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Designing an Effective Model of Virtual Education Using Artificial Intelligence in the Educational System of Islamic Azad Universities of West Azerbaijan Province

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A B S T R A C T

Higher education in the twenty first century has undergone extensive technological transformations. One of the most significant of these changes is the expansion of virtual education and its integration with modern technologies such as artificial intelligence. Virtual education is no longer merely an alternative to face to face instruction; rather, it has become a strategic approach within educational systems that can enhance learning quality, educational equity, and equal access to opportunities. Accordingly, the present study was conducted with the aim of designing an effective model of virtual education using artificial intelligence within the educational system of Islamic Azad Universities in West Azerbaijan Province. This research employed a sequential exploratory design, meaning that qualitative data were first collected and analyzed to identify the key dimensions and components. In the qualitative phase, the statistical population consisted of 15 experts in virtual education, educational technology, and key administrators of the Azad Universities in the province. Participants were selected based on criteria such as specialized knowledge, practical experience, credible research background, familiarity with the challenges and opportunities of virtual education, and the ability to provide analytical insights. Purposeful and snowball sampling methods were used until theoretical saturation was achieved. Data were collected through semi structured interviews and analyzed using thematic analysis with MAXQDA 11 software. The coding process consisted of three stages: open coding, axial coding, and selective coding. Ultimately, seven main dimensions of AI based virtual education effectiveness were identified: educational, technological, psychological, social, managerial, human, and organizational. Overall, the findings indicate that the effectiveness of AI based virtual education requires strategic synergy between data driven management, sustainable technological infrastructure, human capital empowerment, and organizational support. The proposed model can serve as a valid framework for the design, evaluation, and improvement of intelligent virtual education in Iranian universities.

Keywords: *Virtual Education, Artificial Intelligence, Educational Effectiveness, Thematic Analysis, Islamic Azad Universities*

1. Introduction

Higher education systems are undergoing a profound transformation driven by the rapid expansion of digital technologies, changing learner expectations, globalization, and the growing demand for flexible, accessible, and lifelong learning opportunities. Within this transformation, virtual education has moved beyond its earlier status as a supplementary or emergency mode of instruction and has become a strategic component of contemporary university education. Universities increasingly rely on learning management systems, online communication platforms, digital content, automated assessment tools, and data-based instructional services to extend educational access and sustain teaching and learning across geographical and temporal boundaries. Artificial intelligence has emerged as one of the most influential technologies capable of reshaping the design, delivery, management, and evaluation of virtual education. In educational settings, artificial intelligence encompasses intelligent algorithms, machine learning systems, generative models, learning analytics, adaptive platforms, educational robots, automated assessment systems, and conversational agents that can perform or support tasks traditionally undertaken by instructors and educational administrators. These technologies can analyze large volumes of learner data, identify patterns of performance, predict academic difficulties, personalize content, recommend appropriate learning activities, automate feedback, and facilitate administrative decision-making. Consequently, artificial intelligence is not merely an additional technical feature within virtual education; it can alter the underlying logic of teaching and learning by moving educational systems from uniform and reactive instruction toward personalized, predictive, and data-informed learning environments. Reviews of artificial intelligence in education indicate that its applications have expanded rapidly across instructional support, student assessment, academic advising, resource management, and learning personalization, although the educational value of these applications depends on their pedagogical alignment and responsible implementation (Huang, 2021; Nader, 2023).

The integration of artificial intelligence into education is often described as a potentially revolutionary development because it can respond to persistent limitations of conventional and virtual instruction. Traditional educational systems generally provide the same content, instructional sequence, pace, and assessment procedures to heterogeneous groups of learners, despite substantial differences in students' prior knowledge, cognitive abilities, learning preferences, motivation, and academic needs. Artificial intelligence can address this limitation through adaptive learning systems that continuously analyze learner responses and adjust the difficulty, sequence, format, or timing of educational materials. Intelligent tutoring systems may offer personalized explanations, targeted exercises, and immediate corrective feedback, while educational robots and automated assistants can support students beyond the restricted time and availability of human instructors. Alam argued that adaptive learning and intelligent tutoring technologies can contribute to the development of smart classrooms and campuses by making educational provision more responsive to individual learning needs (Alam, 2022). Similarly, the literature on AI-based adaptive learning emphasizes that personalization can improve engagement and learning efficiency when technological recommendations are based on reliable data and sound pedagogical models (Gligorea et al., 2023).

The growing body of research on artificial intelligence-supported e-learning also demonstrates a shift in scholarly attention from the technical capabilities of educational technologies to their pedagogical, social, managerial, and ethical implications. Earlier research frequently concentrated on developing intelligent systems and evaluating their computational performance. More recent studies have increasingly examined how artificial intelligence influences learner engagement, instructor roles, learning design, assessment, educational equity, and institutional decision-making. A systematic review and co-citation analysis of research on AI-supported e-learning identified the progressive expansion of the field and showed that artificial intelligence has become connected with adaptive learning, intelligent tutoring, learning analytics, personalized feedback, and automated evaluation (Tang et al., 2023). This development suggests that universities must no longer evaluate artificial intelligence only in terms of software efficiency. They must determine whether AI-enabled systems improve educational quality, strengthen meaningful interaction, support students with diverse needs, and contribute to the achievement of institutional goals.

