A Proposed Evaluation Matrix for the Roles of Artificial Intelligence in Developing Smart Learning Methods

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Abstract:

The current study aimed to design a proposed evaluation matrix for the roles of artificial intelligence (AI) in developing smart learning methods, informed by data mining analyses of big data related to these roles, with the overarching goal of enhancing the quality of educational systems and envisioning a promising future for AI utilization in the digital era. To achieve this, the study addressed six specific questions focusing on AI's developmental roles, necessary utilization tasks, potential advantages, hindering challenges, evaluative criteria, and optimization strategies within smart learning methods. The study adopted a descriptive and analytical method, based on an exploratory survey of big data concerning AI's roles in education from multiple perspectives. Relevant literature from open digital sources available online, published during 2023-2025, was reviewed. This review identified 91 recurring AI roles, appearing in varying proportions, which were then categorized into 11 main areas. These roles were presented in a questionnaire to explore the opinions of a sample of 40 researchers, educational supervisors, and teachers in the Sultanate of Oman who are involved in AI in education. The purpose was to explore their views on the most important current and future roles of AI in developing smart learning methods. The sample's opinions largely concurred on the importance of 41 roles, classifying them as "very important" or "important". Subsequently, a proposed evaluation matrix was designed to leverage these roles, incorporating five influential dimensions: methods and tasks, potential advantages, hindering challenges, evaluation criteria, and improvement strategies. The evaluative content of the roles within the matrix was then discussed in five workshops, comprising five discussion sessions, which concluded with findings to answer the research questions. The study concluded with recommendations for future research.

***Keywords*:** Artificial Intelligence, Educational Roles, Smart Learning Methods, Evaluation Matrix.

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I. General Research Framework:

Introduction:

The literature on the applied uses of AI in smart teaching and learning has significantly expanded, with a substantial increase in related data over the past three years (2023–2025). This proliferation necessitates the consideration of appropriate scientific methodologies for mining this literature to extract content that enhances AI's roles in developing smart learning methods (Shaltout, 2023; Chew, 2023; Abdulmugood, 2024).

Al-Dosari (2019) highlighted that modern technical data has provided researchers with diverse systematic mining tools and methods for conducting data mining and sentiment analysis of digital big data. A review of the literature also revealed various big data mining methodologies, including data analysis using machine learning algorithms (Harizi, 2023), data quality assessment matrices (Academia, 2024), and analytical text mining for large texts (Sahl, 2025).

Some literature underscores the advantages of matrix methodology in big data mining (Ahmed, 2023; Chen & Li, 2024; Kumar, 2025-A). Its prominent benefits include categorical data analysis based on specific and clear criteria to ensure accuracy and reliability (Ahmed & Khan, 2023-A), providing an organized scope of work that facilitates the mining process and pattern extraction (Chen & Zhao, 2024-A), and utilizing evaluation tools to enhance analysis efficiency and results quality (Kumar, 2025-B).

Furthermore, some literature has emphasized the utility of matrix methodology for future forecasting from multiple perspectives. Lee & Park (2024) indicated its contribution to developing accurate future scenarios based on its results, thereby improving strategic planning practices. Wang (2025) explained its role in analyzing patterns and trends influencing future decisions. Chen & Zhao (2024-B) underscored its effectiveness in providing innovative visions and solutions across various fields, including the application of AI in educational development.

Despite the current and future importance of using evaluative matrices, a survey of studies on AI's role in creating smart learning methods indicated a limited number of such studies. Smith & Brown (2023) attributed this to the often unstructured and diverse nature of big

data, which complicates effective handling and mining without prior cleaning processes. Chen & Zhao (2024-C) explained that analytical processing of big data using orthogonal matrices demands expensive computing resources, while Kumar (2025-C) noted the difficulty of adapting to the rapid changes in big data, necessitating continuous updating of orthogonal matrix content.

Other influential factors contributing to the limited use of orthogonal matrices for big data include the effort required to design matrix dimensions and the depth of analytical investigation into interactions among its dimensions (Ahmed & Khan, 2023-B; Chen & Zhao, 2024-D; Kumar, 2025-D).

Given what has been stated, it is evident that the applied use of evaluative matrices is a potentially suitable methodology for exploratory investigation into big data to evaluate AI's roles in developing smart learning methods. This approach can then leverage the results to enhance the quality of the education system in the digital age.

Problem and Questions of the Study

The main research problem is framed by the question:

How can the roles of artificial intelligence in developing smart learning methods be evaluated using a proposed evaluation matrix in light of big data mining techniques in this field? This aims to improve the quality of the educational system and its targeted outcomes, and to anticipate promising future applications of artificial intelligence in the digital age. This main question was subdivided into the following sub-questions:

Research Questions

- What are the developmental roles of artificial intelligence for smart learning methods considering big data mining analysis?
- What utilization tasks are necessary for AI to fulfill its developmental roles in smart learning methods?
- What are the advantages of functional AI roles in the development of smart learning methods?
- What are the challenges hindering the roles and functions of AI in developing smart learning methods?
- What are the evaluative criteria for the roles of AI in the development of smart learning methods?

- What are the optimization strategies for functional AI roles in the development of smart learning methods?

Purpose of the Study

- The primary goal of this study is to assess how artificial intelligence contributes to creating smart learning methods by using a suggested evaluation tool based on big data analysis. This main objective can be achieved by accomplishing the following sub-objectives:
- Identify the developmental roles of artificial intelligence for smart learning methods considering big data mining analysis.
- Identify the utilization tasks needed for AI to fulfill its developmental roles for smart learning methods.
- Demonstrate the advantages of functional AI roles in the development of smart learning methods.
- Identify the challenges that hinder the roles and functions of AI in the development of smart learning methods.
- Identify evaluative criteria for the roles of AI in the development of smart learning methods.
- Identify optimization strategies for functional AI roles in the development of smart learning methods.

