

метод DEMATEL в качестве концептуальной рамки, позволяющей рассматривать компетенции как элементы единой системы.

Результаты исследования показывают, что рынок труда акцентирует внимание на таких характеристиках, как мотивация, адаптивность, инновационное мышление, профессиональная подготовка и способность поддерживать баланс между работой и личной жизнью, которые формируют основу эффективного функционирования проектных команд. В то же время компетенции, связанные с управлением взаимодействием, разрешением конфликтов и коммуникацией со стейкхолдерами, проявляются преимущественно в ответ на организационные и контекстуальные условия.

Полученные выводы подчёркивают необходимость применения системных подходов к оценке и развитию компетенций в проектной среде. Интеграция структурированных аналитических инструментов в практику управления проектными офисами способствует повышению обоснованности управленческих решений и эффективности формирования проектных команд.

Ключевые слова: человеческий капитал; проектное управление; контент-анализ; компетентностный подход; DEMATEL; формирование проектных команд; организационная эффективность.

Информация о финансировании

Данное исследование финансируется Комитетом науки и высшего образования Министерства науки и высшего образования Республики Казахстан (грант № AP26102429 «Повышение подотчетности и прозрачности при планировании и реализации цифровых проектов в государственном управлении на основе применения проектного менеджмента в Республике Казахстан»).

ABOUT THE AUTHORS

Ismailova R. S. – Doctor of Economic Sciences, Professor, Astana IT University, Astana, Kazakhstan, e-mail: r.ismailova@astanait.edu.kz, ORCID ID: 0000-0003-1476-9542

Satpayeva D.S. – PhD Student, Candidate of Economic Sciences, Professor, Astana IT University, Astana, Kazakhstan, e-mail: nur7725@gmail.com, ORCID ID: 0000-0001-8513-2843*

Ibadildin N. – PhD, Associate Professor, Astana IT University, Astana, Kazakhstan, e-mail: ibadildin.nurkhat@astanait.edu.kz, ORCID ID: 0000-0002-6352-8713,

MPHTI: 06.52.13

JEL Classification: M20

DOI: <https://doi.org/10.52821/2789-4401-2026-2-72-89>

THE ROLE OF AI-BASED EDUCATIONAL PLATFORMS IN HUMAN CAPITAL BUILDING

A. M. Kassenkhan¹, A. Bekarystankyzy^{2*}

¹Satbayev University, Almaty, Kazakhstan

²Narxoz University, Almaty, Kazakhstan

ABSTRACT

Purpose – This paper examines the relationship between AI-driven educational platforms, economic efficiency, and human capital formation in the context of digital transformation in education. It focuses on extra-curricular education and considers how AI-enabled personalization and gamification may contribute to more efficient learning processes and to the development of cognitive and non-cognitive skill

Methodology – The study adopts an exploratory analytical approach grounded in human capital theory and the economics of education. It uses a conceptual framework to assess an AI-based extracurricular learning

platform in terms of learning productivity, scalability, resource utilization, and potential human capital outcomes. The analysis is based on the interpretation of platform mechanisms in relation to insights from recent literature.

Originality – The paper contributes to the literature by integrating three perspectives that are often examined separately: AI-based educational platforms, economic efficiency in education, and human capital development. It offers a structured analytical framework for considering how personalization and engagement mechanisms may be interpreted from an economic perspective.

Findings – The study suggests that AI-driven educational platforms may enhance educational efficiency by supporting scalable delivery, reducing coordination burdens, and improving the alignment of learning activities with learner needs. It also indicates that such platforms may support human capital formation through the development of critical thinking, autonomy, motivation, and adaptability when implemented within an appropriate pedagogical framework. However, the findings are exploratory and should be interpreted as analytical rather than as direct empirical evidence.

Keywords: artificial intelligence, human capital, economic efficiency digital education, personalized learning, gamification

Gratitude: This research has been funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. BR24993072).

Бұл зерттеуді Қазақстан Республикасы Ғылым және жоғары білім министрлігінің Ғылым комитеті қаржыландырды (грант № BR24993072).

Данное исследование было профинансировано Комитетом науки Министерства науки и высшего образования Республики Казахстан (грант № BR24993072).

INTRODUCTION

The development of human capital is generally understood as a basic engine for economic growth and competitiveness. In the current knowledge economy, the importance of human capital is increasingly tied not only to educational attainment but also to the development of higher-order cognitive skills such as critical thinking, analysis, adaptability, and self-directed learning skills. Such skills are crucial for a resilient workforce in the face of technological change and structural shifts in the economy.

As a result, there is increasing pressure on education systems to not only improve learning outcomes but also the economic efficiency of learning processes. The traditional learning system often uses a one-size-fits-all approach to learning, which hinders scalability and results in inefficient allocation of learning resources. From an economic perspective, this hinders productivity in the education sector and reduces the long-run return on public and private investments in human capital.

As a result of such challenges, education platforms based on artificial intelligence have become a promising solution to improve not only learning effectiveness but also economic efficiency. These platforms based on artificial intelligence make it possible to implement personalized learning processes, automated content suggestions, adaptive testing, and immediate feedback. Thus, such platforms allow educational institutions to maximize learning inputs, cut time and coordination costs, as well as increase learning productivity without increasing operating expenses. As a result, education based on artificial intelligence is increasingly viewed not only as a pedagogical innovation but also as a relevant economic tool of human capital development.

There is an emerging body of literature that points to the important relationship that exists between personalized learning environments and the development of human capital. From the literature, adaptive computer-based learning systems have been shown to improve the motivation of the learner, enhance cognitive performance, as well as the development of skills that are strongly related to the concept of employability. Additionally, the concept of gamification in computer-based systems has been shown to enhance motivation, thus the effectiveness of investment in education.

This can be gauged by looking at the dynamics of research publication over time in the major scientific databases. As shown in Figure 1, the number of research papers related to artificial intelligence in education, human capital development, digital educational platforms, and economic efficiency in education gradually increases over time from 2018 to 2025. Additionally, research papers related to artificial intelligence in educa-

tion are growing at a fast rate, indicating an increase in the application of AI in educational contexts. At the same time, research papers related to human capital development and economic efficiency in education are gradually showing an upward trend, indicating an increase in the economic investment aspect of education.

This highlights an emerging interdisciplinary focus on evaluating educational technology from an economic and human capital point of view. Though existing scholarship has mainly focused on evaluating either its efficacy or performance, very little scholarship has been conducted on an economic analysis of how AI-enabled educational technology can enhance resource efficacy and overall human capital, especially in terms of extracurricular schooling, which has an important bearing on cognitive and non-cognitive skill development outside of traditional schooling.

This study fills an important gap by assessing the economic efficiency and the role of human capital within an educational platform that incorporates artificial intelligence for extracurricular educational purposes at schools. The educational platform incorporates artificial intelligence for personalization and gamification for effective content delivery and skill development. The study examines the economic efficiency of the platform to understand the role of digital educational tools in improving the productivity and social return on investment within the educational sector for the development of human capital. The results have important implications for policymakers, institutions, and other stakeholders interested in economically feasible approaches for the development of human capital through digital transformation in the educational sector.

Research Aim and Contribution

The aim of this study is to examine the economic efficiency of an AI-driven educational platform in the context of human capital formation, with a particular focus on extracurricular education. The study seeks to provide an analytical perspective on how AI-based personalization and gamification mechanisms can be interpreted as factors influencing learning productivity, scalability, and resource efficiency.

The contribution of the paper is threefold. First, it integrates the perspectives of human capital theory, economic efficiency in education, and AI-driven learning platforms within a unified analytical framework. Second, it proposes a structured approach for evaluating AI-based educational platforms using qualitative economic indicators such as learning productivity, scalability, and resource utilization. Third, it extends the discussion of digital education by linking personalization and engagement mechanisms to broader economic outcomes related to human capital development.

