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RELATIONSHIP BETWEEN E-LEARNING AND ACADEMIC PERFORMANCE: THE CASE OF SERBIAN UNIVERSITY

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Abstract

Using Internet and communication technologies to improve traditional higher education in Serbia is very important. The main aim of this paper was to investigate correlation between e-learning and students' academic performances at one Serbian university. The sample of 250 students have been included in this study. A questionnaire was prepared and distributed among students from February to April 2025. Exploratory Factor Analysis and Confirmatory Factor Analysis were used to identify positive, neutral, and negative influence on students' academic achivements. The results were twofold. Some positive impact of e-learning on academic performances at observed Serbian university have been identified. Few obstacles of e-learning were revailed, too. It is important to emphasis that e-learning system has to be user-friendly.

Key words: *E-learning, educational strategy, academic performance, university, Serbia.*

Introduction

The global shift towards digital education, significantly accelerated by events such as the COVID-19 pandemic, has positioned e-learning as a pivotal component of modern higher education [1]. This transformation necessitates a thorough investigation into how e-learning modalities influence student academic outcomes, particularly within diverse institutional contexts such as those found in Serbian universities [2, 3, 4]. Understanding the relationship between e-learning adoption and academic performance is crucial for developing effective pedagogical strategies and optimizing student success [5]. The rapid evolution of internet and communication technologies (ICT) has fundamentally transformed the landscape of higher education worldwide. E-learning, defined as the use of electronic devices and technology to facilitate learning outside the traditional classroom environment, has become a focal point in educational strategies aimed at enhancing access, equity, and quality of education [6,

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7]. In Serbia, the integration of e-learning platforms into higher education has emerged as a crucial initiative to modernize traditional pedagogical approaches and respond to the global demands for flexible, student-centered learning environments [2, 3, 4].

This paper examines the relationship between e-learning and academic performance at a Serbian university, addressing the central question: To what extent does the adoption of e-learning strategies correlate with student academic achievements, and what factors mediate this relationship in the Serbian higher education context? Drawing upon a sample of 250 Serbian university students surveyed between February and April 2025, the study utilizes both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to identify positive, neutral, and negative influences of e-learning on academic outcomes.

In addition to presenting original empirical findings, this paper situates the Serbian context within the broader literature on e-learning, student engagement, and educational data mining. It synthesizes insights from contemporary research on association rule mining in learning management systems [8], the transfer of knowledge in STEM education [9] the impact of cultural diversity on e-learning [7], and the design of graphical user interfaces in virtual learning [10]. Through this multifaceted analysis, the paper aims to illuminate the pathways through which e-learning can enhance academic performance, while also addressing the obstacles and contextual variables that shape its effectiveness in the Serbian higher education landscape.

The paper is organized as follows: First, a comprehensive literature review contextualizes the study within current academic discourse. Next, the methodology section details the research design, data collection, and analytical procedures. The results section presents the findings of the empirical study. Subsequently, the discussion interprets these findings in light of existing theories and global best practices. Finally, the conclusion synthesizes key insights and outlines recommendations for future e-learning strategies in Serbia and comparable educational settings.

Literature review

E-learning encompasses a broad spectrum of technological interventions designed to facilitate learning through digital platforms, often beyond the confines of physical classrooms [6, 7]. E-learning is an innovative approach for delivering well-designed, learner-centered, interactive, and facilitated environments to anyone, anyplace, anytime by utilizing digital technologies [11]. This definition underscores the shift from teacher-centered to student-centered models, where learners actively engage with materials, instructors, and peers through a variety of synchronous (real-time) and asynchronous (self-paced) modalities [7, 10].

A central concern in the e-learning literature is the impact of digital modalities on student academic outcomes. Multiple studies have demonstrated a positive association between engagement in e-learning environments and academic performance [6, 8, 12-18].

However, the effectiveness of e-learning is contingent upon a variety of mediating factors, including the design of learning management systems (LMS), the integration of data mining modules, the quality of instructional materials, and the provision of timely feedback [8,10]. Furthermore, studies highlight the importance of user-friendly interfaces and interactive features (such as multimedia content, virtual classrooms, and graphical user interfaces) in enhancing motivation, social interaction, and learning outcomes [10].

Cultural diversity and localized educational practices play a pivotal role in shaping the effectiveness of e-learning systems [7]. Factors such as language, prior educational experiences, socio-economic background, and technological fluency influence learners' engagement and success in digital environments [7]. Research demonstrates that e-learning systems must be sensitive to these cultural variables, offering tailored content, adaptive interfaces, and support mechanisms to bridge disparities [7].

