

Designing Future-Ready Education: Criteria for AI Learning Tool Selection and AI Learning Design

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ARTICLE INFO	ABSTRACT
Article history: Received 27 October 2024 Received in revised form 3 November 2024 Accepted 30 November 2024 Available online 31 December 2024	The digital age is moving fast, and we are in the era of Artificial Intelligence. The increasing advancements in technology facilitate humans to interact more easily with computers. Edu 4.0 refers to Education 4.0, it is a process of integrating the internet with education and devising ways in which an educational system could be more student-centric and align itself according to the fourth industrial age. Al technology can assist in establishing interactive learning environments. Malaysia has rolled out its Digital Education Policy to create a digitally literate nation. However, selecting the Al learning tools is difficult given their plethora of tools. There is an increasing need to identify the selection criteria and learning design for maximizing the use of Al tools. This paper aimed to identify criteria for selecting Al tools and develop a learning design for their application in education. The study used snowball sampling to analyze eleven literature studies and develop a comprehensive framework using content analysis. The paper identified the Al tools selection criteria: 1) Personalization and Adaptability; 2) Motivation and Engagement; 3) Real Time Feedback and Data; 4) Security and Transparency; 5) User Experience and Accessibility; 6) Critical and Collaborative Thinking; and 7) Emotional and Psychological Support. A learning design was formulated and validated by experts through the Fuzzy Delphi Method (FDM) based on the criteria and aligned with the requirements of Web 4.0 and EDU 4.0 to help educators with Al tools. In conclusion, the integration of Al in education requires careful selection of Al learning tools, a solid design, and reiterative development to meet changing needs. Future research should explore Al's impact on student outcomes, teacher professional development, and ethical considerations. This will help create a digitally compliant educational system that prepares future-ready students for an interconnected digital world.

1. Introduction

The digital environment and technical progress are changing rapidly in the digital age. These changes redefine social relations in society. Web 4.0 is the latest phase of Internet evolution [1]. Web

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4.0 is defined by the ability to produce user interfaces that are more complex, intelligent, and less problematic than previous webs. Web 4.0 is built on Web 3.0 to act as a semantic web and data sharing. Several technologies such as Artificial Intelligence, Internet of Things (IoTs), and blockchain develop a sophisticated and dynamic web. The current evolution of the Internet is to improve simple interactions between humans and computers so that the interactions that occur are more contextual and adaptive [2].

Education 4.0 (Edu 4.0) is a process in which the Internet enhances the development of education in line with current developments. This change in educational practices was initiated to meet the needs of the fourth industrial age, which is characterized by a high level of technology and information economy. Edu 4.0 specifically targets strategies that are based on the ability to use information and communication technology and introduce new technology into the learning system [3]. Edu 4.0 promotes student-centered learning because students are placed at the center of the learning process with learning approaches such as adaptive learning, learning environments, and digital platforms. This education model has been designed to prepare students to meet the types of skills and levels of competence expected today characterized by technology and globalization [3].

Many apps related to educational technology have been developed to provide students with learning and practical experience [4]. Digital transformation is a significant driver for economic growth and development in Malaysia. A report by the World Economic Forum [5], "Schools of the Future" finds that Malaysia was placed somewhere in the middle with a moderately high level of digital readiness among some countries. Malaysia announced Digital Education Policy would be introduced to equip the population with digital literacy. This extends to ensuring that students are well-versed with digital tools and resources. However, research on the choice of AI tools remains scarce. Despite many AI tools being used, an organized and evidence-informed framework for selecting AI learning tools catered to the needs of Malaysian educators is still missing [32]. Research has shown that the absence of guidelines on what tools to use can result in inconsistent implementation, underuse, and failure to realize intended educational outcomes. As a result, educators must navigate complex barriers to find tools that work and are grounded in local education priorities and policies. In line with that, this paper aims to identify and formulate the criteria for the selection of AI tools and develop a theoretical framework for artificial intelligence learning design in education.

