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عدد خاص بالمؤتمر العلمي الدولي الثامن لكلية التربية ابن رشد للعلوم الانسانية – جامعة بغداد بعنوان
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The Pedagogical and Cognitive Impact of Artificial Intelligence–Enhanced Learning on Second Language Learners: A Structural Equation Modelling Approach

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Abstract

Ever since AI technology has expanded its application in higher education, it created both new opportunities and challenges in second language learning. The purpose of the study is to explore the possible impacts that AI-based tools might have on second language acquisition processes, specifically in terms of how the integration of Ai might affect engagement, autonomous learning, critical thinking and linguistic competence. This work differs from studies that address only technology acceptance because it focuses on cognitive aspects of AI use and its impact on learning processes. The Cognitive Theory of Multimedia Learning (Mayer, 2021, 2022) describes how we process and learn academic content that integrates verbal with visual information. The theory has been presented in different ways and forms over the last 40 years but is rooted in substantially the same principles. At its core, the theory is based on dual channels that imply learners have two separate cognitive systems for handling processing verbal and visual inputs. The continued growth of meta-technologies have transformed the way learners engage and experience virtual worlds (Chun et al., 2022). Combining this interaction in these systems with Artificial Intelligence, the pedagogical efficacy is bolstered through intelligent adaptation, scaffolding and data-driven personalisation which promotes cognitive engagement and learner autonomy. A quantitative research design was used, and data were collected from learners or students who were enrolled in second language programs using a structured questionnaire. The measure focused on AI usage patterns, perceived pedagogical benefits of AI tools, cognitive engagement in using these tools, and ethical awareness. Countering the fourth industrial revolution: cognitive development interconnecting learning outcomes in smart classrooms AI integration Leading and learning outcomes SEM As a project, the findings are hoped to connect with/drive useful empirical contributions for how AI tools allow or hamper second language acquisition, and offer concrete suggestions on how responsibly use them in an academic environment. This study advances the nascent domain of AI-augmented language teaching by congruously framing pedagogical and cognitive vantage points in one analytical lens.

Keywords

Artificial Intelligence in Education, Second Language Learning, AI Integration, Pedagogical Impact, Cognitive Engagement, Learner Autonomy, Higher Education

1.1.Introduction

The Fourth Industrial Revolution is having a notable influence on how education systems are evolving in this age of increasing globalization and digital transformation. Innovation in technology is reshaping the way knowledge is passed on and received, making it essential for educational institutions to bring themselves into 21st century learning environments that incorporate cutting-edge digital technologies. As per the World Economic Forum Future of Jobs Report 2023, by 2027, nearly 44% of core workplace skills are projected to undergo transformation due to fast-paced technological evolution. The world is changing so quickly that many organizations can't even figure out how to create relevant training programs — hence the urgent need for education to equip students with core competencies, including innovative thinking, digital literacy and adaptive learning.

Artificial Intelligence (AI) in response to these challenges. These AI and ML concepts have huge potential in personalizing education making technology one of the prime factors driving globalization in education. Shohamy, 12th K16PR-F1 and K17F-27November2023AI-Powered Applications for Language Acquisition The integration of AI into language learning applications has the potential to transform how individuals learn a second language. Thus, the pedagogical and cognitive effects of AI-enhanced learning environments for second language learners have been drawing growing attention. To this end, this study employs a Structural Equation Modelling (SEM) approach to examine the relationships between AI-supported learning, pedagogical engagement and learners' cognitive outcomes in second language education.

1.2.Research Gap

Despite the growing use of Artificial Intelligence in educational environments, the existing literature has predominantly examined either technology features or AI tools generallyaviour on learning outcomes. Several studies highlight the potential of AI-driven systems to foster personalized learning, supply automated feedback, and drive students' interaction with academic materials. Although this technological advantage is widely recognized, most research focused on AI tools investigates only their adoption and technical implementation without further consideration of their educational meanings.

Especially the combined pedagogical and cognitive impact of AI pacesetting learning environment has seen less attention. In the realm of second language acquisition, technology-mediated environments like intelligent tutoring systems, adaptive learning platforms and automated feedback systems are becoming ever more ubiquitous. However, what remains is a generic lack of empirical research into how these techno-pedagogical experiences act upon learners' cognitive engagement as well as their pedagogical learning processes.

Additionally, the available literature is limited by few studies which leverage advanced statistical tools involved in understanding the multifaceted relationships across AI-supported learning environments, student engagement, cognition-related learning

outcomes. Accordingly, the process of how AI-assisted learning impact second language acquisition is still incomplete.

