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## METHODOLOGICAL FEATURES OF USING GAMIFICATION ELEMENTS IN THE TRAINING OF FUTURE INFORMATICS TEACHERS

*Abstract*

This study investigates the methodological features of integrating gamification elements into the professional preparation of future Informatics teachers in higher education and digital learning settings. The research is grounded in a quasi-experimental mixed-method design that incorporates comparative and observational procedures. Analysis of both quantitative and qualitative data reveals that the use of gamification contributes to a notable increase in students' academic motivation, their level of engagement in the learning process, and the formation of methodological as well as digital competencies. Particular attention is given to the incorporation of gamification into the structure of academic courses and to the active role of the instructor as a facilitator of learning activities. At the same time, the study draws attention to possible challenges and constraints connected with students' attitudes toward gamified approaches and indicates directions for further research and pedagogical innovation. The outcomes may be applied in the development of contemporary teacher education programs that strengthen digital pedagogical culture and foster professional competencies in prospective educators.

**Keywords:** gamification, digital pedagogy, academic motivation, professional competencies, quasi-experiment, mixed methods.

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## БОЛАШАҚ ИНФОРМАТИКА МҰҒАЛІМДЕРІН ОҚЫТУДА ГЕЙМИФИКАЦИЯ ЭЛЕМЕНТТЕРІН ҚОЛДАНУДЫҢ ӘДІСТЕМЕЛІК ЕРЕКШЕЛІКТЕРІ

*Аннотация*

Бұл зерттеу жоғары білім беру мен цифрлық оқыту жағдайларында болашақ информатика мұғалімдерін кәсіби даярлауға геймификация элементтерін енгізудің әдістемелік ерекшеліктерін қарастырады. Зерттеу салыстырмалы және бақылау рәсімдерін қамтитын квази-эксперименттік аралас әдіснамалық дизайнға негізделген. Сандық және сапалық деректерді талдау геймификацияны қолдану студенттердің академиялық мотивациясын, оқу процесіне қатысу деңгейін, сондай-ақ әдістемелік және цифрлық құзыреттіліктерді қалыптастыруды едәуір арттыратынын көрсетті. Ерекше назар геймификацияны оқу курстарының құрылымына енгізуге және оқытушының оқу іс-әрекеттерін үйлестіруші әрі фасилитатор ретіндегі белсенді рөліне аударылады. Сонымен қатар, зерттеу студенттердің геймификацияға деген көзқарасына байланысты туындайтын қиындықтар мен шектеулерді айқындап, әрі қарайғы зерттеулер мен педагогикалық инновациялардың бағыттарын белгілейді. Алынған нәтижелер заманауи мұғалімдерді даярлау бағдарламаларын жетілдіруде қолданылып, цифрлық педагогикалық мәдениетті нығайтуға және болашақ педагогтардың кәсіби құзыреттіліктерін дамытуға ықпал ете алады.

**Түйін сөздер:** геймификация, цифрлық педагогика, оқу мотивациясы, кәсіби құзыреттілік, квазиэксперимент, аралас әдіс.

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## МЕТОДИЧЕСКИЕ ОСОБЕННОСТИ ИСПОЛЬЗОВАНИЯ ЭЛЕМЕНТОВ ГЕЙМИФИКАЦИИ В ОБУЧЕНИИ БУДУЩИХ УЧИТЕЛЕЙ ИНФОРМАТИКИ

### Аннотация

Данное исследование рассматривает методические особенности интеграции элементов геймификации в профессиональную подготовку будущих учителей информатики в условиях высшего образования и цифрового обучения. Исследование основано на квази-экспериментальном смешанном дизайне, включающем сравнительные и наблюдательные процедуры. Анализ количественных и качественных данных показал, что использование геймификации способствует значительному повышению академической мотивации студентов, уровня их вовлечённости в учебный процесс, а также формированию методических и цифровых компетенций. Особое внимание уделяется включению геймификации в структуру учебных курсов и активной роли преподавателя как фасилитатора учебной деятельности. Вместе с тем исследование обращает внимание на возможные трудности и ограничения, связанные с отношением студентов к игровым подходам, и обозначает направления для дальнейших исследований и педагогических инноваций. Полученные результаты могут быть использованы при разработке современных программ подготовки учителей, направленных на укрепление цифровой педагогической культуры и формирование профессиональных компетенций у будущих педагогов.