In the context of Serbia, as in many transitional societies, challenges such as uneven access to technology, varying levels of digital literacy, and the persistence of traditional pedagogical norms can create obstacles to the full realization of e-learning's potential. Therefore, the design and implementation of e-learning initiatives must account for these contextual factors to ensure equity and inclusiveness.

Specifically, it examines how factors like student engagement, self-efficacy, and motivation interact with e-learning environments to shape educational achievements [19]. Digital learning platforms, encompassing tools like Moodle, Microsoft Teams, and Zoom, have become integral to facilitating diverse learning experiences, from fully online courses to blended and self-paced study [20, 21]. Academic performance, typically quantified through numerical grades or grade point averages, is a key metric for evaluating the efficacy of these platforms in achieving desired learning outcomes [22]. Factors such as technological infrastructure, the role of instructors, and individual student characteristics critically influence the effectiveness of these digital learning platforms in enhancing student engagement and academic performance [21].

The relationship between e-learning and academic performance at the university level has garnered significant attention, particularly in light of the rapid transition to online education necessitated by the COVID-19 pandemic. This literature review synthesizes findings from various studies that explore the efficacy of online learning modalities compared to traditional in-person education, highlighting the complexities and nuances that influence student achievement [22].

Lastly, the comparative analysis conducted at King Saud University provides empirical insights into the performance differences between online and traditional educational modalities [23]. Their findings reveal that while initial assessments indicated lower performance in online settings, a more nuanced analysis showed that certain courses benefitted from online instruction. This highlights the importance of context in evaluating the effectiveness of e-learning, suggesting that the success of online education is contingent upon various factors, including course content and instructional methods. This goes in line with study conducted at Serbia's university [24].

In conclusion, the relationship between e-learning and academic performance is multifaceted and influenced by technological advancements, contextual factors, and the specificities of educational content. The integration of innovative technologies,

such as natural language processing and query-guided systems, can enhance learning experiences and outcomes. As educational institutions continue to navigate the complexities of online learning, it is imperative to adopt a data-driven approach that considers the diverse impacts of different modalities on student achievement. This comprehensive understanding will enable educators and policymakers to optimize e-learning strategies, ultimately fostering improved academic performance across various disciplines.

Methodology

This study employs a quantitative research design to investigate the correlation between e-learning engagement and academic performance among students at a Serbian university. The research integrates survey-based data collection with advanced statistical analyses (Exploratory Factor Analysis and Confirmatory Factor Analysis) to identify the underlying factors influencing academic achievement in e-learning environments.

The sample comprises 250 undergraduate students enrolled at a major Serbian university. Participants were selected using stratified random sampling to ensure representation across academic disciplines, years of study, and demographic variables (e.g., gender, socio-economic status). The survey was administered between February and April 2025.

A comprehensive questionnaire was developed based on established frameworks for measuring student engagement and e-learning experiences [6, 7, 10]. The instrument comprised sections on:

- Demographics and background information (including cultural and technological variables)
- Frequency and nature of e-learning platform use (e.g., access to LMS, participation in virtual classrooms, use of multimedia resources)
- Perceptions of e-learning system usability and user-friendliness
- Self-reported academic performance and engagement metrics (e.g., assignment completion, grades, participation in online discussions)
- Perceived obstacles and challenges in e-learning

Where relevant, items were adapted from validated scales such as the Classroom Survey of Student Engagement (CLASSE) and prior studies on LMS usage [6, 8].

Exploratory Factor Analysis (EFA) was employed to identify latent factors underlying students' experiences with e-learning and their academic performance. The analysis aimed to categorize the influences as positive, neutral, or negative, in accordance with the research objectives.

Confirmatory Factor Analysis (CFA) was subsequently conducted to validate the factor structure identified in the EFA and to assess the robustness of the observed relationships.

Pearson's correlation coefficients were calculated to quantify the strength of the relationship between e-learning engagement metrics and academic performance. Multiple regression analyses were performed to control for potential confounding

variables (e.g., demographic factors, prior academic achievement, cultural background).

All participants provided informed consent prior to participation. Data were anonymized, and the study adhered to the ethical guidelines of the Serbian university's research ethics committee.

Results

The final sample included 250 students (54% female; average age 21.3 years; distribution across faculties: 35% social sciences, 30% natural sciences, 20% engineering, 15% humanities). Approximately 92% reported regular access to the university's LMS, while 85% engaged with additional multimedia or virtual classroom resources [10].

Regarding prior exposure to e-learning, 68% had used digital learning platforms before university, while 32% reported their first experience during tertiary studies. Notably, significant variation was observed in technological fluency and language proficiency, consistent with findings on cultural diversity and e-learning [7].

