use technology for feedback, adaptation, assessment, and evidence-informed instructional planning [1], [5], [10]–[12], [29]. Thus, Agile readiness and test-oriented digital assessment competencies should be considered essential components of contemporary teacher professionalism in digital higher education. Therefore, unlike previous studies that investigated Agile readiness or digital competence independently, this study integrates teachers' Agile readiness, assessment competencies, and labor market expectations within a single empirical framework, thereby extending current knowledge on digital transformation in higher education. Although the study was conducted in Kazakhstan, many higher education systems undergoing digital transformation face similar challenges related to Agile pedagogy, digital assessment, and competency development. Therefore, the findings may also be relevant for universities in other emerging and digitally transforming educational systems.

5. CONCLUSION

This study described teachers' Agile readiness, test-oriented digital assessment competencies, and labor market expectations, providing an exploratory comparison of these dimensions. The findings show that although teachers recognize the importance of iterative feedback, continuous assessment, adaptive digital courses, and learning analytics, the actual implementation of these practices remains uneven. The comparison with labor market requirements also indicates a gap between teachers' reported competencies and the practical skills expected in the digital education sector. The study contributes to digital pedagogy by showing that effective digital transformation requires not only technological infrastructure, but also Agile-oriented pedagogical readiness, digital assessment literacy, and competency-based teacher development. The findings also have practical implications for universities, teacher training institutions, and policymakers. Professional development programs should include targeted modules on Agile pedagogy, LMS-based feedback, digital assessment design, learning analytics, and adaptive instructional planning. The findings may also inform national policies related to teacher certification, digital competency standards, curriculum modernization, and continuing professional development within higher education systems.

This study has several limitations. First, the sample was limited to teachers from three Kazakhstani universities, which may restrict the generalizability of the findings. Second, the study relied mainly on self-reported questionnaire data, which may not fully reflect actual classroom practice. Third, the labor market analysis was based on selected job advertisements and may not capture all national trends in the digital education sector. Furthermore, because teachers' survey data and employer requirements were obtained from different populations using different methodological approaches, the comparison should be interpreted as exploratory rather than inferential. Future research should include a larger and more diverse national sample, combine survey data with interviews or classroom observations, and apply more advanced statistical methods to examine relationships between Agile readiness, digital assessment competencies, and teaching effectiveness. Longitudinal studies may also help determine how teachers' Agile and test-oriented competencies develop over time in response to digital transformation initiatives.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Zhandos Zulpykhar	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	
Dinara Meirgazina		✓		✓		✓	✓	✓	✓	✓	✓	✓		✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research related to human use has been compiled with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review board or equivalent committee.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [DM], upon reasonable request.

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BIOGRAPHIES OF AUTHORS



Zhandos Zulpykhar is a Candidate of Pedagogical Sciences, associate professor of the Department of Informatics of the Eurasian National University named after L.N. Gumilyov. His research interests include informatics, educational informatization, particularly the use of robotics and artificial intelligence in education. He can be contacted at email: astzhan@gmail.com.



Dinara Meirgazina is currently a Ph.D. candidate and serves as the Head of the Regional Testing Center of the National Testing Center of the Republic of Kazakhstan in Ust-Kamenogorsk. She received her bachelor's degree in Mathematics in 2003 and her a master's degree in Computer Science in 2007 from Sarsen Amanzholov East Kazakhstan University. Her research interests focus on the development of test-oriented agile learning systems within a digital educational environment. She can be contacted at email: dinara_ckt@mail.ru.