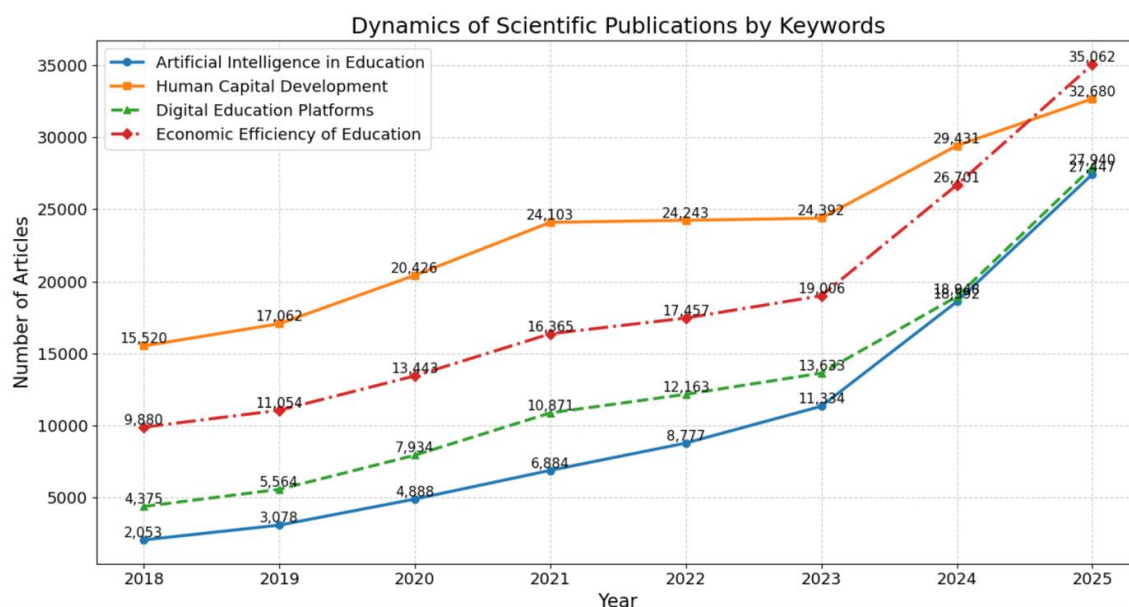


Figure 1. Dynamics of scientific publications indexed in ScienceDirect by selected keywords related to artificial intelligence in education, human capital development, digital education platforms, and economic efficiency of education (2018–2025)

LITERATURE REVIEW

This section provides an overview of the literature on human capital development, the efficiency of educational systems from an economic point of view, and educational platforms that are based on artificial intelligence. This structure of the section corresponds to the interdisciplinary nature of the research problem and provides a conceptual framework for the subsequent analysis.

To begin, the literature on the theory of human capital is analyzed in order to provide a theoretical basis for the concept of education as an investment. This is followed by the review of literature that focuses on the economic efficiency of educational systems, particularly in terms of the allocation of resources, productivity, as well as returns in the long term. This is followed by the review of literature that focuses on the economic implications of AI-based educational platforms, as well as the concept of personalized learning as a means of promoting the formation of human capital.

Human Capital Theory and Education

The human capital theory provides a basic theoretical foundation for the application of education and human development as a crucial element within the context of economic growth and productivity. In this theory, human capital development is seen as a fundamental driver within the context of individual productivity as well as overall economic performance.

Recent empirical studies extend a classic view of human capital as a function of educational attainments with a wider perspective on human development issues. Guo et al. (2025) analyze a panel data set of 31 Chinese provinces from 2003 to 2021 and investigate how public health expenditures influence economic resilience and its relationship with health-related human capital accumulation and labor productivity and optimal restructuring of the economy as a whole. The findings of this study support a human capital approach and highlight that public expenditures on human development are a crucial factor in ensuring a stable economy [1].

At the same time, the theoretical basis of human capital theory has been critically reviewed. According to Edeji (2024), the theory of human capital must be considered in the broader context of the neoliberal economic order, because the focus of modern education is on the market outcome of employability, skills, and productivity. While the economic perspective of education is in consonance with the developmental priorities of the state, it is necessary that education is not considered in terms of its utility function alone, because of the conflict that may arise in terms of the social and developmental role of education (Edeji, 2024) [2].

In a similar fashion, the work of MacKenzie & Chiang (2023) questions the hegemony of for-profit discourse on human capital, especially in relation to education equity and agency for students. From the theory of human development and the capability approach, the authors show that education outcomes are determined not only by skill-building but also by structural factors of constraint and agency, especially for students from low socioeconomic backgrounds. The study highlights the limitations of for-profit thinking on education and the need for a more inclusive capability-based education paradigm [3].

Further evidence from empirical studies also shows that the process of human capital formation is firmly grounded within intergenerational, institutional, and cultural settings. Wang et al. (2024) investigate the impact of parental participation in China's Household Responsibility System land reform on educational investment decisions for the next generation as a result of exposure in early life. Based on micro-data, the authors show that greater exposure of parents to the land reform significantly raises educational investment for their children through several pathways, such as parental income, wealth, human capital, and better public services. The results show significant regional and educational heterogeneity, implying that the process of human capital formation takes place through several economic-institutional mechanisms across generations [4].

The early stages of the development of human capital are also affected by social and cultural elements. Using the place-based analysis with 103 Italian provinces, Ripamonti (2023) finds that cultural capital, rather than economic capital, is the key driver for participation in center-based early childhood education in the short- and medium-term periods. Using structural equation modeling, the findings show that cultural capital mediates the historical economic impacts, which highlights the continued importance of cultural capital in early educational participation. This highlights the development of the human capital theory, which finds that early educational investment is highly dependent on cultural factors before the start of education proper [5].

To complement this approach, Wang et al. (2026) examine socioeconomic inequalities in the early emergence of non-cognitive skills in kindergarten children in Hangzhou, China. Employing a combination of machine learning algorithms and econometric analysis, the authors pinpoint parental income and parental university education as the strongest predictors for the emergence of non-cognitive skills. Children from more income- and education-advantaged families exhibit a strong “double advantage” in terms of communication, self-regulation, autonomy, and socialization skills. Parenting quality and economic investments are found to be crucial intervening factors, indicating that inequalities in human capital formation begin at an exceptionally early life stage and remain persistent over time [6].

The impact of education policies related to human capital accumulation is further qualified by findings related to the development of non-cognitive abilities. Entorf and Dohmen, in their study published in 2025, use education policy changes in four developing countries to examine the causal relationship between increased compulsory education and personality and economic preference traits. The study finds that, although some personality and economic preference traits increase, others, such as emotional stability, grit, patience, and risk tolerance, decrease. This study underlines the shortcomings of education policy based only on quantity and the need for education policy based on the human capital approach to be context-specific and targeted [7].

Recent developments in the field of behavioral genetics further add to the complexities of human capital theory. Buser et al. (2024) use the Swedish Twin Registry and administrative data to estimate the causal effects of genes associated with cognitive and non-cognitive skills and their impact on education and the labor market. By leveraging within-family variation in genes, the authors show that polygenic scores for cognitive and personality traits have a strong impact on income, occupation, and education. By comparing within-family estimates to OLS estimates, the authors demonstrate that associations between skills and economic outcomes capture both exogenous individual variation and institutional settings. The results show a considerable degree of variation in skill distribution and that education and labor market outcomes are jointly determined by individual and institutional factors [8].

