Artificial Intelligence & Robotics Development Journal
Volume 6, Issue 2, pp 438-450, April 2026,https://doi.org/10.52098/airdj.20266273
ISSN: 2788-9696 Received: 1/3/2026 Revised: 2/3/2026 Accepted: 3/3/2026

Artificial Intelligence Revolution: Enhancing Modern Education Through Zone of Proximal Development Approach

[1]*Dawood Salim Al Hamdani , Sohar University, Oman
* Corresponding author: Dawood Salim Al Hamdani[1], AlHamdani@su.edu.om

Abstract

This paper discusses the attitude and willingness of teachers to use an instructional model that employs Artificial Intelligence, supported by Zone of Proximal Development (AI -ZPD). The suggested model incorporates personalization guided by AI and real-time evaluation, scaffolding, and collaborative learning to improve constructivist pedagogies. The survey given to a sample of 50 teachers consisted of six attitudinal dimensions, namely Technology, Pedagogical Alignment, Interaction and Collaboration, Teacher Professional Role and Autonomy, Student Impact and Assessment Support. The descriptive results revealed moderately positive attitudes on all dimensions (M = 3.10 -3.18 on a 5-point scale). Tests of hypotheses revealed that teachers who had passed through AI before exhibited increased descriptive acceptance of the model, but this was not necessarily significant. Regression analysis did not indicate the significant predictive value of demographic variables, such as years of experience and previous AI use, to accept the model ($F(3,46) = 0.59$, $p = .63$, $R^2 = 0.04$). Nonetheless, the teachers perception in student-centred pedagogy, formative assessment and the perception of the AI-ZPD model as a whole had positive correlations with each other ($r = 0.94$- 0.97, $p < .001$). These findings are strong indications that the background factors are not determinants of teacher preparedness to adopt the AI-based ZPD-oriented instruction, but pedagogical and assessment beliefs are important determinants. This research presents a theoretically based AI-ZPD framework and provides viable implications on professional growth, designing policies and teaching and learning with AI.

***Keywords**:* Artificial intelligence; AI -ZPD; regression analysis; teaching and learning; student-centred pedagogy

1. Introduction

Technology integration is becoming common in the ever-changing education environment, which provides new prospects for improving learning and teaching practices. Among the new technologies, Artificial Intelligence (AI) is identified as an effective application that can change how education should be handled (Yousif, J, 2025). AI is described as computer algorithms that have the ability to perform tasks that are equivalent to human intelligence in terms of learning, solving, decision-making, and identifying patterns.

The use of AI in the educational sector has tremendous potential to increase the efficiency of teachers and the performance of students. Although conventional learning methods are quite successful, they sometimes encounter difficulties in addressing the diverse needs of learners at the same time. AI-based learning solutions can ensure personalized learning and data-driven support to teachers to help them design better learning techniques (Alkishri, et al.,2025). One of the major benefits of AI in the educational context is the ability to provide personalized learning. The AI system has the ability to analyze data of the learners, such as their learning preference, strengths, weaknesses, and progress, enabling the AI system to provide personalized learning paths to the learners, which can enable increased engagement, understanding, and effectiveness of learning for the learners, thus enabling each learner to achieve their full potential.

Intelligent tutoring systems and virtual assistants enabled with AI technologies are capable of offering feedback and guidance to learners in an adaptive and interactive way by simulating the activities of a human tutor as in constructive approach because the student’s responses or performance influence the adaptive and dynamic nature of the system as proposed by Vygotsky in the year 1978 (Yousif, J, 2025).

Furthermore, the use of AI can benefit teachers by helping them in several tasks, like the automatic evaluation of assignments, the automatic provision of in-depth feedback on students' work, and the aggregation of appropriate learning resources for students (Poth, 2023, Randazzo, 2024). This will allow teachers to focus on lesson design and the development of students' social-emotional development (Poth, 2023, Randazzo, 2024). Moreover, the application of AI-powered learning analytics has the ability to provide important insights into the learning activity of the students. It also helps the teachers in making decisions and understanding areas where the students require support and adapting teaching techniques based on that (Alasmari, 2024).

Assessment is an important aspect of measuring and controlling the learning of the student. The suggested AI-ZPD constructivist model is a hybrid of conventional and AI-assisted assessment plans to offer an adaptive and dynamic process of the evaluation. AI can help improve assessment in a number of major ways (Furze et al., 2024). Although it is possible that AI can positively impact education, it is crucial to state that it cannot be regarded as something that will substitute human teachers; nonetheless, AI can be considered a tremendous tool to supplement their functions and capabilities. The importance of human educators to guide and offer critical thinking, as well as develop the social-emotional skills, cannot be overvalued in the educational process (Wired et al., 2024).