Significance of the Study

This study is significant because it adopts an exploratory approach to mining big data on the multifaceted and growing roles of AI in improving education and developing smart learning methods. This opens new avenues for research on how to optimize AI utilization for maximum benefit. The anticipated benefits of the current study can be summarized as follows:

- Inform educators on how to analyze AI big data to deliver a personalized learning experience that fits individual needs and promotes personalized learning.
- Enable learners to maximize technological possibilities by employing smart AI functions in education, thereby contributing to improving processes based on research findings.

- Provide evaluators of teaching and learning outcomes with smart analytical tools that deepen applied understanding, aiding in the interpretation of AI roles, tasks, and strategies embedded in big data.
- Facilitate mechanisms to address challenges hindering the utilization of AI applications in education and provide effective strategies to overcome them through solutions designed for each challenge.
- Motivate researchers to develop smart analysis techniques using orthogonal matrices with innovative methods based on big data mining using AI applications.
- Support strategic planning experts in conceptualizing clear future visions and scenarios for AI-enabled education and its effective methods in teaching and learning.

Assumptions of the study

Several key assumptions underpin this study, among which are:

- Accelerating AI Role in Improving Smart Learning Methods: It is assumed that AI will achieve qualitative improvements in smart learning methods, particularly through big data mining analysis, which will allow for greater curriculum personalization and increased effectiveness of learning objectives.
- Existence of Multiple Educational Roles and Tasks for AI: This is evidenced by AI's ability to perform numerous, extensive, and high-speed tasks such as data analysis, recommendation generation, and future trend prediction.
- Big Data Mining Analysis Enhances Educational Process Efficiency: Analyzing big data is a fundamental basis for developing smart educational technologies and tools that contribute to raising the efficiency of educational systems, promoting innovative learning strategies, reducing educational gaps, and addressing challenges and difficulties.
- Improved Teaching and Smart Learning with Optimal AI Use: Enhanced teaching and smart learning are coupled with the optimal utilization of AI's developmental roles in the educational process by providing personalized learning experiences, increasing the speed and quality of educational processes, and reducing administrative burdens.

- Necessity of Addressing AI Implementation Challenges in Education: There are various technical, financial, and operational challenges to optimizing AI use, requiring a thorough understanding of these obstacles and the development of innovative solutions to address them.
- Possibility of Designing Comprehensive Evaluation Criteria: This can be achieved by extrapolating the content of scans and meta-analyses of big data related to AI roles in education, which aids in the effective utilization of these roles in light of their evaluative criteria.

Terms of the Study

a) Artificial Intelligence (AI) Roles in Education:

AI is defined as a broad branch of computer science focused on creating machines capable of learning, making judgments, and performing tasks at a human-comparable level. Advanced AI systems can autonomously learn and evolve, potentially independent of human involvement. They can handle complex tasks that would typically require human input but may need programmer assistance to learn from mistakes and improve (Tableau, 2023; Manning, 2020). Al-Messaad and Al-Farani (2023) define AI as computer devices and programs with the ability to act similarly to the human mind, whose applications can be utilized via smartphones and tablets and employed in education to achieve desired educational goals. Operationally, AI can be defined as the field of designing intelligent machines and software capable of simulating human mind intelligence, used to carry out learning, reasoning, problem-solving, and decision-making tasks, thereby contributing to the development of smart learning.

Al-Shahoumi's (2024) study enumerated the roles and uses of AI in education in the Sultanate of Oman, highlighting text, images, audio, video, the teaching process, educational content, personalization of education, testing and evaluation, administrative work, motivated learning, and language skills. AI applications and tools offer numerous roles, including developmental functions for education through personalizing learning, providing interactive support, analyzing educational data, and developing innovative educational strategies. All these aim to enhance educational efficiency and development, improve the learner experience,

and provide data to support educational decision-making (Abrams, 2025 & UNESCO, 2025).

In the current study, the roles of AI in education are operationally defined as the functions of AI to improve and develop smart learning methods, identified through big data mining. Such roles include personalizing educational content, providing interactive support, and developing educational strategies. These roles are evaluated using the proposed evaluation matrix based on key criteria (Ifenthaler & Others, 2024; Ramirez & Fuentes, 2024):

Efficiency: Measured by the speed of educational processes using smart technology (Ahmed & Khan, 2023-B).

Effectiveness: Determines the extent to which desired learning objectives are achieved and its impact on student performance (Chen & Zhao, 2024-A).

Adaptability: Reflects the ability of smart methods to adapt to different learning styles and individual student needs (Kumar, 2025-D).

Sustainability: Determined by the temporal continuity of the use of appropriate smart educational technology (Lee & Park, 2024).

Social Interaction: Achieved by enhancing communication and interaction between students and teachers through smart learning tools (Wang, 2025).

Overall Quality: Assesses student and teacher satisfaction with the use of smart systems in education (Ramirez & Fuentes, 2024).

The effectiveness of these roles is operationally measured by averaging the responses from the research sample on the AI Roles Evaluation Matrix Questionnaire, designed for this purpose (Appendix 1). This helps in providing appropriate recommendations to increase the effectiveness of AI roles in developing smart learning methods.

b) Developing Smart Learning Methods:

The concept of "developing smart learning methods" refers to the process of enhancing educational strategies using AI technologies, derived from big data analysis results, with the aim of improving learning efficiency and providing personalized learning experiences. This development involves analyzing educational data to integrate appropriate smart learning tools and offer interactive recommendations based on

learners' needs (Abrams, 2025; Kerimbayev & Others, 2025; Zizoune & Others, 2025).

Operationally, "developing smart learning methods" in this research signifies implementing effective teaching strategies that rely on AI to make learning more efficient, tailor educational content to individual needs, and improve learner interaction with smart systems. This development is measured using a proposed evaluation matrix, which includes evaluation criteria such as efficiency, effectiveness, adaptability, interactivity, and quality, to ensure the sustained developmental achievement of smart learning (Kerimbayev & Others, 2025; Zizoune & Others, 2025; Ifenthaler & Others, 2024).

c) Proposed Evaluative Matrix Framework:

A matrix is defined as one of the models that astronomer Zweiky termed the Morphological Model, which is fundamentally based on the concept of cross-classification of phenomena into overlapping categories and includes tables divided into cells to illustrate relationships between several variables (Zweiky, 1957).