The educational dimension is therefore central to any effective model of AI-enabled virtual education. Digital platforms and intelligent systems can enhance learning only when they are integrated into purposeful instructional designs. Effective instructional design involves clearly defined learning outcomes, logically organized content,

suitable learning activities, active student participation, meaningful instructor–student interaction, collaborative opportunities, and continuous formative assessment. Artificial intelligence can reinforce these elements by generating differentiated learning resources, recommending activities based on learner performance, supporting instructional content development, and providing immediate feedback. However, indiscriminate reliance on automated content or algorithmically generated recommendations may weaken educational coherence when such outputs are not reviewed by knowledgeable instructors. Kumar maintains that artificial intelligence can revolutionize teaching and learning by improving personalization, feedback, accessibility, and instructional efficiency, but its educational contribution remains dependent on how appropriately it is incorporated into teaching practices (Kumar, 2024). Accordingly, an effective model must place pedagogical objectives above technological novelty and must ensure that AI tools support, rather than determine, the teaching–learning process.

Artificial intelligence also changes the professional role and identity of instructors. In AI-enhanced education, teachers are increasingly expected to function as learning designers, facilitators, interpreters of educational data, evaluators of AI-generated material, and ethical supervisors of technology-supported learning. This transition may create tensions between traditional conceptions of teaching and emerging expectations regarding digital competence, automation, and human–machine collaboration. Some instructors may perceive artificial intelligence as a threat to professional autonomy or academic credibility, whereas others may regard it as an opportunity to reduce repetitive tasks and devote more attention to higher-order educational activities. Research on AI-enhanced teacher training shows that engagement with artificial intelligence can influence professional identity and generate identity-based motivations, particularly when educators attempt to reconcile established professional values with new technological demands (Lan, 2024). Therefore, faculty acceptance, professional development, AI literacy, and confidence in using intelligent tools constitute essential human components of effective virtual education.

The successful integration of artificial intelligence also requires attention to students' readiness and attitudes. Although many university students regularly use digital technologies, familiarity with social media or personal devices does not necessarily translate into the academic, informational, and ethical competencies required for AI-supported learning. Students must be able to communicate effectively in digital environments, evaluate the credibility of AI-generated information, protect personal data, use intelligent tools responsibly, and maintain academic integrity. Their willingness to engage with virtual education is also shaped by perceptions of usefulness, accessibility, fairness, interaction, and media representations of e-learning. Research examining students' attitudes toward the coverage and presentation of e-learning has shown that perceptions of online education are influenced not only by direct learning experiences but also by broader communication and social contexts (Tahat et al., 2024). Consequently, an effective model should include student orientation, digital literacy development, technical assistance, psychological support, and clear guidance regarding acceptable AI use.

Assessment represents another critical area in which artificial intelligence can improve virtual education while simultaneously introducing new risks. Conventional online examinations may be limited by delayed feedback, high grading workloads, difficulties in verifying authorship, and vulnerability to academic misconduct. Artificial intelligence can support automated scoring, item generation, formative feedback, competency diagnosis, and continuous assessment based on students' learning activities. These capabilities may make assessment more timely, individualized, and informative. Nevertheless, the rise of generative artificial intelligence has complicated the interpretation of student work because AI systems can produce essays, solve problems, summarize readings, and generate responses that may not reflect the student's independent competence. Educational institutions must therefore redesign assessment strategies to emphasize authentic performance, critical thinking, oral explanation, process documentation, project-based tasks, and reflective engagement. Gundu emphasizes that e-assessment in the era of generative artificial intelligence requires strategic adaptation rather than reliance on traditional forms of online testing (Gundu, 2025). Khlaif likewise argues that educational assessment must be reconsidered in response to artificial intelligence, including its implications for validity, reliability, integrity, and the interpretation of learning outcomes (Khlaif, 2024).

The technological dimension remains the operational foundation of AI-enabled virtual education. Intelligent learning systems require reliable internet connectivity, adequate bandwidth, stable learning management platforms, secure data storage, interoperable software, accessible user interfaces, and appropriate hardware. Technological

instability can interrupt instruction, increase student frustration, reduce participation, and weaken confidence in online education. These challenges are especially important in university systems whose branches serve populations with unequal access to devices, connectivity, or technical support. Furthermore, AI systems are often computationally demanding and may require sustained institutional investment, specialized technical personnel, and mechanisms for updating software and protecting data. The experience of integrating artificial intelligence into the education of agro-engineering students demonstrates that successful implementation depends on matching technological tools with disciplinary learning requirements, institutional conditions, and students' practical competencies (Kravets & Tokarchuk, 2024). Thus, technological infrastructure should be understood as a combination of equipment, platforms, support services, security arrangements, and usability rather than merely internet availability.