Taken together, these studies make it clear that the issue of human capital formation is a complex and context-sensitive process that is affected by a number of economic, institutional, cultural, and individual factors, and that this complexity is what is increasingly addressed through online educational platforms that use AI technology.

Economic Efficiency in Education Systems

In more contemporary economics literature, education systems are viewed more and more not only as social institutions but also as strategic spheres of investment, where efficiency plays a pivotal role in shaping economic performance over time. From this stance, education is judged on its ability to turn inputs of finance, technology, and institutions into steady productivity growth.

At the macroeconomic level, Kirikkaleli and Kirikkaleli (2025) have found concrete and strong empirical support for the growth function of investment in artificial intelligence (AI)-assisted educational and training expenditures in the United States. Using data from 2012 to 2022 and applying the techniques of Fourier ADL, DOLS, and CCR, the study reveals the existence of a long-run relationship among GDP, the workforce, capital accumulation, and educational investment in the form of AI-assisted educational expenditures in the United States and that the increase in the latter has a significant and positive effect on economic growth, independent of the conventional growth factors of the economy. In this study, the role of AI-assisted education is highlighted as a factor that improves the efficiency of the workforce and capital, thereby presenting the investment in educational technology as a highly effective growth strategy at the macroeconomic level, and not just a social expenditure [9].

Though investment magnitude matters, it is important that educational spending efficiency is critically dependent on investment allocation and management practices. While dealing with this problem, Drama et al. (2025) analyze the efficiency of public investment in each sector among 75 developing countries from 2002 to 2022, utilizing Data Envelopment Analysis and Stochastic Frontier Analysis methods. The result shows that the educational and health sectors outperform any other public investment category regarding efficiency on average, although they remain with considerable inefficiency with 16% efficiency gains possible

with improved management practices. The major drivers of efficiency are found to be institutional factors, particularly anti-corruption and rule of law practices. This result clearly manifests that efficiency in education is dependent on investment amount as well as institutional quality, and hence, efficiency innovations and management practices are important in a resource-poor educational setting [10].

It is also necessary to take into account extended time horizons in evaluating the efficiency of the education system because, by definition, building human capital is a long-term process. Stenberg (2022) examines whether there are multiplier effects and human capital depreciation in adult formal education by studying Swedes with as many as 24 years of follow-up. Employing a propensity score matching technique, the author finds that absolute returns to earnings from adult education also continue to increase beyond the typical 5-10-year period considered in previous studies. Even as percentage returns converge over time, the fact that absolute returns persist suggests that education is a hardy and enduring form of human capital [11].

In addition to their contribution to earnings, education systems also play a significant role in economic efficiency in terms of more general structural processes, including entrepreneurship and innovation. Zhi et al. (2025) use panel data of 288 cities in China between 2006 and 2023 to examine the impacts of higher education on quality economic development. Using fixed-effect models in combination with robustness tests and corrections for endogeneity, the authors find that higher education significantly improves the quality of economic development by improving human capital and promoting innovation. Mediation tests reveal that the share of entrepreneurial dynamism, measured by the creation of new firms, is about one-tenth of the total impact of higher education on economic development quality. Most importantly, the study reveals that there are large institutional differences across cities, where those that foster policy environments for entrepreneurship show significantly greater economic rates of return on education investments. These results taken together illustrate that education systems improve economic efficiency not only by accumulating skills but also by facilitating entrepreneurial environments that turn knowledge into economic activities [12].

The connection between education and economic efficiency is also influenced by the quality of cognitive abilities. In re-evaluating the role of education in economic growth during the twenty-first century, Boman (2024) investigates the PISA dataset together with the composite measure of cognitive ability for as many as 80 countries. The results show that the role of cognitive ability continues to have predictive power regarding economic growth between 2010 and 2019 despite the inclusion of a wide range of control variables. However, the degree of this association varies significantly across different regions with political instability and economic structural changes affecting the role of education in economic growth. This view supports the human capital theory with the observation that the economic efficiency of education depends on the presence of complementary factors [13].

At the micro-level, the efficiency of educational systems depends on pedagogical design and delivery. Providing rigorous experimental evidence, Agasisti et al. (2025) evaluate the effectiveness of a national financial education program conducted for Italian primary and secondary schools through two randomized controlled trials. The study shows that the delivery by teachers results in a large positive effect on financial knowledge, whereas the distribution of study materials without guided instruction results in no effect, except for the socio-economically advantaged students. In addition, organized class-room teaching results in an improvement in non-cognitive skills, such as patience and the ability to save for the future, with stronger results for the young and disadvantaged students. Taken together, the results clearly illustrate the importance of instructional design and delivery for the achievement of efficiency and equity goals in educational systems [14].

Cumulatively, it appears from the existing literature that economic efficiency in education systems is a function of macro-investment approaches, the level of institutional quality, human capital formation, and micro-instructional approaches. Investments in AI-enabled and digital education have the potential to greatly enhance economic efficiency although this remains dependent on existing governance and contextual parameters. The existing body of knowledge, therefore, indicates that efforts to enhance economic efficiency in education must go beyond mere investments and must seek innovation in education, governance, and delivery approaches. Within this context, digital and AI-enabled education platforms have the potential to act as effective instruments for enhancing productivity and scale, depending on existing parameters of institutional quality and human capital.

AI-Based Educational Platforms and Economic Outcomes

The dynamic spread of artificial intelligence has completely changed the role of educational platforms, making them crucial mediators between technological change, human capital, and economic performance.

The current state of scholarship increasingly suggests that AI-based educational platforms influence economic performance not only through increased learning efficiency, which was a traditional focus, but through shaping labor market incentives and productivity complementarities.

In a cross-country perspective, the relationship between the advancement of AI and the educational progress driven by human capital is explored in 29 countries over the years 2017–2021, as examined in the study of Tian and Zhang (2025). Their findings show a significant and positive relationship in the data between the advancement of AI and educational outcomes that contribute to the growth of human capital. In this study, it is found that the relationship is heterogeneous, where the positive relationship is stronger in developing countries and in the context of the COVID-19 crisis, where online educational platforms became a necessary substitute for the traditional educational process. A mechanism study indicates that the advancement of AI affects the decisions of educational investments through the labor market, where the increase in the gap in wages increases the incentive of individuals to invest in learning and acquiring education and skills [15].

The relevance of the adoption of AI-based educational platforms is inextricably tied to the underlying conditions of human capital, and the ability of organizations and societies to adopt and use highly advanced technologies is dependent on this factor. In a study that focuses on the adoption of AI technology in different countries and industries in Europe, utilizing EUROSTAT data, Brey and van der Marel (2024) conclude that the difference in human capital is a factor that explains one-third to one-half of the total difference in the adoption of AI technology among different countries and industries in Europe. Their results suggest that organizations that use more university-educated staff are more likely to adopt the use of AI technology, specifically in the area of processes that require automation and machine-based production processes, and this is a technology that is specifically designed for the purpose of automation, yet it does not lead to a reduction in the total number of jobs in the short-term period. These findings collectively suggest that education and skills are complementary factors that help organizations achieve productivity benefits through the adoption of technology, and not displace jobs [16].

Despite the efficiency of knowledge dissemination by AI-based platforms, the current state of evidence in educational interventions confirms that purely technological approaches are ineffective in ensuring lasting human capital effects. A summary of the experimental evidence by Llamosas García & Mazas Pérez-Oleaga (2025) explores financial literacy programs using a deep learning classification approach coupled with multivariate statistics. This summary confirms the short-term effects of improved financial literacy, which are often short-lived without persistent reinforcement. It should be noted, however, that this study finds no significant or persistent effects of digital platform delivery modes or monetary rewards. This line of evidence indicates the necessity of adaptive learning approaches in AI-based digital educational platforms for lasting economic benefits, rather than mere technological undertakings [17].