**Ключевые слова:** геймификация, цифровая педагогика, учебная мотивация, профессиональные компетенции, квазиэксперимент, смешанный метод.

**Introduction.** Modern education is marked by the dynamic integration of digital technologies, necessitating a reevaluation of traditional teaching methods and the preparation of a new generation of educators. In recent national education strategies, including the 2024–2025 address by the President of Kazakhstan Kassym-Jomart Tokayev, special emphasis was placed on digitalization, artificial intelligence, and innovative teaching approaches. These directions create favorable conditions for embedding gamification into teacher training as an effective instructional tool.

As shown by contemporary research, gamification has the potential to increase learners' motivation, engagement in the educational process, as well as develop cross-disciplinary competencies such as critical thinking, independence, and teamwork. However, the effectiveness of gamification in teacher training directly depends on the quality of its methodological implementation and its alignment with the educational context. This is particularly relevant when studying its impact on the professional training of future *Informatics* teachers — a discipline that requires a combination of technological and pedagogical literacy.

The scientific novelty of the present study consists in: (1) the development of an original three-level methodological model of gamification integration specifically adapted to Informatics teacher training in Kazakhstan; (2) the empirical substantiation of its effectiveness through a quasi-experimental design; and (3) the formulation of evidence-based methodological recommendations for course designers and instructors. Unlike prior works that treat gamification as a motivational supplement, this study positions it as a systemic pedagogical technology combining formative assessment, project-based learning, and quest-based instructional tasks into a coherent methodological framework.

With the growing influence of digital tools and the transformation of the educational environment, modernizing approaches to Informatics teacher preparation becomes inevitable. Within this framework, gamification is viewed not merely as a motivational element but as a pedagogical strategy that stimulates active learning, builds motivation, and develops professional competencies. As M.Ortiz-Rojas (2025) emphasizes, the use of game elements in teaching computer science significantly increases students' interest in the subject [1]. A similar opinion is expressed by M. Svanberg et al. (2023), who

found that game elements implemented in teacher education programs significantly improved academic achievement and engagement among pre-service teachers [2].

According to Z.Zhan (2022), gamification in programming education particularly enhances students' motivation and learning outcomes, especially when game mechanics like points, badges, and levels are well aligned with the curriculum [3]. This is also confirmed by the systematic review by E. Simsek & T.K. Yilmaz (2025), which showed that online learning environments with gamified elements are effective in improving both affective variables (motivation, participation) and cognitive outcomes in technology-rich subject areas [4].

Achievement systems, point-based ratings, levels, and quests have been shown to significantly boost engagement, support critical thinking, and sustain subject-related interest. E.V.Soboleva, N.L.Karavaev, and M.S. Perevozchikova (2017) underline the significance of such elements for maintaining learners' motivation and shaping methodological readiness in teacher education programs [5].

At the same time, N. Tokzhigitova et al. (2025) demonstrate that gamified assessment formats contribute to the development of methodological competence and support the professional orientation of future teachers [6]. Similar results were reported by R. Smiderle et al. (2020), who showed that badges, points, and leaderboards in programming courses enhance students' engagement and support sustainable learning motivation [7].

A.O.Aldabergenova et al. (2024) emphasized that quest-based formats foster teamwork, algorithmic thinking, and decision-making under uncertainty — qualities that are crucial for the professional preparation of Informatics teachers [8]. A.A. Bekezhanova and N. Qurmanbekqyzy (2024) found that using infographics as a gamified digital tool in programming education enhances visual thinking and motivation [9].

Progress-tracking systems allow learners to follow their individual development, shaping a growth mindset and reinforcing their self-efficacy. N.A.Kulikova and O.P.Merzlyakova (2021) argue that difficulty levels and the possibility of choosing individual trajectories stimulate cognitive activity and support the acquisition of cross-disciplinary competencies [10]. J. Simões R.D. Redondo, and A.F. Vilas (2013) add that, when properly designed, game-based tasks promote functional literacy, collaboration, and critical thinking among students [11].