2. Literature Review

2.1 Artificial Intelligence in Education

Artificial Intelligence (AI) is most often defined as the capability of a machine to imitate intelligent human behavior. This definition includes the attempts of computerized systems to simulate the human mind and behavior [6]. AI is simply an elaborate imitation of human behavior or human thought (using tools or programs) [7]. While the popular interest in AI in education has recently risen, research into the general artificial intelligence theory can be dated back to the 14th century based on the work of Alan Turing in 1937 [8]. Turing's work [9] now appears as an important focal point in academic publications and scientific and research circles. The increased use of artificial intelligence in education is expected to bring significant changes to the education system. Sekeroglu *et al.*, [10] concluded that artificial intelligence has the potential to improve personalized education among students.

AI helps ensure that learners with disabilities, refugees, out-of-school persons, or those living in remote areas of poor countries can attain relevant learning opportunities appropriate to their conditions [11]. Studies show that AI techniques and smart learning settings can be powerful in

personalized approaches [7]. Even though quality education is often reliant on the presence and involvement of educators, AI hopes to enhance education and raise its quality but primarily through a personalization approach [12]. Similarly, Pedro *et al.*, [11] suggested another paradigm of teaching assistance, which uses artificial intelligence to deliver personalized education. Due to the nature of traditional classrooms, teachers spend an excessive amount of time on repetitive tasks and administrative task requirements. The use of AI virtual assistants (virtual tutors) in the classroom will allow for less time spent on routine methods and procedures. This shall enable teachers to concentrate on student learning.

2.2 Challenges of AI Integration in Education

Artificial Intelligence (AI) enables this powerful and transformative synergy between new AI resources and proven approaches to achieve lasting impacts on learning through a few instructional methods. Despite these advancements, however, there are many barriers to schools using AI tools. Firstly, most educational institutes in underdeveloped areas do not have the basic technology for AI Integration. Several studies indicate that access to ICT hardware, stable and continuous power supply, access to the internet, and cheap data are often lacking in many institutions. This not only limits the school to maximizing the benefit of the available AI tools but also opens a bigger digital divide by denying these students the benefits of AI tools simply because they belong to a poor background and have no access to technology.

Implementation of AI technology in education requires a high financial commitment, including expenses for the acquisition of AI hardware, software, and the capital costs of the infrastructure improvements, besides the ongoing maintenance costs [33]. Many education systems face tight budgets, and governments have multiple competing priorities that make it difficult to fund the education necessary for AI to thrive. Differentiated adoption of AI may aggravate the educational gap between schools. The adoption of AI technology in education demands a hefty investment as it will involve costs to purchase AI equipment and software as well as necessary upgrades to infrastructure [33]. Many educational institutions struggle with limited budgets, and governments have competing priorities making it hard to allocate sufficient funding for AI-enabled education. Limited funds cause various schools to opt out of AI, which may aggravate the problem of educational inequality.

Furthermore, privacy considerations are critical in AI integration as the data consists of a lot of personal information such as the students' performance, behaviour, and other personal details [34]. Data Security compliance with data protection rules such as Malaysia's Personal Data Protection Act will be essential yet contentious before data security concerns can be raised in classrooms, and student privacy protected. This encourages the real risk of data breaches since the storage, transport, and analysis of large volumes of data attract ethical issues concerning the use of AI in education.

Moving to AI-assisted education means teachers need skills that go beyond traditional teaching skills. Teachers need to be familiar with how the AI tools work, as well as to develop skills in inspecting data, exercising logic, and distributing resources to ensure the effective implementation of such technologies in improving educational outcomes [19]. The research reminded us of the need for professional development that trains teachers to use AI tools in an appropriate and meaningful way while bridging the gap between professional practice and technology. Many AI technologies are built for a global marketplace and may not be culturally sensitive. AI solutions need to be customized according to local values, languages, and conventions to be effective, especially in multilingual and multicultural environments. Considering these challenges, there is a pressing need for a structured framework that can assist educators in selecting and integrating AI learning technologies effectively. Focusing on these dimensions might allow educators to use AI tools wisely to remedy current

problems causing smart use of AI technology to create an equitable, stimulating, and effective educational environment.