Another set of complementary empirical evidence comes from a field experiment on a low-cost and scalable online financial educational program targeting middle-aged and older individuals, as investigated by Clark et al. in 2025. The evidence shows that educational stories are effective in increasing financial knowledge in a short-term period, with a strong and persistent effect on risk diversification, and that knowledge on other subjects weakens over time with no significant behavioral changes observed within an eight-month timeframe. This evidence underscores that although online and AI-based educational platforms are cost-effective tools of knowledge dissemination, it is important to sustain engagement with them in order to translate knowledge into behavioral and economic outcomes [18].

However, besides the learning achievements, the role of AI-driven education platforms in economic performance is realized by their engagement with the productivity process at the firm level. Park et al. (2026) offer empirical evidence at the firm level from the United States, based on job postings from 2014 to 2023, demonstrating that the adoption of AI leads to a substantial increase in total factor productivity. However, the extent of such productivity gains differs greatly across industries based on the degree of complementary factors and innovation properties. The manufacturing sector records the greatest gains, while within the services sector, gains are realized in the education, health care, public administration, information, and utilities industries. Most importantly, productivity gains are less sensitive to a firm's theoretical vulnerability to AI adoption but rather its usage patterns, with exploitative use recording greater gains than exploratory use [19].

From a more macro-theoretical standpoint, the work by Chigbu and Makapela (2025) brings together the concepts of Industry 5.0, Education 5.0, and Work 5.0 within a comprehensive framework centered on human-

ity as a foundation for transformation with artificial intelligence. This review article specifically points out that the economic value within AI-driven educational platforms is primarily derived from their ability to support human-AI collaboration rather than from their ability to replace human capital. The development of skills, curriculum alignment with industries, as well as sustainability, are highlighted as significant mediating factors within the relationship between education systems and labor market performance and productivity. However, there are also concerns regarding the possibilities of deskilling and increased inequalities within this framework, as highlighted by the authors [20].

Kumar et al. (2025) offer micro-level observations on the functioning of AI-driven educational platforms, analyzing the adoption of generative artificial intelligence in management education using the constructs of AI-human augmentation and expectation-confirmation theory. Based on qualitative findings from students and faculty, the observations suggest that generative AI has the potential to augment learning productivity, personalization, engagement, and readiness in the industry. However, the aspects of ethics, skill gaps, and institutional preparedness continue to be relevant. The observations suggest that the educational and economic potential of generative AI depends on effective human-AI collaboration and related enabling and supportive structures and processes. This perspective, in combination with economic observations, highlights the conditions and circumstances in which AI-driven educational platforms can deliver sustainable human capital returns [21].

In general, the current literature suggests that the economic implications of AI-based educational platforms are driven through a set of complex and interlocking channels, such as human capital development, adoption of AI, productivity, and alignment of the labor market. However, the performance of these platforms is dependent on the availability of complementary skills, quality of institutions, educational design, and the framework of governance. In contrast to the autonomous forces of productivity, the use of AI-based educational platforms can contribute to economic value in the context of inclusive and human-centered human capital environments.

Personalized Learning and Human Capital Development

Recent advances in educational research ever more emphasize the importance of the fact that the process of human capital formation is not homogeneous but heterogeneous. Personalized learning initiatives, particularly those facilitated by digital technologies and artificial intelligence tools, have been identified as key drivers of alignment between the input of education and the profiles of the learning process

In the context of vocational education, Kholifah et al. (2025) analyzed the concept of workforce readiness in terms of human capital theory, particularly in the context of digital skills of vocational education graduates in Indonesia. Based on survey results of 2,587 vocational education graduates, the study, using Partial Least Squares Structural Equation Modeling, confirmed that digital communication and collaboration skills are important mediating variables that link educational input variables to digital creativity and productivity. This confirms that systematic, ICT-based collaborative learning is most useful in turning vocational education into productive human capital, as it meets the digital skill needs of the modern job market [22].

However, personalization still plays an important role within the realm of higher education, especially with regards to the creation of advanced or technology-specific capabilities. Drydakakis (2025) examines the process of building AI capital among non-STEM university students within England within a structured 12-week AI module. This study illustrates how specialized education within the realm of AI significantly improves students' knowledge, skills, and abilities within the field of AI cumulatively referred to as AI capital. This increase within the level of AI capital is directly associated with better academic outcomes and greater employment rates six months after graduation. The conceptual framework of the AI Learning-Capital-Employment Transition model illustrates how personalized learning within the field of AI converts educational outcomes into employment outcomes [23].

Apart from technical skills, non-cognitive skills are a very essential component in the formation of personalized human capital. In their study, Avanesian and Rozhkova in 2025 investigated the role of non-cognitive skills in mediating the relationship between socio-economic status and academic achievement using the OECD Survey for Social and Emotional Skills. In their findings using a multi-country approach through the utilization of mixed models, the study found that non-cognitive skills play a significant role in reducing the relationship between academic achievement and socio-economic status. Task completion and open-mindedness were found to be very influential, particularly in low-SES students, while collaboration showed nonlinear effects [24]

The economic importance of non-cognitive skills is supported by the results from the labor market. Choi and Min (2025) analyze the results of vocational education in Indonesia based on the Indonesian Family Life Survey and a Heckman selection model. The results show that vocational education has a large positive effect on the probability and wage of employment, and this effect is mostly realized in urban labor markets. Among the non-cognitive skills, conscientiousness is revealed to have the strongest impact on both the probability and wage of employment, and emotional stability has a positive effect on the wage of employment. Most importantly, it is shown that ignoring the importance of non-cognitive skills results in an overestimation of the return to formal education [25].

Evidence from previous educational levels confirms the relevance of individualized socio-emotional growth. De Paola and Skatova (2024) examine the role of non-cognitive skills and social isolation as determinants of academic performance using a highly informative panel dataset of Italian students. Controlling for previous cognition, their results show that academic motivation and strong time-management skills, as observed in primary education, forecast significant individual outcomes in literacy and numeracy skills at later educational grades, while social isolation in class has persistent adverse effects on academic performance. The results show significant heterogeneity across gender and socio-economic groups, implying the need for individualized educational policies targeting individual behavioral characteristics as well as social integration mechanisms for effective human capital formation [26]

For personalized learning to become effective within the education sector, it is important to have effective personalization tools at one's disposal that are capable of measuring the heterogeneity of the individual. Wang et al. (2026) propose a multidimensional evaluation method for college students' programming skills by applying the AHP & TOPSIS method with grades and competition results. The study concludes that comprehensive evaluation systems are capable of making effective distinctions among the skill levels of the students, with the ability of mathematical analysis being the most important factor for determining programming ability. The fact that gender differences are not significant again highlights the importance of personalized learning profiles as opposed to demographics [27].

According to the literature, personalized learning plays a pivotal role in the process of human capital formation by aligning learning content with the cognitive, non-cognitive, and technical profiles of the individual. The use of digital technology and artificial intelligence in personalization improves the efficiency and equity of the education system by enabling skill creation, overcoming socio-economic inequities, and sustaining alignment with the demands of the labor market. However, the efficiency of personalized learning depends on the use of complementary assessment instruments, inclusive design, and support systems, thereby emphasizing the fact that the process of human capital formation is complex and adaptive in nature. Although there is a significant amount of evidence on the role of personalized learning in skill creation, relatively less research attempts to combine personalization instruments with economic efficiency concepts, especially within the context of the extracurricular education environment.