In addition to technical capacity, virtual education must address psychological and social dimensions. Students in online environments may experience isolation, reduced belonging, diminished motivation, cognitive overload, technology anxiety, and difficulty sustaining self-regulated learning. Artificial intelligence can help identify disengagement, provide motivational prompts, personalize learning tasks, and offer immediate assistance through chatbots or intelligent tutors. Nevertheless, automated interaction cannot fully substitute the emotional, relational, and social functions of instructors and peers. Virtual education becomes more effective when AI-supported personalization is combined with human communication, collaborative learning, instructor presence, and opportunities for students to participate in academic communities. Emerging technologies, including artificial intelligence, virtual reality, and online learning platforms, may significantly transform future teaching and learning processes, but their effectiveness depends on their capacity to create engaging and interactive educational experiences rather than merely digitizing instructional materials (Hayati et al., 2023). Earlier analyses of artificial intelligence and virtual reality in education similarly show that immersive and intelligent technologies can enrich learning when they are aligned with educational objectives and learner characteristics (Zafari et al., 2021).

Institutional and managerial factors are equally decisive. AI-enabled virtual education generates extensive data concerning attendance, participation, task completion, assessment, learning pathways, and student behavior. When appropriately analyzed, these data can support early identification of at-risk learners, resource allocation, curriculum revision, faculty support, and strategic planning. However, data-driven management requires institutional policies that define responsibility, access, security, transparency, and the acceptable use of educational data. University administrators must also determine which AI applications are educationally necessary, financially sustainable, technically compatible, and ethically defensible. A meta-synthesis of artificial intelligence functions in higher education identified multiple dimensions and indicators, demonstrating that AI applications extend beyond teaching to include research, management, support services, evaluation, and institutional development (Khatib Zanjani & Karimi, 2024). This breadth highlights the need for a comprehensive model that coordinates AI-related initiatives across different university functions and prevents fragmented or duplicative implementation.

Ethical considerations are inseparable from institutional effectiveness. AI systems may reproduce biases embedded in training data, produce inaccurate or fabricated information, reduce transparency in decision-making, and create privacy risks through the collection of sensitive student data. Unequal access to high-quality devices, internet services, premium AI tools, and digital competencies can also intensify existing educational inequalities. Universities must therefore establish safeguards related to informed consent, confidentiality, algorithmic accountability, human oversight, academic integrity, accessibility, and nondiscrimination. They must also ensure that AI-based recommendations do not automatically determine consequential decisions about students without appropriate professional review. These concerns are directly related to educational equity because the benefits of intelligent virtual education may be concentrated among technologically advantaged groups unless institutional policies actively support disadvantaged learners.

The relationship between artificial intelligence, higher education, and sustainable development further extends the strategic importance of this issue. AI-supported virtual education can reduce geographical barriers, extend educational services to remote populations, support efficient use of institutional resources, and facilitate lifelong learning. It may also help universities monitor sustainability indicators, analyze institutional performance, and align educational activities with broader social and developmental objectives. Research on the use of artificial intelligence for

implementing the United Nations Sustainable Development Goals in higher education institutions indicates that AI can contribute to institutional planning and sustainability initiatives, although its use requires governance structures and strategic coordination (Leal Filho et al., 2024). In this sense, designing an effective AI-based virtual education model is not only an instructional concern but also part of the university's responsibility to promote inclusive, resilient, and sustainable education.

Artificial intelligence may additionally contribute to the development of competencies needed by future graduates and educators. Contemporary labor markets increasingly value communication, collaboration, adaptability, creativity, problem-solving, digital literacy, and the ability to work productively with intelligent systems. Virtual education environments supported by AI can provide simulations, scenario-based tasks, individualized coaching, collaborative projects, and continuous feedback that facilitate the development of these competencies. Research on AI and the development of soft skills among future educators suggests that intelligent technologies can support professional preparation when they are embedded in participatory and competency-oriented learning experiences (Raissouni et al., 2025). Therefore, the effectiveness of virtual education should not be evaluated only through examination scores or course completion rates; it should also encompass students' capacity to transfer knowledge, develop professional skills, collaborate, solve problems, and participate responsibly in digitally mediated environments.

Despite the expanding literature, several gaps remain. Many studies focus on a particular technology, application, discipline, or educational outcome, whereas effective virtual education is produced through the interaction of educational, technological, psychological, social, managerial, human, and organizational factors. Moreover, frameworks developed in technologically advanced or culturally different educational systems cannot necessarily be transferred directly to Iranian universities. Differences in digital infrastructure, organizational culture, faculty readiness, student access, administrative structures, and local educational expectations require context-sensitive analysis. The existing manuscript identifies seven interconnected dimensions—educational, technological, psychological, social, managerial, human, and organizational—suggesting that the effectiveness of AI-based virtual education depends on strategic synergy among instructional design, stable infrastructure, learner engagement, social participation, data-driven management, human capacity, and institutional support. A locally grounded model can therefore provide university administrators with a coherent framework for planning investments, developing faculty capabilities, redesigning assessment, supporting students, protecting educational data, and evaluating the actual outcomes of intelligent virtual education.