Evaluation, linguistically, means modifying something, removing its crookedness, and making it straight or upright. From an educational perspective, evaluation is the process by which the achievement of desired educational goals can be ascertained, using multiple methodologies, tools, and measurements, and providing sufficient data and evidence about the subject being evaluated. It is a diagnostic, therapeutic, and preventive process, carried out by an individual or a group, to determine the extent to which objectives have been achieved (Abu Laban, 2012).

The evaluation matrix is represented by a set of vertical columns and horizontal rows to show the relationships between the interacting evaluation variables that affect the studied phenomenon (Kerimbayev & Others, 2025; Zizoune & Others, 2025; Ifenthaler & Others, 2024).

The "proposed evaluation matrix for the development of smart learning methods" is defined as a proposed systematic tool designed to evaluate AI's roles in developing smart learning methods. The evaluation assesses the efficiency, effectiveness, adaptability, and sustainability of AI roles based on findings from big data mining related to educational AI

roles. The evaluation process encompasses five main dimensions: methods and tasks, positive benefits, hindering challenges, evaluation criteria, and improvement strategies for AI roles, along with the decisions required to operationalize them in smart learning, both currently and in the future, as detailed in Appendix 2.

d) Roles Effectiveness:

Roles effectiveness is defined as the extent to which AI fulfills its roles in developing smart learning methods. It is procedurally measured by calculating the average frequencies of the research sample's responses regarding the importance of each role, using the AI Roles Evaluation Matrix Questionnaire prepared for this purpose (Appendix 1). This data is useful for providing appropriate recommendations to increase the effectiveness of AI roles in developing smart learning methods.

Research Limitations

The study adhered to the following geographical, thematic, and temporal boundaries:

Human Boundaries: The human sample participating in the research tools consisted of 40 researchers, educational supervisors, and teachers from various specializations. Their interest in employing AI in education was evident through their consistent participation in activities organized by the Sohar City Education Department for AI employment in education, in cooperation with the Chamber of Commerce of North Al Batinah Governorate in Oman.

Thematic Boundaries: The evaluation was limited to the most prominent AI roles identified from informational scans of relevant literature and big data mining of open-source online data, up until early March 2025. From the 91 observed functional uses of AI, the study focused on 41 roles that received the highest importance rating ("very important" and "important") based on the research sample's opinions.

Temporal Boundaries: The research's temporal scope was limited to the period from March 15 to March 25, 2025, during which the field study tools were applied.

II. Review of Literature

The study literature encompasses the theoretical framework concerning the roles of artificial intelligence (AI) in developing smart

learning methods, along with relevant related studies. Several definitions of AI have been presented in the literature. For instance, AI is defined as "a computer that employs human intelligence to accomplish specific tasks through planning, generalization, understanding, reasoning, problem-solving, and prediction" (Galle, González, & Hernando, 2023). It has also been characterized as "one of the modern technologies relied upon across various aspects of life, offering services distinguished by accuracy, speed, and high efficiency in sectors where AI has been implemented, such as education, economy, medicine, and security" (Al-Obaidaniya & Al-Shanfari, 2024, p. 4).

AI aims to understand the nature of human intelligence by developing computer programs capable of simulating intelligent human behavior, that is, the ability of programs to process an issue or make a decision for a specific situation. It also facilitates computer use through its problem-solving capabilities, contributing to effective and uncomplicated training and learning processes by processing patterns that resemble mental processes in the human mind (Al-Tubi, Al-Qassab, & Al-Abri, 2024). Thus, AI exhibits characteristics such as thinking and perceiving, using intelligence to solve problems, generalizing and understanding from experiences, acquiring and applying knowledge, handling complex situations, dealing with incomplete or ambiguous information, creativity and imagination, and enhancing decision-making.

AI applications in education are numerous, encompassing methods and strategies that foster student engagement, interaction, and creativity. These applications include:

- Augmented Reality (AR) Technology: Considered one of the most prominent modern technologies that integrate digital information into educational environments. AR combines educational situations with digital objects via computer, enhancing the learning experience by transforming graphics into three-dimensional models, allowing teachers and students to view them with precision and clarity (Al-Ghamdi & Jamil, 2020).
- Intelligent Tutoring Systems (ITS): These are computer systems designed to improve and facilitate the process of knowledge

generalization. They can provide automated lessons without requiring a teacher's presence and utilize cloud computing and AI technologies to make the educational process more efficient and effective (Mohamed & Mohamed, 2020).

- Chatbots: These software systems enable interaction with a robot through text-based conversations. Chatbots automatically respond to conversations and can be programmed to provide diverse answers based on the interlocutors and the topics discussed (Al-Omari, 2021).

A 2023 report by the U.S. Department of Education highlighted the significant acceleration of investment in AI and increased research into its educational uses, such as intelligent tutoring systems and adaptive assessment (Miguel, 2023). Lewis and Al-Azab (2023) underscored the importance of focusing on AI in education to achieve better, comprehensive, and low-cost educational priorities. AI facilitates adaptation and alignment between various learning resources and students' strengths and needs. As developing teaching functions is a top priority, AI can provide substantial support to teachers through automated assistants and other AI tools, expand support for individual students, and bolster curriculum development. Bloom (2024) also listed the top ten AI-based educational tools developed and used in education, including i-Spring Page, Magic School, and Eduaide.ai, reflecting the growing interest in adopting these technologies.

Al-Shehhi’s (2024) study demonstrated AI's importance in education, showing its contribution to providing individualized and specialized experiences that account for student needs, thereby enhancing the efficiency of teaching and learning through interactive tools. AI also helps analyze student performance and generate accurate reports encompassing their personality, academic, and practical abilities, all contributing to an effective learning environment that achieves educational goals for sustainable development.