Building on the existing body of research, it becomes clear that a significant amount of research has been undertaken in the area of human capital formation, economic efficiency in the education sector, and the use of AI-based educational platforms, although these are commonly studied in a disjointed manner. Existing research is commonly focused on either the pedagogical outcomes, the macroeconomic implications of investment, or the adoption of technology, although not commonly incorporating the concepts of personalization techniques, economic efficiency, and human capital outcomes together in a single framework

Furthermore, although it has been observed that personalized and AI-based learning platforms have a significant effect on skill development and engagement, there has been little empirical analysis that specifically evaluates AI-based learning platforms regarding their effect on resource allocation in an economic sense, specifically in an extracurricular education setting. This creates a problem for policymakers and institutions, which view AI-based learning platforms solely from an innovation point of view, without considering it from an economic point of view, specifically regarding investments in human capital

To fill this gap, the current study uses an economic approach to examine an educational platform using AI for extracurricular education at the school level. The methodology used in the study focuses on the assessment of the economic role of personalization and engagement mechanisms enabled by AI in improving the productivity of human capital development and economic efficiency simultaneously. The methodology provides a systematic way to examine the economic role of an educational platform enabled by AI in the current education environment.

METHODOLOGY

This study adopts an exploratory analytical research design aimed at assessing the economic efficiency of an AI-based educational platform from the perspective of human capital theory. Rather than relying on quantitative empirical data, the study uses a structured conceptual and qualitative evaluation approach based on established economic and educational indicators. The analysis focuses on interpreting platform mechanisms and their potential economic implications within a defined analytical framework

Analytical Framework

This study applies an analytical framework grounded in human capital theory and the economics of education to assess the role of AI-based educational platforms. The framework is based on an investment model of education, where educational inputs are transformed into skills, capabilities, and economically relevant outcomes.

Within this framework, the analysis focuses on key platform mechanisms, including AI-driven personalization, gamification, and automation, and examines how these mechanisms relate to economic efficiency dimensions such as learning productivity, scalability, and resource utilization.

Unlike studies focused primarily on pedagogical effectiveness, this research emphasizes the economic interpretation of educational processes, considering AI-based platforms as tools for optimizing resource allocation and enhancing the efficiency of human capital formation in digital learning environment

The framework has three related dimensions:

1. Educational inputs, such as infrastructure, AI-driven personalization tools, and educational content;
2. Transformation processes, such as adaptive learning paths, personalized feedback, and gamification
3. Outputs and Outcomes, as represented by Learning Productivity, Skill Development, and Human Capital Formation Indicators.

This allows the assessment of AI-based education platforms as an economic tool in addition to the educational role they play.

The analysis framework of the study is presented in Figure 2.

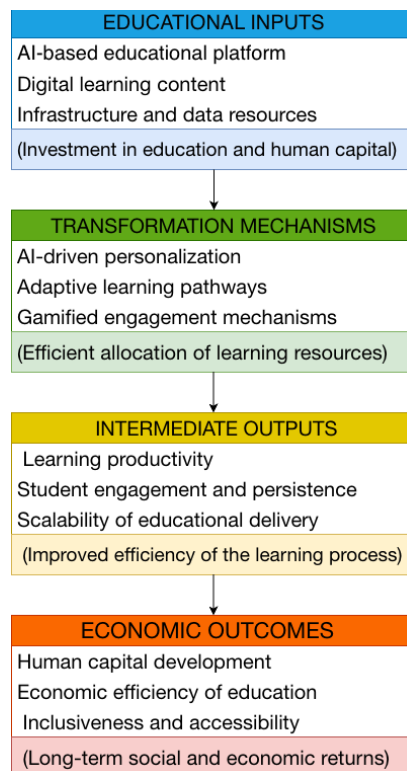


Figure 2 - Conceptual framework for evaluating the economic efficiency and human capital contribution of AI-based educational platforms.

Context of the AI-Based Educational Platform

The empirical context of the proposed study includes an educational platform that utilizes AI. The platform analyzed in this study represents a typical AI-based extracurricular educational system with personalization and gamification features, used as a case for conceptual evaluation rather than as a source of empirical measurement. It enables the recommendations of content, the selection of tasks, as well as the implementation of game-based learning, aiming to improve the engagement of the users as well as the development of their skills.

Extracurricular education is a particularly relevant setting for conducting an economic analysis because it is an addition to education and takes place in a comparatively flexible environment. This allows for the testing of personalization and engagement strategies in a setting in which such strategies would be difficult to enact in an educational curriculum. Such an environment provides insights into the efficiency gains possible in an AI-powered education system.

The platform operates in a digital environment that enables scalability in delivering educational content, with no marginal cost of education for more users. Scalability is one of the key economic characteristics that enable more access to educational content without increasing the cost of instruction.

Measures of Economic Efficiency and Human Capital Outcomes

In order to assess economic efficiency the study uses a number of qualitative/analytical indicators that are commonly used in the economics of education literature. These indicators focus on relative efficiency gains rather than monetary values, which suit the exploratory nature of the study.

The economic efficiency of a firm or industry can

- Learning productivity, referred to as the ability to accomplish the outcome of skill development in less instructional time.
- Scalability, which reflects the capacity of the platform to support more learners without necessarily scaling up the input factors;
- Resource utilization efficiency, measured by the level of automation for content delivery, task assignment, and feedback delivery.

The human capital outcome is measured based on the following indicators related to:

- the development of cognitive and non-cognitive skills;
- engagement with the learning process;
- alignment of learning activities with skills relevant to long-term employability.

This dual attention allows for a connection between efficiency and the formation of human capital without these being considered separate areas of analysis. In order for this framework of analysis to be applied, Table 1 below summarizes the main areas of economic efficiency and formation of human capital that will be used for analysis. Table 1 highlights the main areas of analysis, indicators, and economic interpretation, which allows for an effective analysis of AI-based educational platforms according to this framework

Table 1- Analytical Dimensions and Evaluation Criteria

Dimension	Description	Economic Interpretation
Educational inputs	AI platform, content, infrastructure	Investment in human capital
Personalization mechanisms	Adaptive tasks, feedback	Efficiency of resource allocation
Engagement mechanisms	Gamification, motivation	Learning productivity
Outputs	Skills, participation	Human capital formation
Outcomes	Scalability, inclusiveness	Long-term social and economic returns

Table 1 shows how the indicators operationalize the conceptual framework by connecting platform mechanisms with economically relevant outcomes of human capital.

Analytical Approach

Revised Analytical Approach:

The analytical approach of the study is based on a structured qualitative assessment of the platform using predefined economic and human capital indicators. The evaluation process consists of three main steps

1. Identification of key platform mechanisms, including personalization, automation, and gamification
2. Mapping these mechanisms to economic efficiency dimensions such as learning productivity, scalability, and resource utilization;
3. Interpretation of their potential contribution to human capital formation based on insights from the literature.

This approach allows for a systematic interpretation of the platform's economic role without relying on direct causal inference or quantitative estimation.

Methodological Limitations

There are some limitations that should be acknowledged as well. First, this analysis cannot provide a full cost-benefit or return on investment calculation because, in this case, it is more important to explore efficiency mechanisms and their relevance in economics rather than focusing on investment returns. Second, being limited to a single platform may reduce the ability of this study to be generalized on a different setting with different institutional limitations.

However, the methodological framework remains a useful tool that can be applied in the assessment of AI-based educational platforms in various educational settings as well as in the current economic setting.

RESULTS

Economic Efficiency of the AI-Based Educational Platform

The analysis suggests that the AI-based educational system may possess efficiency advantages in the organization of extracurricular education. As shown in the conceptual framework in Figure 2, the educational AI system enables the process of educational input conversion into educational output through automations of educational content selection, task assignment, and feedback. This enhances educational productivity because the costs of organizing instruction are reduced, as well as the need for constant human intervention.