Moreover, gamification creates a safe learning environment in which mistakes are perceived as part of the educational process. This reduces students' anxiety and contributes to deeper learning through repetition and active engagement. As summarized by M.S.Ararat-Isaeva (2023), game-based approaches strengthen not only knowledge acquisition but also the development of pedagogical abilities such as digital task design, reflective skills, and the adaptation of methods to diverse learners' needs [12].

A.Domínguez et al. (2013) emphasize that gamification supports the development of essential skills among students in teacher education programs, including the ability to select effective learning strategies, apply digital tools in instructional design, and maintain a balance between educational and game components [13]. A.Bozkurt et al. (2018) highlight that adapting gamification practices to local conditions is crucial, noting that blended learning models which combine online and offline activities with game mechanics have proven particularly effective for teacher preparation [14].

N.K.Baltabayeva et al. (2024) further argue that only systematic engagement with gamified IT resources enables students to develop self-organization, reflection, and decision-making skills [15]. E.Y. Bidaibekov, B.G. Bostanov, and S. Koneva (2024) analyze the current state of applying gamification in the training of future Informatics teachers in Kazakhstan, noting that although individual initiatives exist, a coherent methodological framework is still lacking [20].

A critical synthesis of the reviewed literature reveals several persistent gaps. First, the majority of studies focus on motivational outcomes while neglecting the development of methodological competencies as a distinct construct. Second, most experimental designs involve heterogeneous student populations rather than future teachers as a specialized group. Third, the local educational context of

Kazakhstan is underrepresented: while Bidaibekov et al. [20] and Ermakan et al. [17] provide national-level evidence, they do not offer an experimentally validated instructional model. Fourth, qualitative methods in existing mixed-methods studies rarely include systematic coding procedures, limiting their interpretive validity. The present study addresses these gaps by focusing specifically on future Informatics teachers, implementing a structured coding protocol for qualitative data, and developing an actionable methodological model grounded in empirical evidence.

Despite the expanding body of literature, several gaps remain. Many studies are fragmented, addressing either motivational or technological aspects, while comprehensive methodological models are underdeveloped. Furthermore, most experimental work focuses on general student populations rather than specifically on Informatics teacher training. Finally, task design, didactic alignment, and assessment mechanisms in gamified education are insufficiently elaborated within the national context.

**Materials and Methods.** This study contributes to the literature by combining a quasi-experimental design with a mixed-methods approach, enabling both quantitative measurement and qualitative analysis. Its novelty lies in focusing specifically on methodological features of gamification in Informatics teacher training in Kazakhstan — an area where theoretical foundations exist, but empirical validation is scarce.

*Table 1- Research questions*

RQ 1	To what extent does the integration of gamification influence the academic motivation of future Informatics teachers?
RQ 2	In what ways do game-based elements contribute to the development of methodological and professional competencies among students?
RQ 3	Which specific gamification design components (e.g., point systems, quests, digital visualizations) prove to be most effective in the educational context of Kazakhstan?

The purpose of this research is to identify and substantiate the methodological characteristics of applying gamification elements in the preparation of future Informatics teachers, with particular attention to their influence on student motivation and the development of professional competencies.

*Table 2- Levels and forms of gamification in the training of future Informatics teachers (compiled based on [1–19])*

Level	Examples	Pedagogical Role	References
Motivational	Achievement badges, point scales, rankings	Stimulating motivation, enhancing engagement	[3]; [5]; [6]
Methodological	Quests, scenarios, instructional games	Building pedagogical skills, instructional design	[2]; [7]; [10]
Digital / Instrumental	Online quiz tools, infographics, coding environments	Developing digital literacy and visual reasoning	[8]; [11]; [12]
Reflective–Analytical	Feedback-driven games, digital response tools	Formative assessment and reflection	[13]; [14]; [15]
Practice-Oriented	Teaching internships with gamification, case studies	Testing gamified models in real contexts	[9]; [15]; [18]
Interdisciplinary / STEM	STEM assignments, cross-subject projects	Project-based literacy and critical thinking	[1]; [12]
Qualification-Preparatory	Teacher training PD modules	Methodological readiness of instructors	[16]; [17]
Literacy-Oriented	Game-based activities for functional literacy	Communication, research, critical skills	[19]

In summary, the reviewed studies demonstrate that gamification plays an increasingly important role in the training of future Informatics teachers. Nevertheless, further empirical research is required to assess its effectiveness in the national context and to develop coherent methodological recommendations.