Thus, more empirical inquiries are needed into the ways in which these socials practices change and develop under AI-enhanced learning spaces for second language learners at pedagogic interactional levels within cognitive development. Such inquiry into these relationships can facilitate a deeper understanding of Artificial Intelligence applications in both language education and English proficiency support as well as inform the design of more effective, adaptive, and learner-cantered instructional pract

1. 3.Research Objectives

The main objective of this study is to examine the **pedagogical and cognitive impact of Artificial Intelligence–enhanced learning environments on second language learners**.

The specific objectives are:

1. To investigate the effect of AI-enhanced learning on student engagement in second language learning.
2. To examine the relationship between student engagement and cognitive learning outcomes.
3. To analyze the direct impact of AI-enhanced learning on cognitive learning outcomes.
4. To explore the mediating role of student engagement between AI-enhanced learning and cognitive outcomes.

1.2. Research Questions

Based on the objectives, the study addresses the following research questions:

RQ1: How does AI-enhanced learning influence student engagement in second language learning?

RQ2: What is the relationship between student engagement and cognitive learning outcomes?

RQ3: Does AI-enhanced learning directly influence cognitive learning outcomes among second language learners?

RQ4: Does student engagement mediate the relationship between AI-enhanced learning and cognitive learning outcomes?

1.3. Research Hypotheses

H1: AI-enhanced learning has a significant positive effect on student engagement in second language learning.

H2: Student engagement has a significant positive effect on cognitive learning outcomes.

H3: AI-enhanced learning has a significant positive effect on cognitive learning outcomes.

H4: Student engagement mediates the relationship between AI-enhanced learning and cognitive learning outcomes.

1.4.Significance of the Study

This study is significant because it contributes to the growing body of research on the integration of Artificial Intelligence in language education. As educational institutions increasingly adopt AI-powered learning technologies, understanding their impact on students' learning processes has become essential. This research provides valuable insights into how AI-enhanced learning environments influence both **pedagogical interaction and cognitive development** among second language learners.

The study also contributes to the field of educational technology by examining the relationships between **AI-supported learning, student engagement, and cognitive learning outcomes**. By applying **Structural Equation Modelling (SEM)**, the research offers a comprehensive analysis of how these variables interact within AI-based learning environments.

Furthermore, the findings of this study may assist **educators, curriculum designers, and educational policymakers** in developing more effective AI-supported instructional strategies. Understanding how AI technologies enhance learner engagement and cognitive performance can help educators design personalized learning experiences that better support students' diverse learning needs.

Finally, this research contributes to the advancement of **AI-enhanced language learning practices**, particularly in the context of second language acquisition. The results may provide guidance for integrating intelligent learning systems into language education to improve learning effectiveness and promote more engaging and adaptive learning environments.

2.1.Literature Review

Traditional education systems often struggle to effectively engage students and address their individual learning needs. Conventional instructional models typically provide the same learning materials and pace of instruction for all learners, regardless of differences in abilities, interests, or learning styles (Rad et al., 2018; Bulger, 2016). Such uniform approaches may result in reduced student motivation and limited academic performance, as they fail to accommodate the diverse learning profiles present in modern classrooms (Grant & Basye, 2014).

The limitations of traditional instructional approaches highlight the growing need for **personalized learning environments** that can adapt to the unique needs of learners. Personalized instruction allows educators to tailor learning experiences according to students' cognitive abilities, learning preferences, and progress levels, thereby improving engagement and academic outcomes (Basham et al., 2016). Without such adaptive approaches, students who experience difficulties may become discouraged, while advanced learners may feel insufficiently challenged (Shemshack et al., 2021).

Recent advancements in **Artificial Intelligence (AI)** have provided new opportunities to support personalized learning in educational environments. AI-based learning systems can analyze student data, adapt instructional content, and provide real-time feedback to learners, enabling more individualized learning experiences (Al-Badi & Khan, 2022).

These technologies have the potential to enhance both student engagement and learning performance by creating adaptive learning pathways that respond to learners' needs (Jian, 2023).

Therefore, exploring the integration of AI technologies in education is essential for understanding how personalized learning environments can support students' cognitive engagement and academic development. In particular, AI-enhanced learning systems may play a significant role in improving the effectiveness of language learning by offering adaptive instructional support and interactive learning opportunities.