Accordingly, the aim of the present study was to design an effective model of virtual education using artificial intelligence in the educational system of Islamic Azad Universities in West Azerbaijan Province.

2. Methods and Materials

The present study is developmental–applied in terms of its purpose, qualitative in terms of data type, field-based regarding the execution setting, survey-based in terms of implementation method, and cross-sectional in terms of its time frame. According to Creswell's (2003) classification, this research follows a sequential–exploratory design, meaning that qualitative data are collected and analyzed using thematic analysis. In this process, qualitative findings contribute to the development of the quantitative data collection instrument and help identify the main dimensions of the phenomenon under study.

The statistical population consists of experts from Islamic Azad University branches in West Azerbaijan Province, as well as prominent organizational consultants who were selected due to their specialized knowledge, practical experience, and key roles in virtual education and emerging educational technologies. Expert selection in the present study was based on the following criteria:

- Possession of specialized knowledge in virtual education, digital learning, and modern educational technologies.
- Practical experience in teaching, educational management, or virtual course design.
- Having a key role in educational decision-making or policymaking at the university or organizational level.
- Having credible research experience in virtual education or artificial intelligence in education.
- Ability to provide critical and analytical insights during in-depth interviews.
- Familiarity with the challenges and opportunities of virtual education in universities.

Sampling was conducted through a theoretical sampling strategy using purposive and snowball techniques. Interviews were conducted with 15 senior experts and

specialists until theoretical saturation was achieved, and data validation was performed through focus group sessions.

3. Findings and Results

The qualitative data were analyzed using thematic analysis. To accomplish this, the transcribed interviews were repeatedly and carefully reviewed. Subsequently, the coding process was carried out in three stages:

1. **Initial (Open) Coding:** Extracting preliminary concepts from participants' statements and sentences.
2. **Axial Coding:** Grouping similar codes and forming conceptual components.
3. **Selective Coding:** Abstracting the main dimensions and final organization of themes.

Throughout this process, efforts were made to maintain logical connections among the concepts and ensure that the extracted themes closely reflected the lived experiences of the experts.

During the open-coding stage, the full text of the semi-structured interviews was examined line-by-line and multiple times. The aim of this stage was to identify initial, meaningful concepts embedded in participants' narratives. Any meaningful sentence or phrase that referred in some way to the effectiveness of virtual education, the role of artificial intelligence, its challenges, requirements, or consequences was considered an open code.

In this stage, particular attention was given to the following:

• Extracting codes as closely as possible to the participants' own words;

• Avoiding premature merging of concepts;

• Preserving the diversity of viewpoints;

• Linking each code to one or more specific interviews.

In total, after analyzing all 15 interviews, 92 initial open codes were extracted, which formed the foundation for axial coding in the next stage.

In the axial coding stage, the main objective was to consolidate similar open codes into conceptual components, identify logical relationships among the codes, and develop an organized framework of initial concepts to derive the main dimensions of AI-based effective virtual education. In this stage:

In selective coding, the purpose is to integrate all open codes and components into the main dimensions and key concepts. This stage contributes to the development of a unified conceptual model of AI-based effective virtual education. Practically, selective coding involves identifying the core category, its associated dimensions, and the relationships among them.

All 92 open codes and the seven main dimensions were merged and consolidated across three levels of abstraction (open code → component → dimension), demonstrating that the core category is "effectiveness of AI-enabled virtual education," which integrates all dimensions.

The seven dimensions correspond to the dimensions identified in the axial-coding stage, each unifying its respective open codes and conceptual components. The components represent clusters of similar open codes that were grouped into key conceptual elements. Table (2) presents the open, axial, and selective codes.