The present study was designed as a quasi-experiment with the application of mixed methods and was aimed at observing the effects of gamification on students' academic motivation. The research was conducted over one semester and included three stages:

*Stage 1. Baseline Assessment.* At the initial phase, the Academic Motivation Scale (AMS) was administered to measure students' starting levels of academic motivation. In addition, systematic observation and a preliminary evaluation of methodological competencies were conducted.

*Stage 2. Gamified Instruction.* During the second step, the course 'Methods of Teaching Informatics' was delivered with integrated gamification elements. These included online quiz platforms (Kahoot! and Quizizz), project-based assignments via the Blockland1.kz gamified platform, ranking systems, and collaborative tasks. Student progress was monitored through follow-up surveys, interviews, and continuous instructor observations.

*Stage 3. Outcome Evaluation.* At the final stage, the AMS questionnaire was reapplied and interviews were repeated. Comparative analyses between the experimental and control groups were conducted to identify changes in student motivation. The composition of the research sample is presented in Table 3.

Table 3. Characteristics of the Research Sample

Indicator	Description
University	Zhetysu University named after I. Zhansugurov (Taldykorgan)
Program	Informatics, Mathematics- Informatics
Year of study	2nd, 3rd, and 4th year students
Total participants	30 students
Group distribution	Experimental Group (EG) – 15 students; Control Group (CG) – 15 students
Distribution criteria	Based on average academic performance and ethnic composition
Baseline comparability	Academic records from the previous semester compared; no significant differences identified
Ethical considerations	Informed consent obtained; data anonymized

Prior to the application of parametric methods, the normality of score distributions was assessed using the Shapiro–Wilk test ( $n = 15$  per group). The test yielded  $W = 0.94$  ( $p = 0.38$ ) for the experimental group and  $W = 0.96$  ( $p = 0.51$ ) for the control group, confirming that the assumption of normality was not violated. Levene's test for equality of variances produced  $F = 1.12$ ,  $p = 0.31$ . Given the small group sizes ( $n = 15$  per group), Welch's independent-samples t-test was selected as the primary inferential method, as it does not require equal variances and is more robust for small samples. Degrees of freedom were estimated using the Welch–Satterthwaite approximation ( $df \approx 25$ ).

For data collection, both quantitative and qualitative approaches were applied. The AMS, consisting of 20 items, was used as the main quantitative tool due to its high reliability (Cronbach's  $\alpha = 0.81$ ) in assessing intrinsic, extrinsic, and amotivation factors in higher education. Qualitative data were obtained from interviews with ten volunteers in the experimental group, supplemented by reflective observation sheets kept by the instructor.

Statistical processing was performed using IBM SPSS Statistics v. 28 and Microsoft Excel. Given the small group sizes ( $n_1 = n_2 = 15$ ), Welch's independent-samples t-test was applied rather than Student's pooled t-test, as it does not assume equal variances and provides more robust results for small samples. The significance threshold was set at  $p \leq 0.05$ . Effect size was estimated using Cohen's  $d$ , and 95% confidence intervals (CI) were reported for all key comparisons.

Qualitative data obtained from interviews and reflective journals were analyzed following a systematic thematic analysis procedure (Braun & Clarke, 2006). The process comprised six steps: (1) familiarization with the data through repeated reading of transcripts; (2) initial open coding of recurring ideas and expressions; (3) grouping codes into candidate themes; (4) reviewing and refining themes

against the full dataset; (5) defining and naming themes; and (6) producing a thematic narrative linked to the research questions. Coding was conducted independently by two researchers, with Cohen's kappa coefficient  $\kappa = 0.76$  indicating substantial inter-rater agreement. Discrepancies were resolved through discussion and consensus. Three primary themes emerged: (a) perceptual shift from entertainment to professional tool, (b) development of methodological self-efficacy, and (c) barriers related to digital readiness and instructor competence.