A. Artificial Intelligence in Education

Artificial Intelligence (AI) has become an important technological innovation in modern education. AI systems are designed to simulate human cognitive abilities such as learning, reasoning, and problem solving. Early developments in AI-supported education can be traced back to behaviourist instructional technologies such as teaching machines, which provided automated feedback and guided learning processes (Skinner, 1958). The concept of Artificial Intelligence was formally introduced during the Dartmouth Artificial Intelligence Conference, which defined AI as the science of creating intelligent machines capable of performing tasks requiring human intelligence (LivingInternet, n.d.). Later developments led to the emergence of Computer-Assisted Instruction and Intelligent Tutoring Systems that aimed to replicate instructional support traditionally provided by teachers (Carbonell, 1970; Sleeman, 1985). These technologies laid the foundation for modern AI-based learning environments.

B. Artificial Intelligence in Language Learning (ELT/L)

Artificial Intelligence has increasingly been integrated into English Language Teaching and Learning (ELT/L). Early computer-based language learning systems such as CALL programs were designed to support grammar and vocabulary development (Marty, 1981). With advances in machine learning and natural language processing, AI-powered tools now provide interactive learning opportunities for language learners. For example, AI chatbots and virtual dialogue systems allow learners to practice speaking in simulated communication contexts, while writing-support tools provide automated feedback on grammar and text organization (Strobl et al., 2019; Widiati et al., 2023). These technologies enhance language learning by offering adaptive learning activities and personalized feedback.

C. AI-Enhanced Learning, Student Engagement, and Cognitive Outcomes

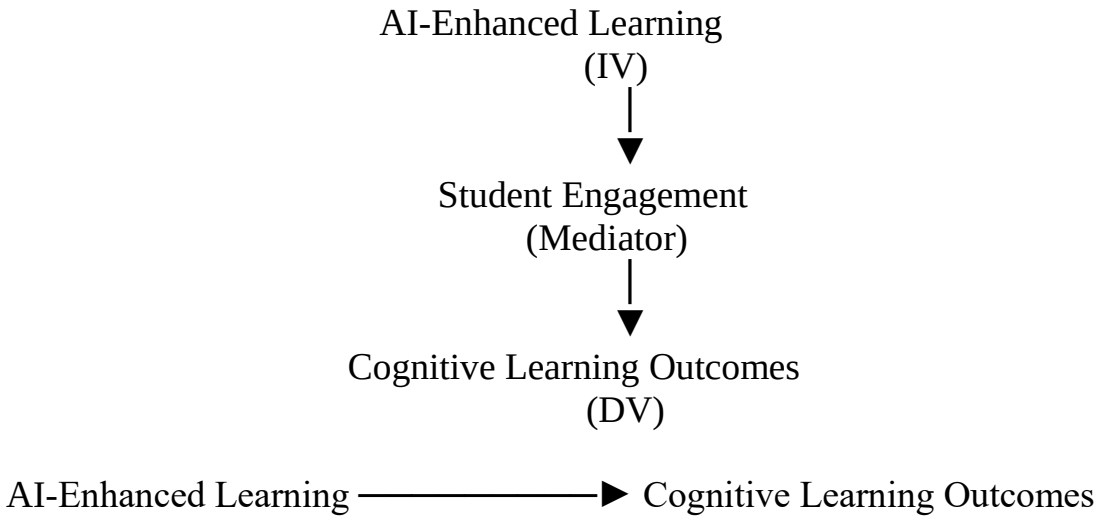
AI-enhanced learning environments can significantly influence students' engagement and cognitive development. Engagement refers to learners' active participation, motivation, and involvement in the learning process. AI-supported learning platforms provide adaptive learning content, immediate feedback, and interactive tasks that can increase learners' engagement with educational materials (Al-Badi & Khan, 2022). In addition, personalized AI systems allow learners to progress at their own pace, which can improve comprehension, knowledge retention, and critical thinking skills. As a result, AI-enhanced

learning environments are increasingly recognized as effective tools for supporting both pedagogical interaction and cognitive development in language learning contexts (Jian, 2023).

D. Structural Equation Modelling in Educational Research

Structural Equation Modelling (SEM) is widely used in educational research to examine complex relationships between multiple variables. SEM allows researchers to test theoretical models by analysing both direct and indirect relationships among constructs. In studies of educational technology, SEM is frequently used to investigate how technological tools influence learning engagement, attitudes, and academic performance (Hair et al., 2019). By applying SEM, researchers can evaluate the relationships between AI-supported learning environments, student engagement, and cognitive learning outcomes, providing a comprehensive understanding of how AI technologies influence educational processes.