Table 1

Open, Axial, and Selective Codes

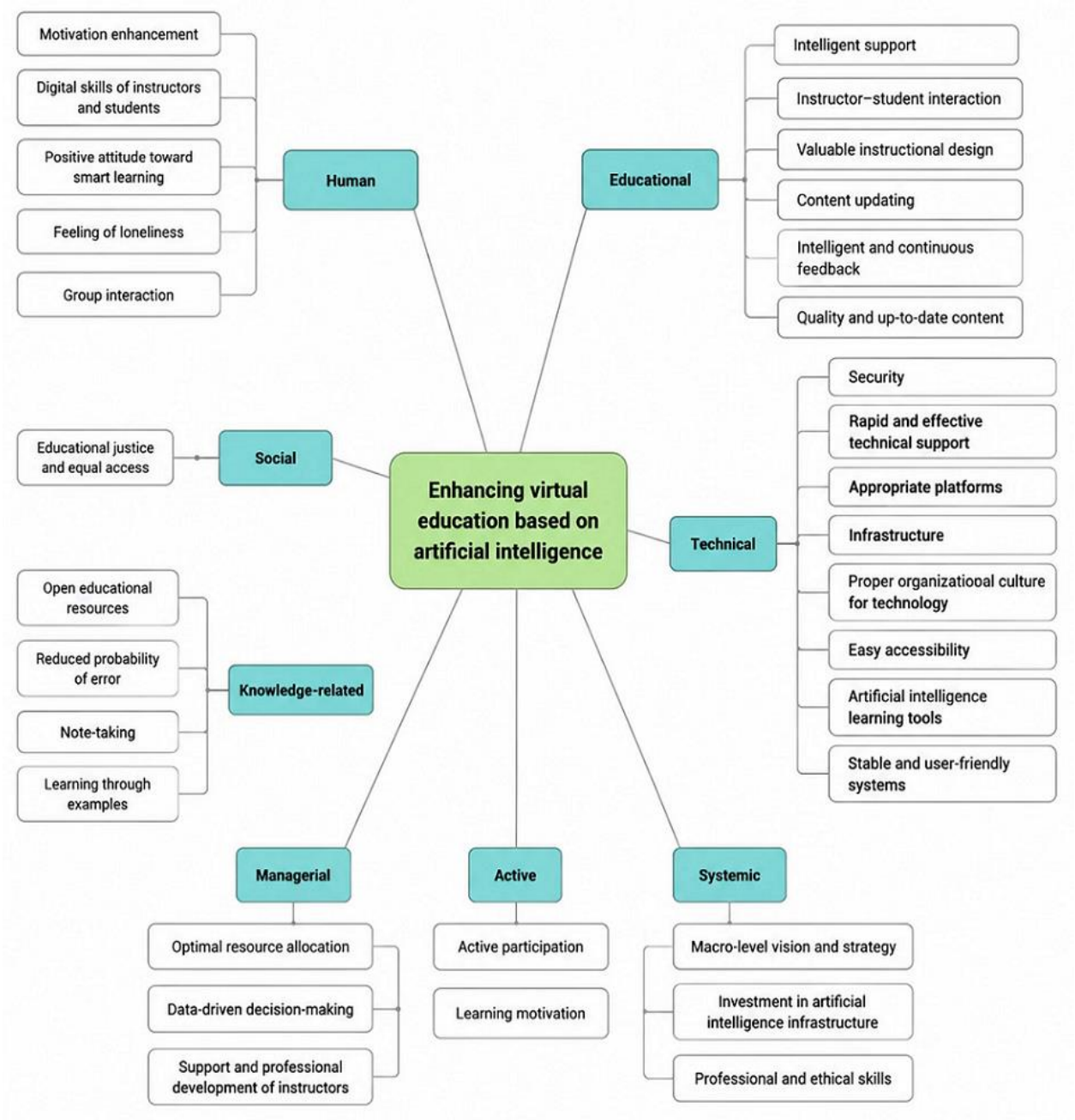
Selective Code	Axial Code	Related Open Codes	Interview No.
Educational	Effective Instructional Design	The necessity of instructional design in virtual education	P1
	Instructor–Student Interaction	Weak interaction between instructor and students in online classes	P1
	Intelligent and Continuous Feedback	The role of immediate feedback in student learning	P2
	Quality and Up-to-Date Content	Importance of keeping digital content updated	P2
	Intelligent Assessment	Inefficiency of traditional assessments in virtual education; high accuracy of intelligent assessment; reduced instructor workload through AI	P3, P3, P4
	Personalized Learning	Need for personalized learning pathways	P4
	Intelligent Support	The role of AI in providing academic support	P3

Technological	Infrastructure and Internet	Weak internet infrastructure in some university branches	P6
	Stable and User-Friendly Systems	Instability of virtual-learning systems; importance of user experience in educational platforms	P6, P7
	Artificial Intelligence Tools	Role of chatbots in quick response; increased student satisfaction through intelligent tools	P5, P5
	Security and Privacy	Importance of securing educational data; concerns about student privacy	P8, P8
	Psychological		
	Learning Motivation	Effect of gamification on student motivation; importance of motivation in self-directed learning	P9, P13
	Active Student Participation	Low student participation in virtual classes	P9
	Reducing Technology Anxiety	Technology anxiety among some students; role of initial training in reducing technology anxiety	P8, P8
Social	Group Interaction	Importance of group interaction in learning; weakness of online group activities	P10, P9
	Sense of Belonging	Lack of sense of belonging in online environments	P10
	Educational Equity and Equal Access	Digital divide among students; unequal access to technological tools; role of technology in promoting educational justice; risk of increasing digital inequality	P11, P11, P9, P9
Managerial	Data-Driven Decision-Making	Need for data-driven decision-making in universities; failure to use data in decision processes; importance of learning analytics for management	P12, P8, P8
	Optimal Resource Allocation	Lack of financial resources for technology development; need for investment in digital infrastructure	P7, P7
	Faculty Support and Professional Development	Weak managerial support for virtual education; need for professional training for faculty members	P13, P15
Human	Readiness and Acceptance of Faculty	Resistance of some faculty to technology; lack of digital skills among faculty members	P14, P14
	Students' Digital Skills	Higher readiness of younger students for technology; need for AI literacy among students	P4, P1
	Attitude Toward Smart Learning	Negative attitudes of some students toward online learning	P15
Organizational	Macro-Level Policies and Strategies	Lack of clear policies for virtual education; role of macro-level policymaking in the success of virtual education	P13, P12
	Innovation-Supporting Organizational Culture	Lack of an innovation-supportive culture; organizational resistance to change	P6, P6
	Investment in Digital Infrastructure	Need for investment in digital infrastructure; fragmented virtual-education initiatives	P7, P1