Table 4- Example Fragment of the Reflective Sheet

Student Engagement	Team Activity	Responsibility	Notes
High, 80% engaged	Active interaction	Independent preparation	Noticeable increase in interest in the topic

It should be noted that the study involved only 30 students from a single institution, which limits broader generalization. Nevertheless, this pilot project provided useful insights into testing the methodology and refining gamification tools for potential scaling.

This study represents the first, pilot phase of a broader multi-institutional research programme currently underway. The 30-participant quasi-experiment conducted at Zhetysu University named after I. Zhansugurov was specifically designed as a methodological proof-of-concept, the findings of which will serve as the empirical basis for a subsequent large-scale replication across multiple universities in Kazakhstan. Follow-up studies with substantially larger and more diverse samples are planned, which will allow for greater generalizability and cross-institutional validation of the proposed methodological model.

**Results and Discussion.** The study yielded significant data indicating the positive impact of gamification elements on learning motivation, engagement, and the development of methodological skills in future Informatics teachers.

#### 1. Quantitative Results

To quantitatively assess the effectiveness of gamification in the educational process, academic motivation of students was diagnosed using an adapted version of the AMS, based on a 5-point Likert scale. The survey was conducted twice, once at the beginning and once at the end of the experimental period, which allowed for a clear comparison of progress across the groups.

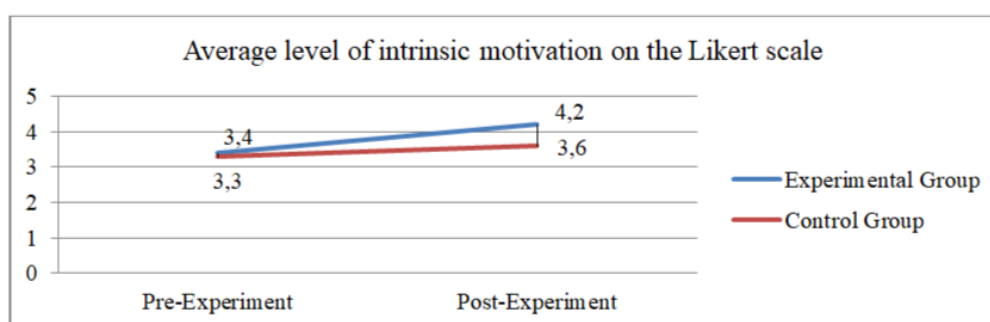


Figure 1 - Average level of intrinsic motivation on the Likert scale (Pre- and Post-Experiment)

Figure 1 presents the average intrinsic motivation scores. The experimental group, which was taught using gamification elements (Kahoot, quest-based tasks, and a rating system), demonstrated a significant improvement in motivation indicators. The average score increased from 3.4 to 4.2 (+0.8), while in the control group the growth was only from 3.3 to 3.6 (+0.3).

Welch's independent-samples t-test was applied to compare motivation gain scores (post – pre) between the two groups. With  $M_1 = 0.80$  ( $SD_1 = 0.365$ ,  $n_1 = 15$ ) for the experimental group and  $M_2 = 0.30$  ( $SD_2 = 0.255$ ,  $n_2 = 15$ ) for the control group, the calculated statistic was:

$$t = \frac{M_1 - M_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} = \frac{0.8 - 0.3}{\sqrt{\frac{0.133}{15} + \frac{0.065}{15}}} = \frac{0.5}{\sqrt{0.0089 + 0.0043}} = \frac{0.50}{0.115} \approx 4.35$$

Degrees of freedom (Welch–Satterthwaite approximation):  $df \approx 25$ . At  $\alpha = 0.05$  (two-tailed),  $t_{crit} = 2.060$ . Since  $t = 4.35 > 2.060$ , the null hypothesis is rejected ( $p < 0.01$ ). Effect size: Cohen's  $d \approx 1.54$  (large effect). 95% CI for the mean difference: [0.28; 0.72]. These results confirm that the difference in motivation gains between the groups is statistically significant with a large practical effect.