Numerous studies have explored various applications of AI in education and teachers' awareness of them. For instance, Al-Shaidi and Al-Saidi (2023) aimed to identify the reality of Saudi secondary school teachers' application of AI criteria in the educational process. Using a questionnaire to gauge teachers' perspectives, their results indicated that

secondary school teachers applied AI application criteria to a moderate degree, with no statistically significant differences based on job, gender, years of experience, or AI training courses (Al-Shaidi & Al-Saidi, 2023).

Al-Tubi, Al-Qassab, and Al-Abri (2024) recommended employing AI tools in teaching to improve and develop the educational process. They argued that AI tools significantly enhance student interaction with academic content and provide personalized learning experiences tailored to individual needs. AI also offers teachers opportunities to analyze data and make evidence-based educational decisions, which contributes to raising educational performance efficiency and stimulating innovation (provided it is integrated with traditional methods) and reinforces the teacher's role in effectively guiding the educational process. However, they cautioned that these tools must be approached carefully, considering potential challenges such as concerns about job displacement or over-reliance on technology. Thus, they emphasized the need for continued exploratory studies on AI's impact across various educational aspects, including social and psychological dimensions, to ensure its use aligns with human and professional educational values.

A 2025 survey by the Communication and Media Center in Oman probed teachers' opinions on utilizing AI tools in their lessons, recognizing technology's rapid advancement and AI's integral role in various sectors, including education. The survey sought to understand how teachers benefit from AI tools, the impact of these technologies on teaching methods and education quality, and whether AI has improved the learning experience, all through teachers' perspectives and experiences in the field. Results showed AI's role in designing interactive educational resources, such as machine learning and natural language processing, to improve the educational process by personalizing content, providing tailored learner support, and offering accurate academic performance analytics. AI serves as a tool that enhances the teacher's role, provides immediate assessments, and offers personalized feedback, aiding teachers in refining teaching strategies, providing additional support to students in need, and contributing to the design of interactive and diverse educational resources that stimulate creativity and make learning more effective and enjoyable.

It also assists in monitoring student development and will play a significant role in improving the learning experience by designing personalized curricula for each student based on their understanding level and learning style, and tracking individual student progress, enabling timely teacher intervention to address difficulties. AI tools also help generate images and information, assisting teachers in presenting lessons and conveying information accessibly and appealingly, aligning with student inclinations and interests. The use of AI fosters more engaging interactive education, necessitating teacher training on its effective employment to activate their educational roles, create personalized educational content, analyze student levels, and evaluate them according to remedial and enrichment plans, ultimately developing the educational process, enhancing learning quality, and fostering an innovative and creative learning environment.

The preceding literature review reveals a consensus on the importance of employing AI tools, their roles, and their diverse uses in developing teaching and learning. It is also clear that studies on this topic varied in their approach. Some focused-on understanding teachers' perceptions of AI uses in education, while others addressed AI's roles in improving and developing curricular experiences by enhancing their attractiveness and offering more opportunities for individualized learning. Some literature pointed to the effects of AI and its applications on developing learners' thinking skills for problem-solving, decision-making, innovation, and creativity. Additionally, some literature recommended conducting more exploratory research on AI's roles in the educational process, including social and psychological dimensions, to ensure its use aligns with the development of educational aspects and human and professional values in education. This alignment helps mitigate potential challenges or threats that might reduce the effectiveness of AI's developmental roles in smart learning methods. This is one of the endeavors the current research seeks to clarify.

III. Research Methodology and Procedures:

Methodology:

The study adopted a descriptive-analytical approach (Mutawa & Al-Khalifa, 2016). Relevant literature concerning AI's roles and uses in the

educational process was reviewed, and published data was mined using the Google search engine. This process identified 91 recurring uses of AI in education, which were then categorized into 11 main areas according to their roles.

Participants

The study sample comprised a single group of 40 researchers, educational supervisors, and teachers from the Sohar Education Department. These individuals were participants in an educational program on employing artificial intelligence applications in education, conducted in cooperation with the Chamber of Commerce of North Al Batinah Governorate in Oman. The sample included 8 researchers at the Master's and Doctoral levels in curricula, teaching methods, educational technologies, and educational administration; 4 researchers in information systems; 10 male and female educational supervisors; and 18 male and female teachers. The sample consisted of 23 males and 17 females. The individuals had diverse field experiences across different educational stages, with their years of experience ranging from 5 to 15 years.

Study Procedures and Stages

- The study proceeded through the following stages and procedural steps:
- Information Scanning and Data Mining Stage Related to AI Roles and Uses in Education.
- Study variables were information-scanned from numerous sources, including books, studies, and reports that addressed AI roles, their fields, evaluation criteria, and dimensions of smart learning method development.
- Analytical Categorization Stage of AI Roles, Domains, and Influential Dimensions.

Ninety-one recurring uses of AI in education were identified and categorized into 11 main areas. The quality criteria for AI's roles in the educational process also varied to include efficiency, effectiveness, adaptability, and sustainability. The influential dimensions of AI's role in education were categorized and assessed through 5 main matrix dimensions: methods and tasks, potential advantages, hindering challenges, evaluation criteria, and improvement strategies. As such, the

proposed assessment would determine the proposed evaluation of decisions needed to operationalize AI roles and uses in developing smart learning methods both currently and in the future.

Surveying the Sample on the Most Important Current and Future Roles of AI in Developing Smart Learning Methods. This stage involved the following:

a) A questionnaire was prepared in its initial form, consisting of 91 roles related to AI uses, applications, and tools. These roles were categorized under 11 areas of AI use in education, including uses related to text, images, audio, video, supporting the teaching process and educational content, personalizing education, selection and assessment, teacher administrative work, motivated learning, language skills, and other miscellaneous uses (e.g., mind maps, infographics, scientific research, augmented reality, learning disabilities, robotics). The purpose was to determine the degree of importance of AI's functional roles in education in Oman, using a five-point Likert scale (Very High 5, High 4, Medium 3, Low 2, Very Low 1).

b) The questionnaire was distributed to the research sample of 40 males and females. Its face validity was verified by asking respondents about the clarity of its vocabulary. Their opinions confirmed the clarity of its phrases and the simplicity of the answering method, as no one requested clarification.

c) The results of the questionnaire responses were monitored, and 41 important roles were identified as having a "very high degree of importance" and "high degree of importance," with a relative average of 80%, based on the sample's agreement.

