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A Comparative Study of The Pedagogical Effectiveness of Artificial Intelligence Tools in The Higher Education Systems of Different Countries

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Abstract: This article undertakes a comparative study of the pedagogical effectiveness of artificial intelligence tools in the higher education systems of different countries. The study proceeds from the distinction between the technological efficiency of such tools, measured by the speed and quality of task completion, and their pedagogical effectiveness, measured by the durable learning they produce, and substantiates the existence of an effectiveness paradox in which gains in performance may coincide with losses in learning. The author elaborates a six-criterion model of pedagogical effectiveness, comprising learning gain, cognitive autonomy, academic integrity, equity of access, teacher agency and data governance, and applies it to four national-institutional models of AI integration: the regulatory-precautionary, the decentralised-institutional, the state-directed strategic and the transitional models. The analysis establishes that no model dominates across all criteria and that each embodies a characteristic structure of trade-offs. The conceptual polemic between R. Luckin and N. Selwyn concerning the educational promise of artificial intelligence is subjected to critical examination. The findings demonstrate that pedagogical effectiveness is a property not of the tool but of the configuration formed by the tool, the pedagogical design and the institutional context.

Keywords: Artificial intelligence in education, generative artificial intelligence, higher education, pedagogical effectiveness, comparative education, cognitive offloading, academic integrity, teacher agency, data governance, educational policy, digital transformation, national models of integration.

Introduction: Few technological developments in the history of education have diffused through higher education institutions with the speed that characterised the spread of generative artificial intelligence following the public release of large language model interfaces at the end of 2022. Within a period of months, tools capable of producing coherent text, solving problems, generating code, summarising literature and simulating dialogue became available to virtually every student with an internet connection, and they were adopted by students well before institutions had formulated any position regarding their use. Universities across the world thus found themselves in the unaccustomed situation of responding to a transformation that had already occurred rather than planning one that was yet to come, and the resulting diversity of institutional and national responses constitutes a natural field for comparative inquiry. The central conceptual problem of the present study concerns the distinction between the technological efficiency of artificial intelligence tools and their pedagogical effectiveness. Technological efficiency is measured by the speed, accuracy and quality with which a task is completed; pedagogical effectiveness is measured by the durable change in the knowledge, capacities and dispositions of the learner that results from engagement with the task. In most domains of human activity the two coincide, since the purpose of performing a task is to obtain its product. In education they diverge fundamentally, since the product of an educational task — the essay, the solved problem, the program — is of no intrinsic value; its value lies entirely in the cognitive work that producing it requires of the student. A tool that produces the product while relieving the student of the

cognitive work is therefore technologically efficient and pedagogically counterproductive at the same time. This divergence gives rise to what may be termed the effectiveness paradox. A growing body of experimental research indicates that access to generative tools can substantially improve students' performance on tasks completed with their assistance while leaving unchanged, or even diminishing, their performance on subsequent tasks completed without it. The mechanism responsible is cognitive offloading: the student delegates to the tool precisely those operations of retrieval, organisation and reasoning whose repeated exercise constitutes learning. The same research indicates, however, that the paradox is not inevitable, since tools configured to guide rather than to answer, and pedagogical designs requiring students to generate their own attempts before consulting the tool, can mitigate the effect considerably. Effectiveness, in other words, depends less upon the tool than upon the manner of its integration. It is precisely here that comparative study acquires its justification. The same tools are available to students in virtually every country, yet they are integrated into institutions governed by different regulatory frameworks, different traditions of assessment, different relations between teacher and student, different levels of digital infrastructure and different cultural conceptions of the purpose of higher education. If effectiveness is a property of integration rather than of the tool, then these national and institutional differences should produce systematically different pedagogical outcomes from identical technologies, and the comparison of national models offers a means of identifying which configurations favour learning and which undermine it. The regulatory landscape within which this integration takes place is itself strikingly heterogeneous. The Artificial Intelligence Act adopted by the European Union in 2024 classifies artificial intelligence systems used to determine admission to educational institutions, to evaluate learning outcomes and to monitor students during examinations as high-risk systems subject to stringent requirements, and it prohibits the use of emotion recognition systems in educational institutions. UNESCO's guidance on generative artificial intelligence in education and research, published in 2023, advocates a human-centred approach, calls for the validation of tools before their educational use and proposes minimum age limits for independent use. Other states have adopted national strategies oriented principally towards the rapid development of artificial intelligence capacity, while in several major systems regulation has been left largely to individual institutions. For the Republic of Uzbekistan the relevance of these questions is determined by several converging factors. The strategy for the development of artificial intelligence technologies until 2030, adopted in 2024, and the broader programme of digital transformation have established artificial intelligence as a national priority. The rapid expansion of access to higher education has increased the number of students while placing pressure upon the capacity of teaching staff, which creates both an incentive to employ artificial intelligence tools and a risk that they will be employed as a substitute for, rather than a support to, pedagogical interaction. The country thus faces the characteristic situation of a system that can learn from the experience of others before its own institutional patterns have become fixed. The comparative study of this field nevertheless presents distinctive methodological difficulties. The empirical evidence is heterogeneous, being drawn from studies that differ in their populations, tools, tasks and measures of outcome. The technology evolves more rapidly than the cycle of research and publication, so that findings concerning a given generation of tools may be superseded before they appear in print. Most studies measure short-term outcomes, whereas the pedagogical consequences of greatest concern, such as the development of independent reasoning and professional judgement, manifest themselves over years. A comparative study must therefore be conducted at a level of conceptual abstraction sufficient to remain valid across changes in the particular tools while remaining close enough to the evidence to yield substantive conclusions. The scholarly problem of the study arises from the intersection of these considerations.