3. Methodology

To identify criteria for selecting AI tools and a theoretical framework that guides application, the methodology for this paper has been divided into three phases based on objectives. In Phase 1, a review was conducted of literature studies related to artificial intelligence tools in education. A total of eleven (11) literature studies were identified with the snowballing sampling technique with the keywords that was "Artificial Intelligence Tools in Education". A matrix table was built based on the analysis of the literature review. Phase 2 involved the development of a theoretical framework for artificial intelligence learning design in education. The data collected during Phase 1 was used to build the theoretical framework. The criteria for the selection of AI tools were also identified and discussed in this phase. In Phase 3, the study employed the Fuzzy Delphi Method (FDM) to gather expert consensus on the AI learning tools selection criteria and the proposed learning design framework. The FDM process included seven subject matter experts from universities, schools, and other educational institutions, all with specialized knowledge in AI in education, instructional design, and technology implementation. The following sections detail the findings from the FDM analysis, highlighting expert consensus levels, key criteria validations, and final modifications based on expert feedback.

4. Results

4.1 Criteria for Selecting AI Learning Tools

Table 1 shows past studies that integrate AI technology in education. Based on past studies, there are several themes identified in line with Education 4.0 and Web 4.0 trends. Among them are as follows: 1) Personalized Learning; 2) Adaptive and Dynamic Content; 3) Collaborative Learning; 4) Performance Prediction; 5) System Security and Transparency, and 6) Holistic Development. These themes can be achieved through the integrated use of digital tools to improve students' creativity, communication, collaboration, and critical thinking in education.

Table 1

Past studies	that	integrate	Al i	n edu	ication
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Authors	Research Topic	AI	Application	Findings
Graesser <i>et</i> <i>al.,</i> [13]	Educational technologies that support reading comprehension for adults who have low literacy skills	Intelligent Tutoring Systems (ITS)	Personalized instructions and feedback	The Smart Tutor System can significantly improve learning outcomes by providing appropriate ZPD support.
Khosravi <i>et</i> <i>al.,</i> [14]	Explainable Artificial Intelligence in Education	Adaptive Learning Platforms	Customized dynamic content	Adaptive platforms increase student engagement and achievement by keeping students in their ZPD.

Dillenbour g <i>et al.,</i> [15]	The Evolution of Research on Digital Education	AI-Assisted Collaborative Learning	Collaborative learning with peers	A collaborative environment powered by AI enhances learning through peer interaction
Luckin <i>et</i> <i>al.,</i> [16]	Intelligence Unleashed: An Argument for Al in Education	Internet of Things (IoT)	Real-time data collection and analysis	Internet of Things (IoT) systems improve the quality of education and personalized learning paths.
Devlin <i>et</i> al., [17]	BERT: Pre-training of deep bidirectional transformers for language understanding	AR/VR	Customizable and immersive simulation	AR/VR environments enriched with AI technology provide effective learning opportunities and experiences.
Holmes <i>et</i> <i>al.,</i> [18]	Artificial Intelligence in Education – Promises and Implications for Teaching and Learning.	Predictive Analytics	Prediction and intervention of student performance	Predictive analytics helps in identifying at-risk students and improving student retention and success rates.
Chen <i>et al.,</i> [19]	The Impact of Artificial Intelligence and Blockchain Technology on the Development of Modern Educational Technology	Al in Blockchain	Security management in education	Blockchain is combined with Al to ensure secure and transparent management of educational records.
Slamet [20]	Potential of ChatGPT as a digital language learning assistant: EFL teachers' and students' perceptions	ChatGPT in Education	Language proficiency and personalized learning experience	The results of the study emphasize the importance of pedagogical support, curriculum alignment, user- friendly interfaces, and interactive activities.
Rehman <i>et</i> <i>al.,</i> [21]	Assessing the usage of ChatGPT on life satisfaction among higher education students: The moderating role of subjective health	ChatGPT in Education	Life satisfaction	Chat-GPT interactions increase freedom, productivity, and happiness by meeting emotional needs, increasing academic engagement, and positively influencing student perceptions and behaviour.
Ruiz-Rojas <i>et al.,</i> [22]	Collaborative Working and Critical Thinking: Adoption of Generative Artificial Intelligence Tools in Higher Education	Al in Education	Critical thinking and collaborative practice	The study found that 87% of respondents had prior knowledge of AI generative tools, with 38% using them occasionally. Popular tools include Canva 2024, Chat PDF, and YOU.COM. A total of 64% believe this tool improves

critical thinking. However,

ongoing training and technical support is required.