The results presented in Table 3 led to the extraction of a three-level coding structure for the research model. Accordingly, 102 subthemes were identified and organized into 33 main, or organizing, themes. These themes were ultimately integrated into 11 global themes: green institutional capacity, green energy policymaking, green financing, green economic support, green energy infrastructure, green technological innovation, green human capital, green social participation, environmental sustainability, green diplomacy, and energy security. Before designing the model, a sensitivity analysis was conducted. The results are presented in Table 4.

Figure 1

Final Conceptual Model of AI Enabled Effective Virtual Education Derived from the Selective Coding Stage



4. Discussion and Conclusion

The present study was conducted to design an effective model of virtual education using artificial intelligence in the educational system of Islamic Azad Universities in West Azerbaijan Province. The qualitative analysis of expert interviews resulted in the identification of seven interconnected dimensions: educational, technological, psychological, social, managerial, human, and organizational. These dimensions were developed through the integration of 92 open codes into conceptual components and higher-order themes. The findings indicate that the effectiveness of AI-based virtual education cannot be explained solely by the availability of intelligent technologies or online platforms. Rather, it emerges from the coordinated interaction of appropriate instructional design, reliable technological infrastructure, student motivation and participation, social interaction and educational equity, data-driven management, the digital readiness of instructors and students, and supportive organizational policies. In other

words, artificial intelligence becomes educationally effective only when it is embedded within a comprehensive institutional system that connects pedagogical, technological, human, and managerial capacities. This interpretation is consistent with the final conceptual model presented in the study, in which multiple dimensions converge around the central category of enhancing virtual education through artificial intelligence.

The first major dimension identified in the study was the educational dimension, which included effective instructional design, instructor–student interaction, intelligent and continuous feedback, high-quality and updated content, intelligent assessment, personalized learning, and intelligent educational support. These findings suggest that the educational value of artificial intelligence depends primarily on whether it improves the actual teaching–learning process. Participants emphasized that virtual instruction should not be limited to uploading content or holding synchronous online sessions. Instead, it should include purposeful learning activities, regular interaction, continuous monitoring of student progress, and adaptive support. This result is aligned with the view that artificial intelligence can improve teaching and learning by personalizing instructional pathways, offering immediate feedback, and assisting instructors in tailoring content to students' needs (Kumar, 2024). It is also supported by Nader, who concluded that the application of artificial intelligence in teaching and learning includes adaptive instruction, automated support, learning analytics, and personalized educational services (Nader, 2023).

The importance assigned to personalized learning in the present model is particularly noteworthy. In conventional virtual education, students often receive identical content, assignments, and assessments despite differences in prior knowledge, learning pace, motivation, and academic performance. Artificial intelligence can reduce this uniformity by analyzing learner behavior and recommending appropriate content, exercises, or interventions. The present findings therefore support the argument that adaptive learning systems can transform virtual education from a standardized process into a flexible and learner-centered experience. This result is consistent with Gligorea et al., who showed that artificial intelligence-based adaptive learning can improve personalization, responsiveness, and learner engagement in e-learning environments (Gligorea et al., 2023). Alam similarly emphasized that adaptive systems and intelligent tutoring technologies can reform education by providing individualized assistance and supporting smart virtual classrooms (Alam, 2022). Thus, the educational dimension of the proposed model reflects a transition from content delivery toward intelligent orchestration of learning experiences.

The identification of intelligent and continuous assessment as an essential component also demonstrates that evaluation practices must be reconsidered in AI-supported virtual environments. Participants pointed to the inefficiency of traditional assessment, the higher speed and accuracy of intelligent evaluation, and the possibility of reducing instructors' workload. Artificial intelligence can facilitate formative assessment by analyzing patterns of student performance, identifying learning difficulties, and providing rapid feedback. However, the increasing availability of generative AI also challenges the validity of conventional written assignments and online examinations. This makes it necessary to adopt more authentic, process-oriented, and competency-based forms of assessment. The present findings are consistent with Khlaif's argument that assessment systems must be redesigned in response to artificial intelligence, particularly regarding validity, fairness, feedback, and academic integrity (Khlaif, 2024). They also align with Gundu, who emphasized that e-assessment strategies in the generative AI era should move beyond conventional testing and incorporate diversified, authentic, and monitored assessment procedures (Gundu, 2025).