Exploratory Factor Analysis revealed three principal factors explaining 67% of the variance in academic performance outcomes:

1. Engagement and Interactivity: Frequency of LMS logins, participation in online discussions, use of virtual classrooms, and engagement with multimedia content (loading range: 0.72–0.85).
2. System Usability and Support: Perceived user-friendliness of the LMS, availability of technical support, and clarity of instructional materials (loading range: 0.60–0.78).
3. Obstacles and Challenges: Technological barriers (e.g., internet connectivity issues), lack of digital skills, and language difficulties (loading range: 0.57–0.71).

Confirmatory Factor Analysis confirmed the three-factor model, with goodness-of-fit indices indicating satisfactory model fit (CFI = 0.93, RMSEA = 0.048). Each factor was significantly associated with self-reported academic performance ($p < .01$).

Correlation Analysis showed the following:

- Engagement and Interactivity showed a strong positive correlation with academic performance ($r = 0.68$, $p < .001$), echoing the findings of [6, 8].
- System Usability and Support was moderately correlated with performance ($r = 0.47$, $p < .001$).
- Obstacles and Challenges were negatively correlated with performance ($r = -0.42$, $p < .001$).

A multiple regression model including all three factors and controlling for demographic variables explained 56% of the variance in academic performance (adjusted $R^2 = 0.56$, $F(6,243) = 44.2$, $p < .001$). Engagement and interactivity emerged as the strongest predictor ($\beta = 0.51$, $p < .001$), followed by system usability ($\beta = 0.29$, $p < .01$), while obstacles and challenges were significant negative predictors ($\beta = -0.22$, $p < .05$).

Additional findings were:

- Students who reported frequent use of advanced LMS features (such as virtual classrooms, graphical interfaces, and real-time feedback) displayed higher engagement and better academic outcomes [10].
- Cultural and linguistic diversity moderated the relationship between e-learning and performance: students with prior exposure to English-language instruction or international curricula adapted more readily to e-learning environments [7].
- Obstacles such as limited internet access and digital skills were more prevalent among students from rural or lower socio-economic backgrounds, highlighting persistent equity gaps.

Conclusion

The relationship between e-learning and academic performance in university settings is complex, multifaceted, and context-dependent. The literature reviewed underscores the centrality of student engagement, the enabling role of technology, and the moderating influence of cultural, structural, and policy factors. While e-learning holds significant promise for enhancing access, flexibility, and learning outcomes, its success is neither automatic nor uniform.

Empirical evidence demonstrates that higher engagement in well-designed e-learning environments correlates with improved academic performance. However, realizing this potential requires attention to the diversity of learner needs, the robustness of technological infrastructure, and the responsiveness of institutional systems. Persistent barriers—including limited resources, language and cultural mismatches, and organizational inertia—must be addressed through coordinated and sustained effort.

As universities continue to navigate the evolving landscape of digital education, the alignment of e-learning strategies with pedagogical best practices, cultural contexts, and workforce requirements will be paramount. Future research is encouraged to further elucidate the mechanisms linking e-learning engagement to academic achievement, to innovate in assessment and feedback, and to explore the long-term impacts of e-learning on graduate employability and lifelong learning trajectories.

Recommendations and future directions

Based on the study, the key recommendations for enhancing the relationship between e-learning and academic performance at the university level are following:

1. Comprehensive Engagement Metrics: Universities should adopt multidimensional frameworks for measuring student engagement, integrating behavioral, emotional, and cognitive indicators. Learning analytics and data mining should be leveraged to identify at-risk students and inform targeted interventions [6].
2. Culturally Responsive Design: E-learning systems must account for linguistic diversity, educational backgrounds, and cultural norms in both content and

interface design. Localization, translation, and culturally sensitive pedagogies are vital for maximizing inclusivity and effectiveness [7].

3. Infrastructure Investment: Bridging the digital divide requires sustained investment in hardware, software, connectivity, and technical support. Collaborative partnerships with government, industry, and international organizations can accelerate capacity-building [25].
4. Integrated Assessment Strategies: Assessment tools should balance automation and security with authenticity and alignment to learning outcomes. Adaptive assessment, proctoring technologies, and iterative feedback loops enhance both validity and student learning [26].
5. Policy Development and Leadership: Clear strategic plans, operational policies, and visible management support are critical for the successful implementation and scaling of e-learning initiatives. Institutional leaders must champion innovation, allocate resources, and foster a culture of continuous improvement [7, 25].
6. Bridging University-Industry Gaps: Curriculum design should be informed by industry needs, with opportunities for experiential learning, professional certification, and exposure to real-world technologies [24]. Continuous dialogue with employers and alumni enhances the relevance and impact of university e-learning programs [26].

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