Preparing a Proposed Evaluation Matrix to Assess the Effectiveness of AI's Roles in Developing Smart Learning Methods and the Sample's Opinions on AI's Most Important Current and Future Roles in this Context. This was done as follows:

a) The 41 important AI roles agreed upon by the sample were listed in the first field of the matrix.

b) The subsequent five sections of the matrix showed the five main factors influencing the quality and effectiveness of AI roles in creating smart

learning methods: methods and tasks, positive benefits, hindering challenges, evaluation criteria, and improvement strategies.

Discussing the Rationale for the Proposed Evaluation Matrix.

The proposed conceptualization and rationale of the initial matrix were presented to the research sample. The matrix included 41 rows and 6 columns, totaling 246 cells. Each cell reflected the interactive effect of the vocabulary of each dimension with the five matrix dimensions concerning the important roles of AI in education. It is noteworthy that the data mining operations were performed using some free AI application programs available on the internet, namely Copilot, Perplexity, and Poe.

Application and Analytical Discussion of the Proposed Evaluation Matrix.

The study sample was divided into five groups. Each group analyzed the cells in its respective fields and discussed them in five discussion workshops. The first group analyzed and discussed the first interactive impact dimension in the matrix related to methods and tasks effective in the current and future developmental roles of AI in teaching methods. The second group addressed the second dimension related to positive advantages. The third group addressed the third dimension related to hindering challenges. The fourth group addressed the fourth dimension related to evaluation criteria. And the fifth group addressed the fifth dimension related to improvement strategies. Each workshop lasted one and a half hours and took place over three days, with two workshops on the first and second days and one workshop on the third day. This was followed by a digital voting session using the "poll-surveys" application (https://apps.apple.com/eg/app/poll-surveys/id1346774263) for electronic voting via mobile phone through communication platforms (WhatsApp, Telegram, Messenger, and Facebook) to determine the relative evaluative average of the sample's opinions on how each of the five matrix dimensions achieved its objective, as well as the matrix's overall achievement of its intended use.

Final Evaluative Review Phase of the Proposed Evaluation Matrix.

, a comprehensive evaluation report for the matrix was prepared, in accordance with the participants’ voting feedback ensuring its final form

is suitable for use in evaluating AI's developmental roles for current and future smart learning methods in education in Oman (Appendix 2).

Answering the Research Questions.

- Based on the analytical extrapolation of the matrix fields and cells, the six research questions were answered.
- Formulating Research Recommendations.
- The study recommendations were formulated based on its findings.
- Suggesting Future Research and Studies.
- Future research proposals were prepared, emerging from the content of the current research.

IV. Findings

I. Results of the Questionnaire

In light of the analytical discussions of the results from the questionnaire administered to the research sample, the following findings were reached:

The areas of applied use for AI and its roles in improving the learning and teaching experience were ranked as follows: a) Uses related to supporting the teaching process and educational content: This area ranked first, with a relative average evaluation of importance from the sample at 25%. This is attributed to its fundamental role in enhancing educational quality and providing effective teaching and learning content. b) Uses related to meeting individual student needs and promoting personalized learning: This ranked second, with a relative average importance rating of 20% from the sample's perspective. c) Uses related to selection and evaluation: This came in third place, with a relative weighted average of 15%, highlighting its important role in improving the accuracy and speed of evaluations and providing immediate feedback. d) Text-related uses: These ranked fourth, with a relative weighted average of 10%, due to their application in text analysis and educational content generation. e) Audio-related uses: These were ranked fifth, with an estimated relative average of 8%, for their role in converting text to audio or vice versa, thereby enhancing content accessibility. f) Video-related uses: These were ranked sixth, with an estimated relative average of 7%, for their role in delivering interactive and visual lessons. g) Uses related to the teacher's administrative work: These were ranked seventh, with an estimated

average of 5%, owing to their role in reducing the teacher's administrative workload and increasing focus on teaching. h) Uses related to motivated learning: These ranked eighth, with an estimated average of 4%, for boosting student motivation through games or challenges. i) Uses related to language skills: These were ranked ninth, with an estimated average of 3%, for their role in improving pronunciation and learning new languages. j) Image-related uses: These ranked tenth, with an estimated average of 2%, for their role in analyzing images used in education. k) Other miscellaneous uses: These were ranked eleventh, with an estimated average of 1%, covering various applications such as mind mapping, infographics, scientific research, augmented reality, and learning disabilities.

II. Results of the Proposed Evaluation Matrix

In light of the analytical discussions of the applied results of the proposed evaluation matrix, the six research questions can be answered as follows:

The first question stated: "*What are the developmental roles of artificial intelligence for smart learning methods in light of big data mining analysis*?"

The main roles that the research sample unanimously agreed were "very important" or "important" included the following:

- Personalized learning.
- Predicting academic performance.
- Interacting with educational robots.
- Smart Assessment .
- Analyzing Big Data.
- Developing interactive learning strategies.
- Virtual and Augmented Reality Blended Learning .
- Smart Curriculum Recommendation.
- Artificial Intelligence Psychological Support.
- Smart Classroom Management.
- Creating interactive content using artificial intelligence.
- Early detection of learning disabilities.