Further confirmation was obtained by analyzing high motivation rates, defined as responses of 4 or 5. As shown in Figure 2, the share of highly motivated students in the experimental group nearly doubled, rising from 45.0% to 82.5% (+37.5%). In contrast, the control group showed almost no progress, with only a 2.0% increase (from 44.0% to 46.0%).

These findings highlight the divergence between the groups and reinforce the effectiveness of gamification as a driver of academic engagement.

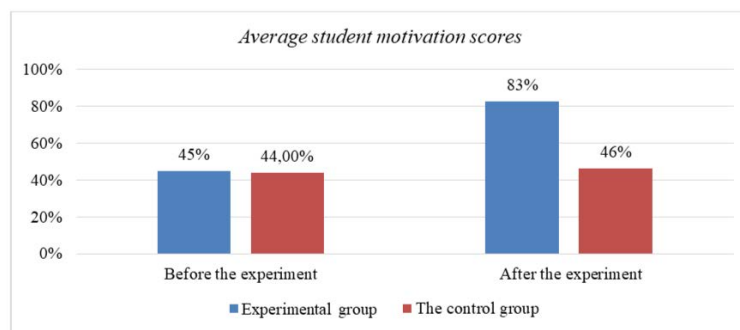


Figure 2 - Average student motivation scores (based on the Likert scale)

## 2. Qualitative observations and interviews

To complement the statistical results, qualitative data were collected through reflective questionnaires, interviews, and instructor observations.

### 2.1. Reflective Questionnaires and Open-Ended Comments

Thematic analysis of reflective questionnaires ( $n = 15$ , experimental group) yielded three primary themes: perceptual shift, methodological self-efficacy, and professional relevance. Typical student comments supporting the theme of professional relevance included statements about gamification helping them understand how to explain complex topics, about sessions feeling both useful and exciting, and about progress tracking sustaining their motivation.

### 2.2. Interviews

As part of the final evaluation, 10 interviews were conducted with students from the experimental group. Questions focused on perceptions of the learning format, sense of motivation, and understanding of the relevance of game-based technologies to their future professional activities.

Applying the thematic analysis protocol described in the Methods section, three themes were confirmed across interview transcripts. Under Theme A (Perceptual shift), students distinguished between superficial 'play' and structured pedagogical practice; 8 of 10 participants articulated this distinction explicitly. Under Theme B (Methodological self-efficacy), students expressed growing confidence in designing their own game-based lessons; 7 of 10 indicated they intended to apply

gamification in their teaching practice. Under Theme C (Barriers), 5 participants cited uneven digital literacy as a challenge, and 4 mentioned the need for stronger instructor scaffolding in the early stages of gamified instruction. These thematic findings directly address Research Questions RQ2 and RQ3.

### 2.3. Instructor Observations (Reflective Journal)

Observations revealed a gradual transformation of classroom dynamics:

- initial caution gave way to active participation by the second session;
- by the third week, self-directed preparation and mini-case development were evident;
- by the end of the course, students proposed their own game-based lesson models.

### 2.4. Final Summary

Qualitative evidence confirmed that gamification not only enhanced student motivation but also encouraged the development of professionally significant attitudes, including self-directed growth, willingness to experiment, and methodological awareness. The originality of this work lies in embedding gamification into Informatics teacher training as a systemic component, where formative assessment, project-based activities, and STEM integration were combined into a single pedagogical model.

Qualitative evidence confirmed that gamification not only enhanced student motivation but also encouraged the development of professionally significant attitudes, including self-directed growth, willingness to experiment, and methodological awareness.

When compared, the quantitative and qualitative data consistently demonstrated the positive contribution of gamification to the professional preparation of future Informatics teachers. These findings align with prior research [5], [7], [12], which also emphasized that game-based methods increase motivation and foster skills such as initiative, flexibility in teaching strategies, and confidence in applying digital tools.