Opportunities fortheir skills in evaluatingGenAI-empoweredtraditional AI and GenAI tools.assessment practices

The criteria for choosing AI tools in education were developed to match the identified themes and the requirements of Web 4.0 and EDU 4.0. These criteria are as follows: 1) Personalization and Adaptability; 2) Motivation and Engagement; 3) Real Time Feedback and Data; 4) Security and Transparency; 5) User Experience and Accessibility; 6) Critical and Collaborative Thinking; and 7) Emotional and Psychological Support (see Table 1). Table 3 shows the relevance of AI tool selection criteria with attributes or principles of Web 4.0 and Edu 4.0. For the first criterion, AI tools should be able to provide personalized instructions and feedback, as demonstrated by the Smart Tutoring System [13], and dynamically adjust content to ensure students are in their Zone of Proximal Development, as demonstrated by the adaptive learning platform [14]. For the second criterion, AI tools can increase student engagement through interactive environments, such as AR/VR enriched with AI technology [17]. AI tools should be collaborative enablers to foster peer interactions and serve as collaborative [15].

For the third criterion, AI tools should be able to carry out real-time data collection and analysis to improve educational interventions [16]. It should be used to conduct predictive analysis to identify at-risk students and provide timely intervention plans [18]. For the fourth criterion, AI tools need to guarantee data security and manage education records transparently through AI technology in Blockchain [19]. Next, AI tools should have a user-friendly interface and provide interactive activities to improve language efficiency and a personalized learning experience [20]. For the sixth criterion, AI tools should be able to improve critical thinking and collaborative practices [22]. For the last criterion, AI tools should provide interactions that meet emotional needs and increase learning satisfaction, freedom, and productivity [21].

Web 4.0	Edu 4.0	Al in Education	Selection Criteria
Intelligent Integration	Anytime, Anywhere Learning	Personalized Learning	User Experience and Accessibility
Enhanced Interaction	Personalized Learning	Dynamic and Adaptive Content	Personalization and Adaptability
Ubiquitous Connectivity	Student Choice in Learning Methods	Collaborative Learning	Security and Transparency
Collaborative Ecosystem	Project-Based Learning	Performance Prediction	Critical Thinking and Collaboration

Table 2

Manning attributes or principles for Web 4.0 Edu 4.0 and Al in education

Practical Learning Experiences	Secure and Reliable System	Real-Time Data and Feedback
Data Interpretation Skills	Holistic Development	Engagement and Motivation
Alternative Assessment Methods		Emotional and Psychological Support
Student Feedback in Curriculum Design		
 Student Autonomy		

4.2 The AI Learning Design in Education

Figure 1 shows the AI learning design to guide the application of AI in education. The integration of AI-driven learning design in education can be enriched by aligning with the interconnected frameworks presented in Education 4.0, Adaptive Learning, Web 4.0, and foundational Learning Theories. Education 4.0, as outlined by Fisk [24], promotes personalized, student-centered learning that allows for autonomy and active student engagement through methods like project-based learning and alternative assessment models. When intersected with the adaptive capabilities of AI, this model fosters a responsive learning environment, enhancing data interpretation, student feedback, and curriculum design by dynamically adjusting content based on individual learner needs and feedback loops. Web 4.0 further supports this integration by leveraging advanced technologies, such as AI, Big Data, and IOT, which enable a seamless, intelligent learning ecosystem characterized by ubiquitous connectivity and collaborative interaction.



Fig 1. The AI learning design in education

This ecosystem is enhanced by adaptive learning technologies that respond to individual learner profiles, facilitating dynamic and personalized content that supports performance prediction and holistic development. Grounded in established Learning Theories, such as Vygotsky's Zone of Proximal Development [30] and Cognitive Load Theory [31] and implemented through structured strategies like Gagne's Nine Instructional Events [29], Al-driven design effectively operationalizes these educational philosophies, creating a secure, reliable, and supportive learning framework. This

combination of theoretical foundation, adaptive technologies, and learning personalization fosters a transformative approach to education, shaping an inclusive, connected, and student-centered learning environment.