LITERATURE REVIEW

Within Uzbek pedagogical scholarship the theoretical foundation of the present study is supplied above all by the work of A.A. Abduqodirov on the theory and practice of distance learning and the use of information technologies in education. The scholar's principal contribution consists in the demonstration that the introduction of technology into education does not by itself alter the quality of learning and that its effect depends upon the didactic principles according to which technology-mediated instruction is organised. Of particular significance for the present inquiry is his insistence upon the necessity of preserving the active cognitive position of the learner and the guiding function of the teacher under conditions in which the direct contact between them is attenuated by technological mediation. This position anticipates, in the context of an earlier generation of technologies, precisely the problem that generative artificial intelligence has rendered acute, namely the risk that the mediating technology will absorb the cognitive

activity it was meant to support. The second pillar of the theoretical framework is provided by the research of R.J. Ishmuhamedov on the enhancement of educational effectiveness through innovative technologies. The scholar consistently distinguishes between the formal introduction of innovation and the actual improvement of educational results, and argues that the effectiveness of an innovative technology is to be judged not by its novelty but by its contribution to the independent activity and developed capacities of the learner. His emphasis upon the teacher as the decisive agent who determines whether an innovation serves learning or merely decorates instruction supplies the conceptual basis for the criterion of teacher agency advanced below, while his insistence upon diagnosable results provides the warrant for distinguishing pedagogical effectiveness from technological efficiency. The value and institutional dimensions of the problem are illuminated by contemporary research on education and the formation of worldview. In the work of S. Ergashbaev on the development of the spiritual worldview of young people through the system of continuous education, it is substantiated that value orientations are formed through sustained pedagogical processes, a thesis of direct relevance to the question of academic integrity, which depends upon internalised values more than upon external detection. In a further study by the same author concerning the elevation of the spiritual and philosophical worldview of young people, independent critical reflection is singled out as a central educational outcome, which corresponds directly to the criterion of cognitive autonomy. The study by M.M. Mirzaolimjon og‘li and E. Shohbozbek on the educational policy of New Uzbekistan and new models of universities discloses the institutional context within which artificial intelligence is now being integrated.

METHODOLOGY

The methodological foundation of the present study is constituted by the comparative method of educational research, which made it possible to examine the integration of artificial intelligence tools into higher education not as a uniform global process but as a set of nationally and institutionally differentiated configurations whose outcomes may be compared; within this general framework the systemic approach performed the leading function, since it permitted the treatment of each configuration as an integral whole in which the tool, the pedagogical design, the regulatory framework and the institutional culture stand in relations of mutual conditioning, so that the effect of any one element cannot be assessed in isolation from the others. The conceptual analysis of the categories of efficiency and effectiveness was applied in establishing the distinction upon which the study rests and in identifying the conditions under which the two diverge. The theoretical analysis of scholarly literature served to reconstruct the principal paradigms within which artificial intelligence in education has been interpreted. The method of systematic literature review was applied in collecting, selecting and synthesising empirical studies of the pedagogical effects of artificial intelligence tools in higher education, with attention to the populations, tools, tasks and outcome measures employed. Documentary analysis was applied to national strategies, regulatory acts, the guidance of international organisations and the published policies of higher education institutions in order to characterise the regulatory and institutional environment of each national model.