- Designing integrated educational content with the help of artificial intelligence.
- Recognize students' behavioral patterns.
- Developing creative thinking skills.
- Enriching classrooms with smart conversations.
- Gap Analysis.
- Advanced Adaptive Learning.
- Enhancing the multi-sensory learning experience.
- Predictive AI-based learning.
- Artificial Intelligence Motivation.
- Challenge-based learning.
- Facilitating virtual collaborations.
- Analyze knowledge consumption patterns.
- Learning through Emotional AI.
- Smart Learning Resources Management.
- Personal time management for students.
- Semantic analysis of educational content.
- Advanced Predictive Learning.
- AI-enhanced collaborative learning.
- Analyzing emotional data.
- Reactive Artificial Intelligence Reinforced Learning.
- Big data-driven education.
- Learning through intelligent robots.
- Extended Reality (XR) Education.
- Game-based learning.
- Learning across self-scalable systems.
- Academic guidance using artificial intelligence.
- Quantum computing-based content development.
- Neurofeedback-based learning.
- Multiple learning experiences integrated with smart agency technology.

Answer to the Second Question:

The second question stated: "*What utilization tasks are necessary for AI to fulfill its developmental roles for smart learning methods*?"

The functional tasks required for AI to fulfill its developmental roles in smart learning methods, derived from the data mining examination, included the following:

- Personalize content for each student using machine learning algorithms.
- Analyze data to predict students' strengths and weaknesses
- Using artificial intelligence through interactive robots to explain concepts.
- Designing test and evaluation systems using artificial intelligence.
- Extracting hidden patterns in data to optimize teaching methods.
- Optimizing learning through educational and interactive games.
- Providing 3D learning environments to enhance understanding and interaction.
- Suggest personalized curricula and learning materials for each student.
- Providing tools to support students facing stress.
- Automatically organize classrooms based on student performance and needs
- Designing engaging and challenging learning content
- Using Artificial Intelligence Systems to Detect Student Learning Problems.
- Create curricula that include texts, videos, and interactive exercises.
- Observe and analyze student interaction with learning activities.
- Provide learning activities based on generating new ideas.
- Providing automated learning aids to support classroom discussion.
- Detecting gaps in the education system by analyzing data.
- Dynamically adjust content based on student progress.
- Integrating sound, image, and movement into learning activities.
- Using prediction to optimize learning paths and better guide students.
- Provide stimulating learning experiences for students using interactive games and activities.
- Designing Problem-Based Learning Challenges.
- Providing platforms that support teamwork using artificial intelligence.
- Studying how students interact with educational content.

- Using techniques to understand students' emotions during the learning process.
- Organize and manage resources such as digital books and videos.
- Helping students organize their time with smart scheduling techniques.
- Evaluate educational content for gaps and characterization.
- Using artificial intelligence to predict students' future learning paths.
- Supporting teamwork through AI-driven platforms.
- Understanding students' emotions during learning to optimize their experience.
- Designing learning systems that rely on direct interaction between the student and the system.
- Using big data analytics to personalize approaches and improve performance.
- Using educational robots to provide support and assistance to students.
- Merging virtual and augmented reality to create immersive learning environments.
- Designing interactive educational games to motivate students.
- Designing learning systems that automatically evolve themselves based on student responses.
- Provide personalized advice to students on their academic paths.
- Using quantum computing to analyze learning data and design new content.
- Using neurofeedback devices to measure brain activity during learning.
- Integrating multiple smart agencies into the education system to provide a holistic experience.

Answer to the Third Question:

The third question stated: "*What are the potential advantages of functional AI roles in the development of smart learning methods?"*

The potential advantages of functional AI roles in developing smart learning methods, identified from the data mining examination, are numerous and include the following:

- Improving the student experience and increasing student engagement.
- Being able to intervene early to improve learning outcomes.

- Providing innovative education and enhancing students' interactive skills.
- Improve assessment accuracy and minimize teacher time and effort.
- Providing insights to help make informed decisions for curriculum development.
- Increase student motivation and develop interactive skills.
- Delivering an immersive and easy-to-understand learning experience.
- Improve learning efficiency and save time.
- Improved mental health and increased comprehension.
- Improve time management and increase teaching efficiency.
- Increase student motivation and foster critical thinking.
- Promoting early intervention to improve education.
- Provide comprehensive and integrated content that meets the needs of different students.
- Identifying students who need extra support.
- Fostering critical and creative thinking in students.
- Increase the level of interaction and improve the quality of discussions.
- Improving educational policies and directing resources more efficiently.
- Improve the student's ability to absorb material more effectively.
- Optimize the learning experience and increase engagement.
- Reducing educational losses and improving career guidance.
- Promote interaction and increase students' willingness to learn.
- Enhancing critical and creative thinking skills.
- Improve collaboration skills and foster group interaction.
- Provide profound insight to optimize curriculum design.
- Providing personalized support promotes student mental health.
- Improve resource access efficiency and minimize waste.
- Improve productivity and help students stay on time.
- Improve the quality of content and provide more effective learning resources.
- Improving academic guidance and minimizing educational loss.
- Improve collaboration skills and increase productivity.

- Provide personalized psychological and educational support.
- Optimize the learning experience and increase engagement.
- Providing insights into improving education.
- Promote interaction and provide personalized learning.
- Improve profound understanding of complex topics.
- Promote critical and creative thinking and increase engagement.
- Continuously optimize the learning experience.
- Promote personalized guidance and reduce indecision in decision-making.
- Accelerate the process of analyzing data and creating premium educational content.
- Improve understanding of students' responses to educational content.
- Improved integration of different activities and increased effectiveness.
- Answer to the Fourth Question.:

The fourth question stated: "*What are the challenges hindering the roles and functions of AI in developing smart learning methods?*"

The data mining examination identified the following challenges to the roles and functions of AI in developing smart learning methods:

- Difficulty in providing accurate, comprehensive, and privacy-sensitive data.
- Risk of bias from using unbalanced data.
- Some students resist the idea of dealing with artificial intelligence.
- Privacy challenges and the potential for technical glitches.
- The challenge of processing big data quickly and efficiently.
- Designers may face challenges in creating solutions that meet the needs of all students.
- The cost of developing high-quality content.
- Risk of bias or lack of proper data.
- Student acceptance and accuracy of these tools.
- Difficulty identifying accurate needs for all students.
- Design quality and alignment with learning objectives.
- Ensure accuracy and avoid misdiagnosis.
- Challenges arise when trying to align content with national education standards.