One of the most important efficiency outcome areas in which one of the key areas where the platform may demonstrate efficiency is scalability. As mentioned earlier, this platform's digital nature makes it possible for more learners to be integrated without any proportional increase in educational personnel costs. As such, it can be assumed that the marginal cost of new users is low, which makes this platform's efficiency more favorable compared to traditional educational programs. This observation is consistent with the view that an AI educational platform can be viewed as an investment in improving productivity rather than an investment in costs.

In addition, it enhances efficiency in the use of resources through aligning the content of learning with the learner profile. Personalized allocation of tasks reduces irrelevant or misaligned educational activities, allowing educational resources to be focused on fields where there is potential for educational impact. From an economic point of view, it represents a more efficient allocation of educational resources in the educational production process.

Human Capital Development Outcomes

The analysis indicates that, in addition to efficiency gains, the platform may play a significant role in respect of human capital development, and this is made possible through a variety of complementary mechanisms. The integration of learning pathways in the design of the platform ensures the development of cognitive as well as non-cognitive abilities in learners.

Engagement tools that use gamification can therefore complement human capital outcomes, as gamification is a powerful motivator and helps in building persistence among learners. High levels of persistent engagement can help reduce instances of learning disruptions and dropping out of the learning process, which are usually associated with inefficiencies and depreciation of human capital in the education sector.

It is worth mentioning, though, that it is due to the platform's focus on extracurricular education that it is possible to develop skills which are not addressed to a sufficient extent through standardized education, such as critical thinking, self-regulation, or autonomy. These skills are increasingly recognized as valuable attributes from an economic point of view.

Linking Efficiency Gains with Human Capital Formation

The results suggest that economic efficiency and human capital development can be interpreted as inter-related results, as the development of human capital is facilitated by the efficiency gains of the AI-supported educational system. Efficiency gains, such as those that come about through the process of automation, make the development of human capital possible because of the re-allocation of teaching resources to more productive learning. Meanwhile, the development of human capital further enhances the productivity of the educational sector.

This is especially apparent in the platform's ability to strike a balance between inclusiveness and efficiency. The platform expands the number of people who can access educational content by reducing the marginal cost of delivery, at the same time maintaining the quality of learning. From an economic standpoint, this achieves a higher social return on education expenditure by increasing scale and efficiency at the same time.

The outcome is in line with the dimensions of analysis mentioned in Table 1 because it confirms that the AI-driven personalization and engagement activities are functions that act as efficiency tools in human capital development.

Summary of Key Findings

Overall, the analysis suggests that AI-based educational platforms may contribute to economic value in three main ways. First, the platform may contribute to economic efficiency as it optimizes learning productivity, scalability, and the application of resources. Second, the platform adds to the development of human capital as it develops cognitive, non-cognitive, as well as adaptive skills. Third, the platform integrates these dimensions, suggesting that AI-based education can be considered as a potential investment in human capital.

The results have both empirical and analytical backing to support the role of AI-based educational platforms in improving the efficiency and sustainability of educational systems in flexible educational settings.

These findings should be interpreted as analytical insights derived from the proposed framework rather than as direct empirical evidence.

DISCUSSION

The results of this study add to the burgeoning literature that treats education more broadly within an economic paradigm of human capital investment than within a purely social practice. By analyzing an AI-based education platform from an economic paradigm, this study not only adds on to the existing literature but also bridges the connection between AI-based engagement strategies and economic efficiency.

Interpretation of Results in Relation to Existing Literature

The above-mentioned efficiency enhancement is consistent with the existing empirical findings, which have identified AI, digital technology, and other such factors as productivity-enhancing factors in the education and training process. Recent macroeconomic studies have found that expenditures on AI-based education have positive impacts on economic growth and productivity by making labor as well as capital more efficient inputs [9]. On the same note, cross-industry studies have argued that efficiency enhancement in education not only depends on the level of expenditures, which is measured by the quality of education governance, innovation, and delivery approaches, apart from the expenditures themselves [10]. This paper finds supporting evidence for the above-mentioned findings.

On the other hand, these results also support and confirm some of the fundamental principles of Human Capital Theory, which clearly demonstrate that improvements in efficiency do not have negative effects on learning quality, but instead, personalized learning paths support the development of cognitive and non-cognitive skills, which have shown that they retain "substantial predictive validity for long-term economic growth

and individual labor market outcomes” [13]. The complex nature of Human Capital formation can be supported by the fact that “the quality of education and skill composition have more influence than simply the length of formal schooling.”

In addition, the findings verify the common view that technological determinism in education is flawed in practice. In this regard, previous research indicates that artificial intelligence and online platforms do not function independently in the production of productivity, and, in fact, the platforms and technologies can only contribute to the economy in a favorable environment that is aligned with the objectives of human capital [16, 20]. In this study, this view is supported because the efficiency of the platforms is dependent on the design and the alignment of the platforms with the objectives of human capital.

Economic Efficiency, Scalability, and Inclusiveness

A major implication of this study is that it has managed to prove that there is a connection between economic efficiency and inclusiveness. The fact that it can minimize marginal delivery costs and at the same time provide different learners with different content suggests that it can achieve efficiency and equity at the same time, which has been shown in other studies that technology can improve productivity without reducing accessibility in flexible learning contexts [10]

In economic terms, the role of scalability as an important enabler for the increased social return on educational investment through the application of AI-based educational platforms clearly manifests. The ability to scale without necessarily increasing inputs makes the productivity of educational systems improve and ensures the long-term scale-up of educational opportunities. This outcome corresponds with evidence that shows the economic returns on educational investment over time through the scale-up of learning gains [11].

Implications for Human Capital Development

The discussion of results underscores that the development of human capital exceeds educational achievement. The AI-driven platform’s emphasis on engagement, adaptive difficulty and autonomy enables the development of valuable skills to be acquired alongside educational ones. Current research shows that non-cognitive factors, such as motivation, self-regulation, or adaptability, play a crucial mediating role between education and employment outcomes [24, 25]. The current study’s findings support current research, suggesting that AI-driven personalization not only improves learning efficiency but also improves human capital development.

Moreover, the findings also indicate that AI-based personalization can mitigate, but not remove, inequalities in terms of socio-economics by minimizing the inefficient use of uniform teaching methods. These findings are in line with existing research that has shown that adaptive learning environments can lead to enhanced learning outcomes for diverse groups of students when they are complemented with adequate institutional support [26]. Though the study does not aim at any causal relationship between reductions in inequalities, it gives analytical evidence for the inclusiveness of personalized education systems.

Policy and Institutional Implications

From a policy perspective, these results highlight the importance of assessing AI-driven educational platforms as investments in human capital infrastructure over technological solutions with shorter-term horizons. Cross-national findings suggest that the effectiveness of AI-driven educational development is best optimized through incentives related to the labor market and inclusive policy approaches [15]. This study contributes to this existing literature by showing the relationship between economic efficiency gains and the design of these educational platforms.

The focus on extracurricular education is, therefore, a reflection of the potential of flexible learning environments that are enabled through technology and can complement the existing education systems in place. These platforms can serve as innovation spaces where the education system can make use of technological innovation and thereby raise the outcomes of human capital without having to transform the existing education system in place extensively [20].

Limitations and Directions for Future Research

Nonetheless, the study has some shortcomings. First, the study is based on a single platform and uses non-financial indicators, and therefore the results can only be considered as indicators of efficiency and not estimates of the economic gain that can be derived. Secondly, the study is set in a particular environment that may limit the generalizability of the results to other educational settings.