RESULTS

The study established a six-criterion model of the pedagogical effectiveness of artificial intelligence tools in higher education. The criterion of learning gain refers to the durable increase in knowledge and capacity demonstrable in the absence of the tool, as distinct from improvement in performance with its assistance. The criterion of cognitive autonomy refers to the preservation and development of the student’s capacity for independent reasoning and to the avoidance of habitual cognitive offloading. The criterion of academic integrity refers to the authenticity of the relation between the student’s submitted work and his own intellectual activity. The criterion of equity of access refers to the distribution of the benefits of the tools across students of differing socio-economic position and prior preparation. The criterion of teacher agency refers to the degree to which teachers retain control over pedagogical decisions rather than having those decisions determined by the design of the tools. The criterion of data governance refers to the protection of students’ personal and learning data and the transparency of the systems that process them. A second result consists in the identification of four national-institutional models of integration. The regulatory-precautionary model, exemplified by the European Union, subordinates integration to a framework of legal requirements grounded in the protection of fundamental rights. The decentralised-institutional model, characteristic of systems such as those of the United States and the United Kingdom, leaves the regulation of use largely to individual institutions and their academic communities. The state-directed strategic model, characteristic of several East and Southeast Asian systems, integrates artificial intelligence into higher education as a component of national development strategy through coordinated central programmes. The transitional

model, characteristic of systems such as that of Uzbekistan, combines a declared national commitment to artificial intelligence with an infrastructure and an institutional framework still in the process of formation. A third result consists in the finding that no model dominates across all six criteria and that each embodies a characteristic structure of trade-offs. The regulatory-precautionary model performs strongly on data governance and academic integrity but tends to slow the pace of pedagogical experimentation. The decentralised-institutional model favours innovation and teacher agency but produces marked inequalities between well-resourced and poorly resourced institutions.

DISCUSSION

The results obtained require to be situated within the principal theoretical controversy concerning the educational significance of artificial intelligence, namely the opposition between the position advanced by R. Luckin and the critique developed by N. Selwyn. In Machine Learning and Human Intelligence: The Future of Education for the 21st Century, R. Luckin argues that artificial intelligence should be understood not as a rival to human intelligence but as a means of augmenting it. Machines, on her account, excel at the processing of large quantities of information and at the performance of well-defined tasks, whereas human intelligence is distinguished by its capacities for metacognition, for contextual judgement, for social and emotional understanding and for the awareness of one's own knowledge and its limits. The educational promise of artificial intelligence lies in its capacity to relieve teachers and learners of routine tasks, to provide individualised support at a scale no human teaching force could achieve and thereby to free education to concentrate upon precisely those distinctively human capacities. Luckin insists that this promise is conditional upon educators understanding artificial intelligence sufficiently to direct its use, yet the orientation of her argument is towards the opportunities it opens. N. Selwyn approaches the same question from a markedly different standpoint. In Should Robots Replace Teachers? AI and the Future of Education, he subjects to critical examination the assumptions that underlie enthusiasm for educational artificial intelligence. Teaching, on his account, is not the transmission of information that more efficient technologies might perform better, but a relational, social and moral practice whose value lies in the human encounter between teacher and learner. The promise of individualisation, he argues, rests upon a reductive conception of learning as the acquisition of measurable content, and the enthusiasm for artificial intelligence frequently reflects the commercial interests of technology companies and the efficiency concerns of administrators rather than the interests of learners. Selwyn does not argue that artificial intelligence has no place in education, but he insists that the burden of proof rests upon those who would introduce it and that the questions to be asked are social and political before they are technical. The philosophical substance of this disagreement concerns the conception of education that each position presupposes. For Luckin education is centrally the development of intelligence, and artificial intelligence is valuable to the extent that it contributes to that development; for Selwyn education is centrally a human relationship, and artificial intelligence is suspect to the extent that it displaces that relationship. Two further contributions bear upon the controversy. The systematic review by O. Zawacki-Richter and colleagues lends empirical weight to one of Selwyn's concerns, since it established that research on artificial intelligence in higher education had been conducted largely without the participation of educators and without reference to pedagogical theory. The UNESCO guidance prepared by F. Miao and W. Holmes, for its part, occupies an intermediate position, accepting the potential of generative tools while insisting upon human agency and upon validation before educational use.

CONCLUSION

The study has shown that the pedagogical effectiveness of artificial intelligence tools in higher education cannot be inferred from their technological capabilities and must be assessed with reference to criteria specific to learning. The comparison of national models demonstrates that identical tools produce different pedagogical outcomes under different configurations of integration. First, the distinction between technological efficiency and pedagogical effectiveness was substantiated, together with the effectiveness paradox according to which gains in performance with the tool may coincide with the absence of gains, or with losses, in learning demonstrable without it. Second, a six-criterion model of pedagogical effectiveness was elaborated, comprising learning gain, cognitive autonomy, academic integrity, equity of access, teacher agency and data governance.

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