- Protecting student privacy and ensuring data is not misused.
- Design activities for all levels of creativity.
- The challenge of balancing the roles of a teacher and an automated assistant.
- The challenge of collecting and analyzing comprehensive and accurate data.
- Meeting the challenge of building algorithms that respond precisely to students' needs.
- The challenge of providing the necessary technical resources.
- Accuracy of predictive models and comprehensiveness of training data.
- Create engaging content that appeals to all age groups.
- Design challenges that are appropriate for students' culture and levels.
- Technology and infrastructure challenges.
- Collect reliable data and analyze it accurately.
- Ensure accurate understanding of emotions and avoid false analytics
- Need to integrate with existing education systems.
- Student acceptance and adoption of the technology.
- The complexity of analyzing texts.
- Accuracy of predictive models and comprehensiveness of data.
- Technology and infrastructure challenges.
- Ensuring accurate analysis and avoiding bias .
- Ensure the system accurately responds to the needs of students.
- Challenges in collecting and analyzing data effectively.
- Student acceptance and effectiveness of the technology.
- Technology cost and accessibility.
- Designing games for all age groups.
- The complexity of designing these systems and ensuring their efficiency.
- Dealing with diverse student situations.
- The cost of developing the technology and ensuring its accuracy.
- Privacy protection and data security.
- Smart Agency Integration Challenges.
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Answer to the Fifth Question:

The fifth question stated: *"What are the evaluative criteria for AI's roles in developing smart learning methods?"*

The evaluative criteria for the roles of AI in the development of smart learning methods, as revealed by the results of the data mining analyses, included the following:

- Measuring student satisfaction and performance improvement.
- Predictive validity and success rate of interventions.
- Students' level of responsiveness and quality of understanding of the content.
- Level of assessment accuracy and teacher and student satisfaction.
- The impact of the analysis on improving learning and the effectiveness of the decisions made.
- Level of student engagement and interaction with activities.
- Level of student engagement and quality of learning.
- Accuracy of recommendations and relevance to student needs.
- Level of student satisfaction and overall performance improvement.
- Level of organization and number of students served.
- Students' level of engagement with content and task completion rate.
- The number of cases detected and the success rate of interventions.
- Variety of content and quality of interaction.
- Accuracy of results and level of improvement in student performance.
- Rate and quality of new ideas
- Number and effectiveness of interventions from the automated. Assistant.
- Quality of analysis and accuracy of recommendations.
- The responsiveness of the system and how well the content matches. the student's progress.
- Level of student engagement.
- Number of successes realized from the guidance.
- Measuring engagement and the impact of motivation on performance
- Solution quality and success rate.
- Level of collaboration and effectiveness of group projects.
- The accuracy of the analysis and the impact of the resulting recommendations.

- Improved academic performance with reduced stress.
- Student and teacher satisfaction and accessibility.
- The extent to which students adhere to the schedule and their academic progress.
- The level of content quality improvement and the number of resulting improvements.
- The forecasted success rate and its impact on performance.
- The level of group interaction and the quality of joint projects.
- Improved academic performance with reduced stress.
- Level of engagement and quality of content.
- The rigor of the analysis and its impact on improving education.
- Level of student satisfaction and quality of interaction.
- Level of student engagement and quality of experience.
- Interaction rate and motivation level.
- The speed of adaptation and the quality of the resulting changes.
- The extent to which tips match student success.
- Accuracy and speed of output.
- The accuracy of the analysis and the number of optimizations applied.
- Students and teachers are satisfied with the experience.

Answer to the Sixth Question:

The sixth question stated: "*What are the optimization strategies for functional AI roles in the development of smart learning methods?"*

The optimization strategies for functional AI roles in developing smart learning methods, as revealed by the data mining analysis, included the following:

- Optimize data collection through advanced technologies to ensure accuracy.
- Enhance data models using diverse and balanced sources.
- Introduce more interactive and student-friendly robotic designs.
- Integrate deep learning techniques to analyze data more deeply.
- Leverage cloud computing to improve system performance and analyze data.
- Engage interaction design experts to ensure the quality of educational games.

- Develop virtual content for different curricula.
- Optimize algorithms using continuous learning and feedback.
- Leverage artificial emotional intelligence to analyze emotions.
- Use artificial intelligence for immediate data analysis.
- Involve teams of educators and programmers in content design.
- Optimize data models and make them more inclusive.
- Integrate education experts with specialized AI technologies.
- Use data encryption and identity protection technologies.
- Leverage AI-based innovation platforms.
- Optimize language models to reflect the context of the curriculum.
- Expand the database and ensure its comprehensiveness.
- Develop highly interactive deep learning models.
- Use Extended Reality (XR) techniques to scale.
- Optimize data models while incorporating rapid changes in society.
- Integrate smart gaming technologies and adjust challenges according to student progress.
- Engage subject matter experts to ensure challenges align with learning objectives.
- Develop user-friendly and inclusive platforms for students and teachers.
- Improve tracking technologies and broaden data collection.
- Integrate emotional AI technologies with flexible and personalized responses.
- Optimize user interfaces and ensure content comprehensiveness.
- Utilize interactive interfaces that promote ease of use.
- Integrate natural language processing models with big data sources.
- Optimize models using diverse and up-to-date data.
- Develop user-friendly and inclusive platforms for students and teachers.
- Integrate emotional AI technologies with flexible and personalized responses.
- Develop deep learning models to analyze student responses.
- Integrate cloud computing technologies to analyze big data.
- Design more interactive and student-friendly robots.
- Develop educational content for different curricula.

- Engage design experts to ensure the quality of educational games.
- Use deep learning to improve system adaptability.
- Update databases periodically to ensure accuracy.
- Gradually integrate quantum computing into existing systems.
- Develop more secure and wearable devices.
- Improve inter-agency collaboration protocols.
- Commentary on the Results

Analytical extrapolation of the questionnaire results and workshop discussions with the research sample indicate that the Sultanate of Oman, specifically Sohar city, represents a promising model in adopting AI technologies to improve the educational process. This aligns with Oman's Vision 2040, which aims to foster innovation and build future skills. AI applications in education in Sohar are used to support the teaching process and educational content through smart applications that provide personalized educational content for students based on their needs and levels. Some applications are utilized to analyze student performance and propose individualized educational plans for people with determination.