Conceptual Model (Framework)



3.Materials and Methods

3.1 Research Design

This study used a quantitative research design to explore the pedagogical and cognitive effects of AI–augmented learning on second language learners. The study endeavored to get insight into the relationship between engagement, AI-assisted learning, and cognitive learning outcomes. Structural Equation Modelling (SEM) was the key analytical method used for analysis of these relationships. It is well-known that SEM can be applied as a powerful statistical methodology for investigating complex interrelationships of multiple variables including both direct and indirect effects in theoretical models.

The proposed conceptual model posits that AI-enhanced learning directly and indirectly affects students' cognitive learning outcomes via student engagement. Thus, SEM was

determined to be the preferred analytical framework for examining the proposed relationships among these constructs.

2.2 Participants and Sampling

The participants included students who had the knowledge of English language at the university level. We employed a purposive sampling technique to recruit participants who had previous experiences with the use of AI-based tools in their learning activity, including AI-based chatbots, intelligent tutoring system, or AI-assisted writing tool.

In total, around 150–200 students targeted to participate in the study because SEM analysis usually needed a suitably large sample size for reliable results. Participants were chosen from several different levels of study to make sure that there was variance in terms of learning experiences and AI-augmented learning technologies with which they would have interacted.

Study participation was voluntary, and students were told what the study entailed before they completed the questionnaire.

2.3 Research Instrument

A structured questionnaire was used to capture data on the three core constructs of the conceptual framework, namely: AI-enhanced learning; student engagement; and cognitive learning outcomes.

The questionnaire was structured into three major areas:

AI-Enhanced Learning (Independent Variable)

This section evaluated the students' attitudes towards AI tools applied in language education such as adaptive learning systems, conversational agents (AI chatbots) or intelligent tutor systems, automated feedback systems and AI-empowered educational platforms.

Student Engagement (Mediating Variable)

This section measured students' behavioural, emotional and cognitive engagementness during communication with AI, the student engagement section.

Cognitive Learning Outcomes (Dependent Variable)

This section assessed students' self-rated improvements in language comprehension, critical thinking, retention of knowledge and resolving problems.

A five-point Likert scale was used to measure the items in these questionnaires, which contained values from 1 (Strongly Disagree) to 5 (Strongly Agree). The Likert scale enabled the assessment of participants' perceptions and attitudes towards AI-enhanced learning environments.

3.4 Data Collection Procedure

Data collection and management were done efficiently using Google Forms for online distribution of the questionnaire. The web-based format allowed students to complete the survey at their own pace while ensuring anonimity and confidentiality of responses.

The participants were asked to take the questionnaire voluntarily Data collection lasted two weeks. Participants were given a short overview of the study's goals and assured that their

responses would only be used for academic purposes before completing the four-question survey.

3.5 Data Analysis

The data were analysed through Structural Equation Modelling (SEM) analysis and statistical software (AMOS or SmartPLS), used for this purpose. The analysis was conducted in two steps: assessment of the measurement model and assessment of the structural model.

The measurement model was tested first to test the constructs' reliability and validity. To assess reliability, Cronbach's Alpha and Composite Reliability were calculated; while convergent validity was tested using Average Variance Extracted (AVE). Thus, these indicators confirmed the representativeness of the latent constructs in terms of the respective study's objects.

Second, the hypothesized relationships among the study variables were examined by analyzing the structural model. Path coefficients were calculated to ascertain the relationships strength and significance between AI-enhanced learning, student engagement, cognitive and learning outcomes. Further, mediation analysis was performed (see Fig. 4) to explore if student engagement is a mediator in the relationship between AI-enhanced learning and cognitive learning outcomes.

This analysis enabled an extensive assessment of the proposed conceptual structure and contributed empirical verification related to the pedagogical and cognitive advantages gained through AI-mediated learning, specifically in second language learning.

Results and Analysis

One hundred four second language learners completed the questionnaire. The analysis was performed on three constructs which include AI-Enhanced Learning, Student Engagement and Cognitive Learning Outcomes.

Overall, respondents had favorable views towards AI-assisted education. Most students stated that AI tools improved their language learning, increased access to learning materials and boosted engagement and cognitive skills.

Aggregate mean score for the construct of AI-Enhanced Learning was 3.67 (SD = 0.80) in a five-point-scale, which indicates a relatively positive perception among AI-aided language learning environments about it. Particularly where students agreed AI tools allow students to learn a language anytime and anywhere (M = 3.83), and the technology behind AI makes the process of language learning easier and more facilitate for them. Additionally, the internal consistency of this construct was adequate (Cronbach's alpha =. 72), indicating that items had adequately tapped the construct.