The second major dimension was the technological dimension, comprising internet and infrastructure quality, stable and user-friendly systems, artificial intelligence tools, and security and privacy. The findings indicate that technological infrastructure is not merely a supportive factor but a prerequisite for the sustainability and effectiveness of AI-based virtual education. Weak connectivity, unstable platforms, inadequate technical support, and poor usability can interrupt learning, lower student satisfaction, and reduce faculty willingness to adopt intelligent tools. The participants' emphasis on user-friendly systems also shows that technological sophistication alone is insufficient. Systems must be understandable, accessible, and compatible with the capabilities of instructors and students. This result is compatible with Kravets and Tokarchuk, who showed that integrating artificial intelligence into educational processes requires the coordination of technical resources, disciplinary needs, instructional objectives, and user competencies (Kravets & Tokarchuk, 2024). It is also consistent with the broader literature showing that AI-supported e-learning

depends on stable platforms, sufficient computing capacity, and effective technical support (Tang et al., 2023).

Security and privacy emerged as additional technological concerns. The use of artificial intelligence in virtual education requires the collection and analysis of extensive data on students' attendance, performance, interactions, behavior, and learning preferences. Although such data can enhance personalization and managerial decision-making, they may also expose students to privacy violations, unauthorized access, and inappropriate profiling. Therefore, the technological dimension must include secure data storage, access controls, informed consent, transparency, and ethical use of educational information. This finding supports the multidimensional view of AI functions in higher education proposed by Khatib Zanjani and Karimi, who showed that the application of artificial intelligence extends across educational, research, managerial, and support domains and consequently requires coordinated standards and indicators (Khatib Zanjani & Karimi, 2024). The finding also reinforces the need to treat privacy and security as core quality criteria rather than secondary technical matters.

The psychological dimension included learning motivation, active participation, and reduction of technology anxiety. The identification of these components demonstrates that the effectiveness of virtual education depends not only on what technology can do but also on how students experience and respond to it. Students may disengage from virtual courses when they receive limited feedback, feel overwhelmed by platforms, or perceive online learning as impersonal. Artificial intelligence can improve motivation by offering adaptive challenges, immediate responses, progress indicators, and personalized recommendations. Nevertheless, poorly designed systems may increase anxiety and cognitive load. The present findings are consistent with Hayati et al., who argued that emerging technologies such as artificial intelligence, virtual reality, and online education can transform future teaching and learning, but their success depends on their ability to create motivating and meaningful experiences (Hayati et al., 2023). Zafari et al. likewise indicated that artificial intelligence and virtual reality may increase engagement and enrich educational experiences when appropriately integrated into learning environments (Zafari et al., 2021).

The social dimension consisted of group interaction, sense of belonging, educational equity, and equal access. This result indicates that virtual education should not be conceptualized as an individualized and isolated activity. Although AI can personalize learning, excessive individualization may weaken collaborative learning and academic community. Participants emphasized that students need opportunities for peer interaction, group learning, and social participation. They also highlighted the digital divide and unequal access to devices, internet services, and intelligent tools. These concerns show that the social effectiveness of AI-based virtual education depends on whether technology reduces or reinforces existing inequalities. The findings are compatible with Tahat et al., whose study of students' attitudes toward e-learning emphasized that perceptions of digital education are shaped by social, communicative, and contextual factors rather than technical performance alone (Tahat et al., 2024). They also align with Leal Filho et al., who argued that artificial intelligence can contribute to sustainable and inclusive higher education when its implementation supports access, institutional resilience, and the United Nations Sustainable Development Goals (Leal Filho et al., 2024).

The managerial dimension included data-driven decision-making, optimal resource allocation, and faculty support and professional development. This dimension demonstrates that AI-based virtual education requires active institutional leadership. Artificial intelligence generates information that can be used to identify at-risk students, evaluate course performance, allocate resources, and support strategic planning. However, educational data become valuable only when managers possess the competence and authority to interpret them and convert them into informed decisions. The present findings therefore suggest a shift from intuition-based administration toward evidence-based educational governance. This interpretation is supported by Huang et al., who described artificial intelligence in education as a field that increasingly contributes not only to instruction but also to prediction, evaluation, decision support, and educational management (Huang, 2021). The findings are also aligned with Khatib Zanjani and Karimi, who identified managerial and institutional functions among the principal areas of AI use in higher education (Khatib Zanjani & Karimi, 2024).

Faculty support and professional development were particularly important managerial components. Instructors cannot be expected to adopt artificial intelligence effectively without training, technical assistance, instructional consultation, and organizational incentives. The rapid development of AI may generate uncertainty about changing professional responsibilities, evaluation practices, and academic authority. The present study therefore indicates that professional development should address both technical competence and pedagogical judgment. This result is

strongly aligned with Lan, who showed that AI-enhanced teacher training creates tensions in professional identity and that teachers' motivations for adopting artificial intelligence are connected to how they understand their professional roles (Lan, 2024). The result also corresponds with Raissouni et al., who emphasized the potential of artificial intelligence to develop future educators' soft skills, including adaptability, collaboration, communication, and problem-solving (Raissouni et al., 2025). Accordingly, faculty development should prepare instructors not only to operate AI tools but also to critically evaluate their outputs and integrate them into sound instructional practices.