Future studies can extend this research by using longitudinal data, performing comparative analysis across platforms, and using economic frameworks for evaluating efficiency and economic return on human capital. More analysis on distributional effects and heterogeneity can add more insights into how AI-based learning platforms can optimize efficiency and inclusiveness at the same time.

CONCLUSION

This paper examines the economic efficiency of human capital in an AI-based learning platform, focusing on the strategic role of educational technologies beyond their function as simple innovations. It argues that, when interpreted through the lens of the economics of education and human capital theory, AI-based engagement tools may contribute to improvements in productivity, scalability, and inclusiveness of education systems.

The analysis suggests that the economic value of AI-based educational platforms can be understood as emerging from a set of interrelated mechanisms. First, such platforms may enhance efficiency by reducing coordination costs, automating educational processes, and enabling scalable content delivery. Second, they may support human capital development through the enhancement of cognitive, non-cognitive, and adaptive skills, which are increasingly important in dynamic labor market environments.

This study highlights that the economic value of AI-based education is not generated by technology alone. Rather, it depends on human-centered design and the alignment of educational frameworks with broader learning and economic objectives.

From a policy perspective, the findings suggest that AI-driven educational platforms can be considered as part of long-term human capital infrastructure. Their potential benefits are more likely to be realized when they are aligned with educational and labor market goals, particularly in flexible learning environments such as extracurricular education. Therefore, policymakers and educational institutions may benefit from adopting evaluation frameworks that incorporate efficiency, scalability and skill development alongside traditional educational outcomes.

This research is exploratory in nature and does not provide monetized estimates of economic benefits. Future research may extend this framework by incorporating longitudinal data, cross-platform comparisons, and cost-benefit analyses to better quantify efficiency gains and human capital outcomes. Further investigation into distributional effects and institutional heterogeneity would also contribute to a deeper understanding of how AI-based educational systems may influence both efficiency and equity.

In conclusion, this study contributes to the literature on the economics of education by offering an analytical perspective on how AI-powered educational platforms may function as tools for supporting human capital formation and improving the efficiency of educational systems within appropriate institutional context.

REFERENCES

1. Guo, T., Tong, Y., & Yu, Y. (2025). The influence of government health investment on economic resilience: A perspective from health human capital. *International Review of Economics & Finance*, 99, 104050. <https://doi.org/10.1016/j.iref.2025.104050>
2. Edeji, O. C. (2024). Neo-liberalism, human capital theory and the right to education: Economic interpretation of the purpose of education. *Social Sciences & Humanities Open*, 9, 100734. <https://doi.org/10.1016/j.ssho.2023.100734>
3. MacKenzie, A., & Chiang, T.-H. (2023). The human development and capability approach: A counter theory to human capital discourse in promoting low SES students' agency in education. *International Journal of Educational Research*, 117, 102121. <https://doi.org/10.1016/j.ijer.2022.102121>

4. Wang, H., Cheng, Z., & Smyth, R. (2024). Parental early-life exposure to land reform and household investment in children's education. *World Development*, 173, 106391. <https://doi.org/10.1016/j.worlddev.2023.106391>
5. Ripamonti, E. (2023). Cultural capital, economic capital, and participation in early childhood education: A place-based approach. *Regional Science Policy & Practice*, 15(2), 387–403. <https://doi.org/10.1111/rsp3.12635>
6. Wang, D., Shen, M., & Wu, X. (2026). Socioeconomic status and inequalities in early development of non-cognitive skills: Evidence from China. *China Economic Review*, 95, 102586. <https://doi.org/10.1016/j.chieco.2025.102586>
7. Entorf, A. K., & Dohmen, T. J. (2025). The effect of compulsory education on non-cognitive skills: Evidence from low- and middle-income countries. *Economics of Education Review*, 107, 102654. <https://doi.org/10.1016/j.econedurev.2025.102654>
8. Buser, T., Ahlskog, R., Johannesson, M., Koellinger, P., & Oskarsson, S. (2024). The causal effect of genetic variants linked to cognitive and non-cognitive skills on education and labor market outcomes. *Labour Economics*, 90, 102544. <https://doi.org/10.1016/j.labeco.2024.102544>
9. Kirikkaleli, D., & Kirikkaleli, N. O. (2025). AI investment in education and training and economic growth in the USA. *Social Sciences & Humanities Open*, 12, 101777. <https://doi.org/10.1016/j.ssaho.2025.101777>
10. Drama, B. G. H., Soro, K., & Senou, M. M. (2025). Sectoral allocation of public investment: Optimizing efficiency in education and health systems in developing economies. *Social Sciences & Humanities Open*, 12, 102300. <https://doi.org/10.1016/j.ssaho.2025.102300>
11. Stenberg, A. (2022). Does formal education for adults yield long-term multiplier effects or human capital depreciation? *Economics of Education Review*, 90, 102306. <https://doi.org/10.1016/j.econedurev.2022.102306>
12. Zhi, J., Ji, M., & Ma, L. (2025). Higher education, entrepreneurial vitality, and high-quality economic development. *International Review of Economics & Finance*, 104850. <https://doi.org/10.1016/j.iref.2025.104850>
13. Boman, B. (2024). Cognitive skills and economic growth in the twenty-first century: Evidence from PISA and cognitive ability studies. *International Journal of Educational Research Open*, 7, 100360. <https://doi.org/10.1016/j.ijedro.2024.100360>
14. Agasisti, T., D'Ignazio, A., Iannotta, G., Romagnoli, A., & Tonello, M. (2025). Financial literacy calls the roll — The effectiveness of a financial education program in Italian schools. *Economics of Education Review*, 109, 102731. <https://doi.org/10.1016/j.econedurev.2025.102731>
15. Tian, J., & Zhang, Y. (2025). Does artificial intelligence help in improving human capital-based educational development? Evidence from 29 countries. *Technology in Society*, 83, 103004. <https://doi.org/10.1016/j.techsoc.2025.103004>
16. Brey, B., & van der Marel, E. (2024). The role of human-capital in artificial intelligence adoption. *Economics Letters*, 244, 111949. <https://doi.org/10.1016/j.econlet.2024.111949>
17. Llamosas García, G., & Mazas Pérez-Oleaga, C. (2025). What works in financial education? Experimental evidence on program impact. *Journal of Behavioral and Experimental Economics*, 119, 102401. <https://doi.org/10.1016/j.socec.2025.102401>
18. Clark, R. L., Lin, C., Lusardi, A., Mitchell, O. S., & Sticha, A. (2025). Evaluating the effects of a low-cost, online financial education program. *Journal of Economic Behavior & Organization*, 232, 106952. <https://doi.org/10.1016/j.jebo.2025.106952>
19. Park, G., Kang, S., Yi, S., & Kim, J. (2026). Diverse impacts of AI investments on productivity gains: Effects of industry and innovation characteristics. *Technological Forecasting and Social Change*, 224, 124471. <https://doi.org/10.1016/j.techfore.2025.124471>
20. Chigbu, B. I., & Makapela, S. L. (2025). AI in education, sustainability, and the future of work: An integrative review of industry 5.0, education 5.0, and work 5.0. *Journal of Open Innovation: Technology, Market, and Complexity*, 11(4), 100645. <https://doi.org/10.1016/j.joitmc.2025.100645>
21. Kumar, A., Bajjal, A., & Kharat, M. (2025). Evaluating generative artificial intelligence adoption in management education using AI-human augmentation and expectation confirmation theory. *Journal of International Education in Business*, 18(4), 570–594. <https://doi.org/10.1108/JIEB-07-2024-0086>