4.3 Expert Validation

The expert validation was conducted using the Fuzzy Delphi Method to assess the criteria. The experts measured the importance and application of each criterion. Through the FDM, the study reached a consensus level of 85%, suggesting a high level of agreement among experts on the appropriate and effective identification of the selection criteria. The seven proposed criteria-Personalization and Adaptability, Motivation and Engagement, Real-Time Feedback and Data, Security and Transparency, User Experience and Accessibility, Critical and Collaborative Thinking, and Emotional and Psychological Support-were validated with very high agreement indices. Consensus indices were highest (over 90% agreement) for the criteria Personalization and Adaptability, and Real-Time Feedback and Data, together reflecting the importance that these examples of AI tools applications may be perceived to hold in the educational context.

Input from experts was also sought to refine the learning design framework for AI-enhanced learning environments based on the validated selection criteria. The experts came to a consensus on certain aspects of the framework to include cognitive and socio-emotional dimensions to provide comprehensive support for all aspects of student learning. Experts underscored the need to develop ethical and data protection components built into the framework in terms of data privacy and algorithmic bias, making this an important principle in the implementation of AI in education. With a high level of expert agreement achieved, the Fuzzy Delphi Method helped validate both the criteria for the selection of AI tools and the learning design framework. Table 3 provides an evidence-based basis for AI-supported education integration, which complies with Malaysian educational policy and current educational needs globally. The framework offers a holistic, flexible, and developmental approach for educators to choose the best AI technologies that meet diverse use cases and educational needs through the dual lens of pedagogy and ethics.

Criteria	Importance Rating (1-10)	Consensus Level (%)	Expert-Driven Modifications/Feedback
Personalization and Adaptability	9.4	92%	Emphasized as crucial for diverse learner needs. No modifications are recommended.
Motivation and Engagement	9.2	88%	Highlighted the importance of gamification features to sustain student interest.
Real-Time Feedback and Data	9.5	90%	No modifications are needed; considered essential for formative assessments.
Security and Transparency	9.0	87%	Suggested including ethical guidelines for data privacy and transparency.
User Experience and Accessibility	8.8	85%	Emphasized the importance of intuitive design for wider accessibility across age groups.
Critical and Collaborative Thinking	9.1	89%	Suggested adding collaborative learning elements to encourage teamwork and problem-solving skills.
Emotional and Psychological Support	8.7	86%	Recommended expansion to address broader social-emotional needs, including stress and motivation.

Learning Design Framework	9.3	91%	Recommended inclusion of feedback loop mechanism for continuous tool improvement.
Components			
Ethical Considerations	9.6	94%	Added to ensure ethical AI use, addressing transparency, bias, and inclusivity.

5. Discussion

This paper further outlines the importance of establishing a criterion for choosing AI learning tools in combination with developing an AI learning design that ultimately influences quality, effectiveness, and inclusivity within an educational framework containing components that are driven by advancements in artificial intelligence. While many of these educational AI tools are developed with Web 4.0 and Education 4.0 in mind, choosing suitable ones would significantly increase their usefulness for teaching-learning purposes. This paper develops an AI learning design based on the identified criteria - 1) Personalization and Adaptability; 2) Motivation and Engagement; 3) Real Time Feedback and Data; 4) Security and Transparency; 5) User Experience and Accessibility; 6) Critical and Collaborative Thinking; and 7) Emotional and Psychological Support, so that they meet all learners irrespective of their cognitive style providing a learning path and supporting holistic development. The above-described criteria in this paper define the structured design of AI learning and enable educators to select AI learning tools, that serve not only their content requirements but also a supportive environment as well as interactive/adaptive ways for enhanced learning. The value proposition, therefore in the selection criteria and AI learning design should create a balanced student-centered educational ecosystem that meets academic needs but also addresses well-being (social and emotional), and ethical aspects of learner development aligning with Web 4.0 and Education 4.0 principles.

Al technology holds great transformative promise in pedagogy. The application of Al technology has paved the way for individualized learning experiences catered to specific requirements — which in turn boosts student engagement and consequently, their academic results [27]. Several studies offer ways that AI technology has benefited student learning opportunities and learning management systems [16,25,26]. It can help with mundane tasks in an office environment and free up teachers for teaching and mentoring [27]. For example, the Virtual Teacher Assistant (VTA) may have access to some of the other analytics and tracking which will free up more time for the teacher so they can give stronger guidance as needed. Using AI Assistants, teachers can work together to improve the learning experience. AI data analytics tools help to determine how each student learns and offer teachers information on how they could teach better [27].