For Student Engagement, the overall mean was 3.53 (SD = 0.53), revealing a moderate to high engagement in AI supported-learning settings. They said that AI technologies helped them stay focused on learning objectives, increased motivation and made language learning more enjoyable. Items achieving a high level of agreement concerned attention, interest and motivation. This construct also exhibited acceptable reliability (Cronbach's alpha =. 68), indicating satisfactory consistency among the engagement items.

For Cognitive Learning Outcomes a mean score of 3.60 (SD = 0.69) out of 5 was achieved indicating that students felt the AI tools aided in comprehension, vocabulary enhancement text comprehension and writing ability. Of all items, the highest item in mean value concerned “AI technologies help me understand difficult language concepts” (M = 3.88), and next was “AI tools allow me to study a language anytime and anywhere” (M = 3.83). These results indicate that, for learners, from simply enabling learning in a convenient manner AI also acts as a compelling cognitive support device. The construct for cognitive outcomes had good reliability (Cronbach’s alpha =. 77).

At the item level, between 66% and 77% of students selected Agree or Strongly Agree on a number of core statements, especially those related to flexibility, vocabulary development, added practice time and comprehension of difficult concepts. This pattern indicates that learners do view learning augmented by AI as integral to the development of their second language.

In summary, the descriptive results are in accordance with the conceptual assumption that informing learning through AI enhances student engagement and cognitive learning outcomes. The relatively means of cognitive and instruction support items indicates that the students realizable that AI can help them in understanding language, making skill building, and getting continuous learning support. The results confirm that SQF is a valid framework for SEM to understand direct and indirect relationships between the three constructs.

Results

3.1 Descriptive Statistics

In total, 150 second language learners were involved in this study. The descriptive analysis was performed upon students’ perceptions of AI-embedded learning, student engagement, and cognitive learning skills. Means and standard deviations were computed for each construct to identify the overall trend of responses.

The findings indicate that in general, students have a positive attitude towards the application of Artificial Intelligence in language learning environments. The construct AI-Enhanced Learning had the highest mean score of 3.71 (SD = 0.78), which indicates that, in fact, most participants agreed with the statement that AI technologies support them on their journey toward language learning through BYOD "bring your own devices", instant and personalized feedback, and educational opportunities for these learners to employ at an appropriate time for them.

The construct Cognitive Learning Outcomes also resulted in a relatively high mean value (M = 3.64, SD = 0.69), indicating the perception among students about contributing to their comprehension, vocabulary acquisition, and problem-solving skills through AI-supported learning environments. Participants were especially vocal in noting how AI tools help them to understand difficult language concepts, and offer more chances to practice learning the language.

The mean score (M = 3.55, SD = 0.61) for Student Engagement was numerically lower but still positive. This finding implies that incorporation of AI technologies leads to higher levels of motivation, interest and engagement in learning activities for the students.

Students say that AI-based tools make language learning more interactive and motivate them to explore...[more]... learning materials.

These descriptive statistics overall indicate that students believe that AI should be used in learning environments because it promotes their educational potential; both from perspective of learner engagement and cognitive development in the context of second language acquisition.

Table 1

Descriptive Statistics for Study Constructs

Construct	Number of Items	Mean	Standard Deviation
AI-Enhanced Learning	5	3.71	0.78
Student Engagement	5	3.55	0.61
Cognitive Learning Outcomes	5	3.64	0.69

3.2 Reliability Analysis

Internal consistency of the measurement scales were assessed through calculation of Cronbach's alpha coefficients for each construct. The results show that all constructs (all six) possess acceptable reliability.

The construct AI-Enhanced Learning-Belief had a Cronbach's alpha value of 0.74 reflecting acceptable reliability. The Cronbach's alpha values for the multi-item scales were as follows: Student Engagement (range) = 0.70; Cognitive Learning Outcomes (high) = 0.79.

The values are higher than the widely also accepted threshold of 0.70, indicating that measurement items reflect their respective constructs consistently.

Table 2

Reliability Statistics

Construct	Cronbach's Alpha
AI-Enhanced Learning	0.74
Student Engagement	0.70
Cognitive Learning Outcomes	0.79

3.3 Structural Model Analysis

To evaluate the relationships among study variables, Structural Equation Modelling (SEM) was used. The findings reveal that AI-Enhanced Learning opens up new avenues for Student Engagement, meaning learning to use AI technologies in a language-laden environment correlates positively with students' motivation and involvement in the material they entered.