22. Kholifah, N., Nurtanto, M., Sutrisno, V. L. P., Majid, N. W. A., Subakti, H., Daryono, R. W., & Achmadi, A. (2025). Unlocking workforce readiness through digital employability skills in vocational education graduates: A PLS-SEM analysis based on human capital theory. *Social Sciences & Humanities Open*, 11, 101625. <https://doi.org/10.1016/j.ssaho.2025.101625>

23. Drydak, N. (2025). The formation of AI capital in higher education: Enhancing students' academic performance and employment rates. *Computers and Education: Artificial Intelligence*, 9, 100476. <https://doi.org/10.1016/j.caeai.2025.100476>

24. Avanesian, G., & Rozhkova, K. (2025). The effect of non-cognitive skills on academic performance: Does it vary by socio-economic status? *International Journal of Educational Research*, 133, 102680. <https://doi.org/10.1016/j.ijer.2025.102680>

25. Choi, S., & Min, I. (2025). The impact of cognitive and non-cognitive skills on occupational outcomes: Evidence from Indonesia. *International Journal of Educational Research*, 133, 102669. <https://doi.org/10.1016/j.ijer.2025.102669>

26. De Paola, M., & Skatova, E. (2024). Non-cognitive skills and social isolation in late childhood: An investigation of their impact on school performance in Italy. *Economics of Education Review*, 103, 102581. <https://doi.org/10.1016/j.econedurev.2024.102581>

27. Wang, D., Xie, Z., Lian, D., Lu, Q., Li, N., Yuan, H., & Liu, Y. (2026). The integration of technology and education: An innovative research on the evaluation system of college students' programming ability. *Thinking Skills and Creativity*, 59, 101989. <https://doi.org/10.1016/j.tsc.2025.101989>

ЖАСАНДЫ ИНТЕЛЛЕКТ НЕГІЗІНДЕГІ БІЛІМ БЕРУ ПЛАТФОРМАЛАРЫНЫҢ АДАМИ КАПИТАЛДЫ ҚАЛЫПТАСТЫРУДАҒЫ РӨЛІ

А. М. Қасенхан¹, А. Бекарыстанқызы²

¹Сәтбаев университеті, Алматы, Қазақстан

²Нархоз университеті, Алматы, Қазақстан

АҢДАТПА

Зерттеу мақсаты – Бұл мақала білім беруді цифрлық трансформациялау жағдайында жасанды интеллектке негізделген білім беру платформалары, экономикалық тиімділік және адам капиталын қалыптастыру арасындағы байланысты зерттейді. Зерттеу мектептен тыс білім беруге бағытталып, жасанды интеллект арқылы жүзеге асырылатын дербестендіру мен геймификацияның оқу үдерістерінің тиімділігін арттыруға және когнитивтік әрі когнитивтік емес дағдыларды дамытуға ықпал ету мүмкіндіктерін қарастырады.

Әдіснамасы – Зерттеу адам капиталы теориясы мен білім беру экономикасына негізделген зерттеушілік-аналитикалық тәсілді қолданады. Жұмыста оқу өнімділігі, ауқымдылық (масштабталу), ресурстарды пайдалану тиімділігі және адам капиталының ықтимал нәтижелері тұрғысынан жасанды интеллектке негізделген мектептен тыс білім беру платформасын бағалауға арналған тұжырымдамалық модель қолданылады. Талдау платформа механизмдерін қазіргі ғылыми әдебиеттегі тұжырымдармен байланыстыра отырып түсіндіруге негізделген.

Зерттеудің бірегейлігі – Мақалада көбінесе жеке-жеке қарастырылатын үш бағыт біріктіріледі: жасанды интеллектке негізделген білім беру платформалары, білім берудегі экономикалық тиімділік және адам капиталының дамуы. Зерттеу дербестендіру және пайдаланушының қатысуын қамтамасыз ететін механизмдерді экономикалық тұрғыдан талдауға арналған құрылымдалған аналитикалық негіз ұсынады.

Зерттеу нәтижелері – Зерттеу нәтижелері жасанды интеллектке негізделген білім беру платформалары оқу үдерісін ауқымды түрде ұйымдастыруды қолдау, үйлестіру шығындарын азайту және оқу әрекеттерін білім алушылардың қажеттіліктерімен үйлестіру арқылы білім берудің тиімділігін арттыруы мүмкін екенін көрсетеді. Сонымен қатар, мұндай платформалар тиісті педагогикалық негізде

енгізілген жағдайда сыни ойлау, дербестік, мотивация және бейімделгіштік сияқты дағдыларды дамыту арқылы адам капиталын қалыптастыруға ықпал етуі мүмкін. Дегенмен, алынған нәтижелер зерттеушілік сипатқа ие және оларды тікелей эмпирикалық дәлелдер ретінде емес, аналитикалық тұжырымдар ретінде қарастырған жөн.

Түйін сөздер: жасанды интеллект, адами капитал, экономикалық тиімділік, цифрлық білім беру, жекелендірілген оқыту, ойындандыру

РОЛЬ ОБРАЗОВАТЕЛЬНЫХ ПЛАТФОРМ НА ОСНОВЕ ИИ В ФОРМИРОВАНИИ ЧЕЛОВЕЧЕСКОГО КАПИТАЛА

А. М. Қасенхан¹, А. Бекарыстанқызы^{2*}

¹АО КазННТУ Алматы, Казахстан

¹Университет Нархоз, Алматы, Казахстан

АННОТАЦИЯ

Цель исследования – В данной статье рассматривается взаимосвязь между образовательными платформами на основе искусственного интеллекта, экономической эффективностью и формированием человеческого капитала в контексте цифровой трансформации в образовании. Основное внимание уделяется внеклассному образованию и рассматривается, как персонализация и геймификация с использованием ИИ могут способствовать более эффективным процессам обучения и развитию когнитивных и некогнитивных навыков.

Методология – В исследовании используется исследовательский аналитический подход, основанный на теории человеческого капитала и экономике образования. Применяется концептуальная модель для оценки внеклассной учебной платформы на основе ИИ с точки зрения продуктивности обучения, масштабируемости, использования ресурсов и потенциальных результатов в области человеческого капитала. Анализ основан на интерпретации механизмов платформы в связи с выводами из последних исследований.

Оригинальность – Данная работа вносит вклад в литературу, интегрируя три перспективы, которые часто рассматриваются отдельно: образовательные платформы на основе ИИ, экономическая эффективность в образовании и развитие человеческого капитала. Она предлагает структурированную аналитическую основу для рассмотрения того, как механизмы персонализации и вовлечения могут быть интерпретированы с экономической точки зрения.

Результаты исследования – Исследование предполагает, что образовательные платформы на основе ИИ могут повысить эффективность образования, поддерживая масштабируемую доставку, снижая нагрузку на координацию и улучшая согласование учебных мероприятий с потребностями учащихся. Оно также указывает на то, что такие платформы могут способствовать формированию человеческого капитала посредством развития критического мышления, автономии, мотивации и адаптивности при внедрении в соответствующую педагогическую структуру. Однако результаты носят исследовательский характер и должны интерпретироваться как аналитические, а не как прямые эмпирические данные.

Ключевые слова: искусственный интеллект, человеческий капитал, экономическая эффективность, цифровое образование, персонализированное обучение, геймификация

ABOUT THE AUTHORS

A. Kassenkhan – PhD, Associate Professor, Satbayev University, Almaty, Kazakhstan, e-mail: a.kassenkhan@satbayev.university, ORCID ID: 0000-0002-6355-9544

A. Bekarystankyzy – PhD, Associate Professor, Narxoz University, Almaty, Kazakhstan, e-mail: akbayan.bekaristankyzy@narxoz.kz, ORCID ID: <https://orcid.org/0000-0003-3984-2718>*