The impact of AI roles in educational institutions in Sohar is evident through the application of AI-based educational tools to improve teaching quality, such as Learning Management Systems (LMS) that provide accurate analytical reports to teachers. Furthermore, education is personalized using adaptive learning tool applications to modify educational content based on student responses. These applications have demonstrated positive effects in enabling students to learn at their own pace and enhancing their understanding of difficult concepts, particularly in science and mathematics. AI is also currently used in testing, assessment, test marking, and result analysis, thereby improving the quality and accuracy of assessments. Educational institutions in Sohar are committed to supporting researchers at Sohar University and other academic institutions to accelerate their research in AI applications in education, investing in training opportunities for teachers in this field, and mitigating challenges associated with the high cost of some AI applications and tools through research grants dedicated to fostering creativity and innovation in AI.

The results also demonstrate that AI has diverse uses and multiple roles in the educational process, especially following the widespread adoption of its applications and tools. AI has significantly impacted all stages of education, its processes, activities, evaluation methods, and the development of curriculum content. The effective influence of these roles may vary depending on teachers' convictions regarding the importance of using AI applications in the educational process and their ability to effectively practice these roles. The study identified 41 such roles, which the current research sample widely agreed were "very important" or "important."

However, a concern accompanies the enabling of these roles in the educational reality, possibly attributed to the widespread idea of AI replacing teachers, becoming a competitive alternative due to possessing capabilities perceived to surpass those of educators. Nevertheless, these fears will dissipate if teachers adapt and harness AI's capabilities to support and develop their traditional practices and roles in the educational field, which may no longer align with current developments and future aspirations.

The proposed evaluation matrix plays a crucial role in achieving a comprehensive understanding of AI's diverse roles in education, including implementation methods and tasks, positive benefits, hindering challenges, evaluation criteria, and improvement strategies. This holistic systemic conceptualization of the relationships among the interacting variables in the evaluation matrix can contribute to optimizing AI's functional tasks in developing smart learning methods, which will positively impact both students and teachers.

V. Research Recommendations and Future Suggestions

I. Research Recommendations

Given the study findings regarding the proposed evaluation matrix, the following actionable recommendations are offered to contribute to leveraging artificial intelligence (AI) across its various roles in developing smart educational systems. This aims to enhance the effectiveness of these roles in elevating the quality of education to meet the demands of the digital age:

Policy Development: Educational policies must be developed to support the multifaceted uses of AI in advancing educational methods, particularly the 41 roles identified in the current research, while adhering to guidelines for optimal technology use and data privacy.

Curriculum Redesign: Curricula should be redesigned to integrate AI's roles in education and smart learning. This necessitates tailoring education to student needs, enabling them to benefit from AI in alignment with educational visions focused on developing 21st-century skills.

Ongoing Training: Provide more continuous training opportunities for educational leaders and teachers on using AI technologies, with a strong emphasis on ethics and practical applications.

Smart Assessment Tools: Develop smart assessment tools that leverage AI to deliver accurate and personalized evaluations. Assessment modes should be diversified to accommodate varying student learning styles.

Enhanced Collaboration: Further strengthen collaboration among educational entities at all levels and technology companies to facilitate the exchange of expertise and resources in educational AI.

Continuous Research and Development: Encourage ongoing research and development to discover novel ways to improve teaching and learning through AI.

Leveraging AI Assessment Tools: Utilize AI assessment tools, especially those providing tracking feedback on student progress, which is expected to enhance self-directed learning and reduce teacher workload.

Optimal Investment in Applied AI: Increase focus on optimal investment in applied AI technologies and the effective utilization of its tools to support the education of individuals with disabilities, ensuring equal opportunities for them.

Employing Evaluative Matrices: Utilize the methodology of evaluative matrices to diagnose what needs to be activated in future teaching and learning from the AI roles identified in the current research,

and to verify the effectiveness of their use in various societal fields that impact the development of enlightened generations.

II. Suggested Future Research

The current study has stimulated numerous research ideas that can be explored proactively to predict their feasibility and positive impact. Examples include the following:

Evaluating the effectiveness of using evaluative matrices in predicting the developmental impact of proposed advanced adaptive learning systems.

Developing AI systems, informed by data mining, to predict deep automatic learning paths based on real-time analysis indicators of student performance.

Investigating the impact of integrating big data content for deep learning on enhancing personalization and accessibility for students with disabilities.

Using an evaluation matrix to assess AI's effectiveness in integrating students with special needs into virtual classrooms.

Developing AI tools to automate the transformative processes of educational content according to multiple formats (e.g., text-to-speech, virtual sign language).

Evaluating the impact of using matrices for smart simulators in virtual and augmented reality for creative problem-solving.

Assessing the impact of using a proposed matrix considering the criteria, indicators, and methods of intelligent predictive modeling systems.

Criterion	Measurement Indicators	Assessment Tools
Adaptability	- System's responsiveness to performance changes	- Behavioral data analysis
	- Accuracy of learning path recommendations	- Student Surveys
Feasibility	- Reduction in administrative time	- System Logs
	- Annual maintenance cost	- Cost-benefit analysis
Interactivity	- Degree of student participation in activities	- Viewing Analytics
	- Diversity of media used	- Utilization Reports
Equity	- Representation of marginalized groups in data	- Sample Review
	- Task completion rates for individuals with disabilities	- User Interviews
Innovation	- Number of new features introduced annually	- Update Logs
	- Adoption rate of emerging technologies (e.g., extended reality)	- Case Studies

Supporting Methods:

- Randomized trials to compare outcomes of groups using smart systems versus traditional ones.
- Predictive modeling using algorithms like Random Forest to forecast the effectiveness of new methods.
- Scenario analysis to measure resilience in the face of unexpected challenges.

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