In addition to the benefits of using AI technology in education, the development of this technology also comes with challenges, including the need for large investments in technology infrastructure, risk management of biases inherent in AI algorithms, and concerns about privacy and data security [27]. Several recent studies have identified challenges related to the integration of AI technology into education in developing countries. The main factors are as follows: 1) Availability of ICT hardware, 2) Availability of electricity; 3) Internet accessibility; 4) Data cost; 5) Students' basic ICT skills; 6) Language, and 7) Lack of content that suits their respective local cultures. Therefore, a new digital divide is created in the use of data-based knowledge to make decisions due to the absence of basic infrastructure in developing countries [28]. To fill the new digital divide, the transition towards AI technology-assisted education requires educators to equip themselves with new skills and adapt to new roles [27]. Teachers need to develop new competencies, including 1) Understanding the role of AI in facilitating learning; 2) Developing research and data analysis skills for data interpretation and feedback; 3) Developing new management skills for effective resource management; 4) A critical

perspective on AI technology and the impact of digital technology on human life; 5) Utilizing the role of AI technology in improving students' abilities such as guidance and emotional support; and, 6) Helping students acquire skills and competencies that cannot be easily replaced by machines [16].

To broaden the use of these proposed criteria and framework, there is a need to examine the broader application of the proposed AI tools selection criteria and framework to account for the layered educational systems and cultural contexts prevalent in many parts of the world. Although this study was conducted in Malaysia the challenges that inform the decision-making process on AI tool identification are not contextual, these are problems familiar in other education contexts. The regional adaptation of the AI tool selection allows its international application by recognizing and considering local particularities of infrastructure, cultural traditions, and regional educational aims. The criteria described in this study are adaptable according to different educational settings in other countries by various stakeholders. Especially in developing countries where educational resources are limited making the digital divide a still visible issue, the need for culturally adaptive, regionally specific AI tools, is ever great. Through careful choice and implementation of AI tools that meet these obstacles, teachers all over the world can create a learning environment that is more inclusive, effective, and fair. This expanded definition is, of course, part of a global trend in education — with the image of technology assisting lifelong and inclusive learning now strongly enshrined in the aspirations of UNESCO, and other international agencies.

Therefore, the education system has evolved rapidly to ensure that every student acquires the knowledge and skills needed for future jobs facilitated by artificial intelligence. This educational innovation is being implemented in all areas of education, from early childhood education to lifelong learning. The trend towards lifelong learning certainly fits with the rapid development of AI technology. Therefore, we need to balance the opportunities and challenges associated with AI technology so that we can harness the potential of AI technology to create a more effective and equitable educational landscape.

6. Conclusion

The successful integration of AI in education requires an intelligent choice regarding the types of AI learning tools used, a solid design for learning, and reiterative development to cater explicitly to changing requirements considering students, educators as well as the larger context around us. The selection criteria of AI learning tools include 1) Personalization and Adaptability; 2) Motivation and Engagement; 3) Real Time Feedback and Data; 4) Security and Transparency; 5) User Experience and Accessibility; 6) Critical and Collaborative Thinking; and 7) Emotional and Psychological Support, ensure that the AI learning tools cater to pedagogical necessities while also meeting diverse student needs. In this paper, a tailored AI learning technologies as they relate to foundational theories of instruction, while fostering a new way in the teaching/learning process. This learning design is to create personalized learning experiences, support dynamic content adaptation, and ultimately foster an inclusive, supportive technology-rich environment.

Future studies should examine the lasting effects of AI-enabled personalized learning on student outcomes and how it can help level up educational inequities warrant further investigation. Research to address how AI can best support teacher professional development, reducing teachers' administrative burden or enhancing student engagement within a distant learning/hybrid context could open significant research opportunities. The research on ethical considerations when in AI education, especially dealing with data privacy, student autonomy, and transparency will also need to grow as the use of AIs becomes a de facto part of educational systems. Attending to these critical

areas and iteratively improving on the overall integration of AI in education, will help teachers as well as policymakers build a truly digitally compliant educational system that is adaptive enough to create future-ready students with all needed competencies required living in an interconnected digital world.

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