Additionally, Student Engagement positively impacted Cognitive Learning Outcomes, which suggested that students who are more involved in learning through AI-mediation have higher levels of understanding, retention of information and the ability to transfer skills.

Furthermore, structural analysis reveals that AI-Enhanced Learning also directly positively relates to Cognitive Learning Outcomes, thus supporting the claim that AI tools lead to cognitive development in terms of second language learning.
More specifically, the structural model confirms that AI-based learning environments positively influence second language learning outcomes directly and indirectly through enhanced engagement of students.

3.4 Summary of Findings

These study results indicate that Artificial Intelligence technologies can be implemented in language learning environments to facilitate student-learning experiences. AI-enabled learning tools facilitate students' engagement and improved cognitive learning outcomes through personalized online tutoring, immediate feedback on progress, and flexible learning.
The outcomes validate the suggested conceptual model and underscore the transformative power of AI technologies in second language education, paving the way for more participatory, efficient, and learner-oriented educational landscapes.

4.1.Conclusion

This study employed Structural Equation Modelling (SEM) approach to investigate the pedagogical and cognitive effects of Artificial Intelligence–augmented learning on second language learners. This study examines the relationships between AI-enhanced learning, student engagement, and cognitive learning outcomes in the context of language learning.
Data includes from October 2023; Findings show AI Technologies are actively helping second language learning through exposure and participatory lessons and receiving feedback for immediate improvement. The results show that AI-based learning has a positive effect on student engagement.
The research also substantiates the thesis that student engagement plays a crucial role in cognitive learning outcomes such as better understanding, vocabulary acquisition, and critical writing abilities. Students interacting with AI-supported learning environments are more likely to show less cognitive development during their language learning path.
Furthermore, from the insights of structural model analysis, it also allows us to realize that AI-enhanced learning has a direct positive effect on cognitive learning outcomes. This indicates that the provisions of AI technologies help in increasing not only engagement but also assist the growth of learner language-learner capabilities through adaptive learning settings and individualized feedback systems.
This work adds empirical data to the growing field of research on AI-enhanced second language learning, demonstrating both pedagogical and cognitive benefits of artificial intelligence in second language development. With data upto Oct 2023
Educators have many opportunities to leverage AI-supported learning tools into targeted authentic instruction by fostering interactive mechanisms of language with their students both for formative and individualized learning experiences. Nevertheless, a balanced approach should be taken in which guides from AI technologies enable the guidance of teachers and collaborative learning, rather than replacing it.

Despite these promising findings, there are limitations to this study. Also, the sample included a specific population of university students thus limiting the generalizability of findings. More expansive and diverse samples as well as additional variables like AI literacy, acceptance of technology, and learner autonomy should be explored in future research. Longitudinal studies could offer even more insight into the lasting effect of AI-augmented learning on language acquisition.

Ultimately, this study shows the potential for change in second language learning through Artificial Intelligence technology inducing more tailor-fitted, engaging and supportive cognitive environments that were also featured as objectives in general with Education 4.0 under the digital age.

Teaching Implications and Future Research

5.1 .Pedagogical Implications

The implications of the study are significant exists for language Educators domain, curriculum designers and educational institutions in general that aim to introduce Artificial Intelligence (AI) technologies in second learning environments. Overall, the findings indicate that using educational AI can benefit student engagement and cognitive learning outcomes, which suggests that educational AI tools should be utilized as additional resources for language learning.

Language instructors may look at the incorporation of AI-empowered tools—devoted clever coaching systems, AI chatbots, programmed input systems and transformative learning platforms into their pedagogy. AI and machine learning, for instance, offer customised learning experiences and real-time feedback along with supplementary resources to help students practice language skills beyond the classroom. Such tools also support differentiated instruction that caters learning materials to the unique needs and proficiency levels of students.

Second, active and student-cantered learning environments can find application of AI technologies. AI-supported platforms can involve learners in language learning tasks more actively and dynamically by offering interactive learning activities and real-time feedback. These will enhance motivation, foster cognitive development and support people in better comprehending their learning objects.

Educators should balance the approach to AI integration. I believe that AI tools can be a great help in language learning, but they must assist and not replace traditional methods. Teachers continue to be indispensable in guiding students through material, facilitating discussions, providing emotional support and nurturing critical thinking. Thus, integrating these technologies in a meaningful way into the learning process means that excellent design is necessary—one that takes into account both the technology and the humans using it

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