*Table 5 - Risks and Limitations of Gamification Implementation*

Risk Factor / Limitation	Description
Perception of gamification as 'play'	Some learners dismiss game-based methods as unserious, undermining discipline.
Insufficient methodological training	Effective practice requires scenario design skills and digital competencies.
Uneven digital literacy	Varying skill levels may complicate teamwork and progress balance.
Assessment challenges	Game-based activities demand alternative evaluation strategies.
Technical constraints	Limited access to devices or connectivity restricts full-scale application.
Small sample size (n = 30, single institution)	Results cannot be directly generalized to other universities or regions without replication. Future research should involve multi-institutional samples.

Based on the findings of this study, the following concrete methodological recommendations are proposed for educators and curriculum designers seeking to integrate gamification into Informatics teacher training:

(1) Phased implementation algorithm: Begin with low-stakes quiz tools (e.g., Kahoot!, Quizizz) in weeks 1–3 to acclimatize students to game-based formats. Introduce project-based quest assignments in weeks 4–8, linking Blockland1.kz gamified programming tasks to curriculum topics. In weeks 9–14, transition students to independent gamified lesson design, presenting their models to peers for structured feedback.

(2) Gamification scenario template: Each gamified unit should specify: (a) learning objective aligned to professional competency; (b) game mechanics used (points, badges, levels, quests); (c) team/individual format; (d) assessment criteria distinguishing content mastery from engagement indicators.

(3) Instructor readiness: Prior to implementing gamification, instructors should complete at least 6 hours of professional development covering digital tool selection, scenario scripting, and facilitation of competitive/cooperative dynamics.

(4) Diagnostic toolkit: Use the AMS as a pre/post instrument for motivational tracking. Supplement with a Methodological Competency Checklist (MCC) assessing students' ability to design, facilitate, and reflect on gamified lessons — an instrument recommended for development and validation in future research.

**Conclusions.** The research demonstrated that the use of gamification in Informatics teacher education has a substantial influence on student motivation, engagement, and the acquisition of methodological skills. Quantitative results confirmed a statistically significant increase in intrinsic motivation among the experimental group, alongside a higher proportion of students actively participating in learning activities. Complementing this, qualitative findings from questionnaires, interviews, and instructor observations revealed that students perceived gamified formats as both pedagogically meaningful and professionally valuable.

A central conclusion of the study is that the effectiveness of gamification depends on its integration into the overall structure of the discipline rather than its sporadic or superficial application. Critical to this process is the role of the instructor, whose ability to adapt game mechanics to the needs of learners and to align them with pedagogical goals ensures sustainable results.

At the same time, several challenges remain. Among these are differing student perceptions of gamification — with some associating it with entertainment — as well as uneven levels of digital literacy and the methodological readiness of instructors. Technical constraints also pose practical barriers to the wide-scale adoption of game-based formats. Addressing these issues requires targeted professional development and institutional support.

The present study constitutes the first, pilot phase of a broader longitudinal research programme. Being conducted at a single institution with a limited sample ( $n = 30$ ), it was deliberately designed as a methodological proof-of-concept: to test the feasibility of the proposed gamification model, validate the data collection instruments, and identify areas requiring refinement before full-scale implementation. The statistically significant and practically meaningful results obtained ( $t_{\text{Welch}} = 4.35$ ,  $p < 0.01$ , Cohen's  $d \approx 1.54$ ) provide a strong empirical foundation for the next phase. A multi-institutional replication study is currently planned and will involve students from at least three universities across different regions of Kazakhstan, substantially larger cohorts, and extended observation periods of no less than two academic semesters. This follow-up research will address the primary limitations of the present study — namely, the restricted sample size, single-site design, and absence of long-term follow-up measurements — and will enable robust cross-institutional generalisation of the findings.

Promising directions for further investigation include: the development of a typology of gamified tasks for Informatics; the design of ready-to-use constructors for gamified lesson scenarios; and the creation of standardized diagnostic instruments for evaluating gamification effectiveness.

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