The human dimension included faculty readiness and acceptance, students' digital skills, and attitudes toward smart learning. This finding confirms that human acceptance is a decisive factor in technological implementation. Faculty resistance, limited digital literacy, negative student attitudes, and insufficient familiarity with artificial intelligence can prevent even well-designed systems from producing effective outcomes. The result suggests that universities should assess readiness before introducing AI-enabled platforms and should differentiate support according to user needs. It also indicates that AI literacy must include critical evaluation, ethical use, academic integrity, and the ability to recognize inaccurate or biased outputs. The finding is consistent with Kumar's argument that the transformation of education through AI requires changes in teachers' and students' roles and competencies (Kumar, 2024). It is also supported by Nader, who emphasized that the effectiveness of AI in teaching and learning depends on users' preparedness, educational knowledge, and capacity to apply intelligent technologies appropriately (Nader, 2023).

The organizational dimension encompassed macro-level policies and strategies, an innovation-supporting organizational culture, and investment in digital infrastructure. This result indicates that sustainable AI integration cannot be achieved through isolated projects or the individual efforts of innovative instructors. Universities need clear strategies, governance structures, ethical regulations, funding mechanisms, performance indicators, and institutional coordination. Participants' references to fragmented initiatives and resistance to change show that organizational culture may either facilitate or obstruct technological innovation. The findings are consistent with Leal Filho et al., who emphasized that the institutional use of artificial intelligence requires strategic coordination and governance if it is to contribute to sustainable development objectives (Leal Filho et al., 2024). They are also supported by the systematic mapping of AI-supported e-learning, which demonstrates that the field has developed through interconnected technological, educational, and institutional strands rather than through isolated tools (Tang et al., 2023).

Overall, the findings show that the seven dimensions are mutually reinforcing. High-quality instructional design cannot be sustained without stable infrastructure; advanced technology cannot produce learning without human readiness; personalization cannot be educationally justified without ethical assessment; data-driven management cannot function without organizational policies; and virtual access cannot be considered effective unless it promotes equity and social participation. The proposed model therefore advances a systemic understanding of AI-based virtual education. Its principal contribution lies in integrating educational, technological, psychological, social, managerial, human, and organizational elements within a context-specific framework for Islamic Azad Universities in West Azerbaijan Province. This multidimensional result is consistent with the literature review by Gligorea et al., which showed that adaptive learning requires the integration of technology, learner characteristics, instructional design, and data analysis (Gligorea et al., 2023). It is also compatible with the broader conclusion that artificial intelligence may revolutionize education only when its instructional, managerial, ethical, and human consequences are addressed simultaneously (Alam, 2022; Kumar, 2024).

The present study had several limitations that should be considered when interpreting its findings. First, the participants consisted of 15 experts and administrators affiliated with Islamic Azad University branches in West Azerbaijan Province; therefore, their experiences may not fully represent the conditions of public universities, private higher education institutions, or universities in other provinces. Second, the study relied on qualitative interviews, and the findings may have been influenced by participants' subjective interpretations, professional positions, and level of familiarity with artificial intelligence. Third, although theoretical saturation was achieved, some rapidly emerging applications of generative artificial intelligence may not have been fully reflected in the interviews. Finally, the proposed model was derived conceptually from expert perspectives and was not tested through large-scale quantitative validation or longitudinal implementation.

Future studies should quantitatively validate the proposed model using a large and diverse sample of faculty members, students, administrators, and educational technology specialists. Researchers could develop a standardized

questionnaire based on the identified dimensions and use exploratory and confirmatory factor analysis or structural equation modeling to examine relationships among the components. Comparative studies should also be conducted across different provinces, university systems, academic disciplines, and educational levels. Longitudinal and experimental research is needed to determine whether implementing the model improves student learning, engagement, satisfaction, retention, and educational equity. Future studies should also examine emerging issues such as generative AI literacy, algorithmic bias, academic integrity, privacy, faculty workload, and the cost-effectiveness of AI-supported virtual education.

University administrators should adopt the proposed model as an integrated planning and evaluation framework rather than implementing artificial intelligence through separate and uncoordinated projects. Investment should be directed toward reliable internet access, secure and user-friendly learning platforms, technical support, and equitable access to digital tools. Faculty development programs should include instructional design, intelligent assessment, learning analytics, ethical AI use, and critical evaluation of AI-generated content. Students should receive systematic training in digital and AI literacy, privacy protection, self-regulated learning, and academic integrity. Universities should establish clear governance policies for data use, algorithmic decision-making, assessment, and human oversight, while continuously evaluating the educational, psychological, and social consequences of AI-supported virtual learning.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

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Ethics Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were considered.

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