The paper aims at discussing the different applications of AI in enhancing teaching performance, relating the most recent development together with the issue and best practices. By utilizing the power of the Zone of Proximal Development model, a teacher can develop more efficient, personalized and engaging learning environments that ultimately render positive outcomes to the students and provide students with the skills needed to succeed in a fast-paced world.

2. Zone of proximal development (ZPD)

Zone of Proximal Development Zone of Proximal Development (ZPD) The Zone of Proximal Development, a theory conceptualized by psychologist Lev Vygotsky, can be referred to as the range between what a learner can do alone and what can be achieved by the learner under the guidance of a more knowledgeable person, usually a teacher or a peer (Yousif, J., 2025). The Zone of Proximal Development, a theory conceptualized by psychologist Lev Vygotsky, can be referred to as the range between what a learner can do alone and what can be achieved by the learner under the guidance of a more knowledgeable person, usually a teacher or a peer. In contemporary methods of instructing, the Zone of Proximal Development is applied in learning processes in relation to students in the following ways:

1. Differentiation: Teachers identify each student's ZPD to tailor instruction to their needs and abilities. They can scaffold learning and facilitate student progress by providing challenging but achievable tasks and activities with support.
2. Scaffolding: Teachers provide scaffolding, or temporary support, to help students bridge the gap between their current level of understanding and the desired learning outcome. Scaffolding can include modelling, prompts, cues, and feedback tailored to the student's ZPD.
3. Collaborative Learning: Peer collaboration is encouraged to leverage the ZPD. Students can work together to support and challenge each other, helping and feedback within each other's ZPD.
4. Gradual Release of Responsibility: Teachers gradually release responsibility to students as they gain confidence and proficiency. Initially, teachers provided extensive support within the ZPD, gradually reducing support as students become more independent learners.
5. Formative Assessment: Formative assessment gauges students' progress within their ZPD and adjusts instruction accordingly. Teachers use ongoing assessment data to identify student strengths and growth areas, providing targeted support and intervention as needed.
6. Zone of Proximal Development Activities: Teachers design activities and tasks that are precisely aligned with students' ZPDs, offering challenges beyond their current mastery level. These activities promote engagement, motivation, and deeper learning as students strive to reach the next level of proficiency.

The ZPD helps educators to organize dynamic and responsive learning environments that take into consideration each student's growth and development. In recognizing and utilizing this zone, teachers are aptly placed to facilitate much more meaningful learning opportunities while maximizing the potential of all students toward improved academic success. The AI may become a truly powerful tool in the development of teaching skills in manifold directions (Al-Zaabi & Yousif, 2025). Here are some ways in which AI can be used to improve teaching:

1. Personalized Learning: AI can help in analyzing student information like learning styles, abilities, shortcomings, and learning progress, allowing for personalized learning pathways. This can lead to increased interest, comprehension, and overall learning achievements.

2. Intelligent Tutoring Systems: Intelligent tutoring systems utilize AI in tutoring. This is because the systems may react to responses immediately. This helps the students as the systems will change depending on the responses provided as a tutor (Yousif, J. (2021).

3. Automated Grading and Feedback: AI can be utilized to perform the tasks of assignments, quiz, and exam grading automatically, and AI can also be utilized to give feedback to students about their work.

4. Content Generation and Curation: AI can assist teachers with the design and development of educational materials, for example, practice questions, exercises, and learning resources based on learning objectives and the needs of the students. AI can also assist with educational resource curation and recommendations from diverse sources.

5. Student engagement & motivation: Chatbots or virtual assistants can engage with students, answer their questions, as well as offer them motivational support, thereby inducing a more interactive atmosphere inside a classroom for students to flourish (Al-Zaabi & Yousif, 2025).

6. Learning Analytics: AI can use the data of the engaged levels and performances of the learners, as well as the learning patterns of the learners, to provide the educator with useful information and recommendations regarding how the educator can develop the teaching procedure.

7. Adaptive Assessments: The adaptive assessments conducted by AI technology allow the level of difficulty in the questions to be adjusted based on the performance of the student, resulting in a more accurate assessment of the subject matter knowledge of the individual.

8. Language Learning: Artificial intelligence-powered applications can offer personalized feedback on pronunciation, grammar, vocabulary, and involve students in conversational practice through virtual assistants or chatbots.

A model that would bring together AI as an instrument, constructive approach, increased learning, interaction, and the Zone of Proximal Development (ZPD) on increasing learning levels would require identifying and defining the variables linked to each component.

3. Research questions and hypotheses

In what ways, and to what extent, do teachers feel prepared and willing to act in the proposed AI-ZPD educational model, and in what way do their training, level of digital literacy, pedagogical beliefs, and institutional support relate to their perceptions of readiness?

3.1. Research question

What are teachers' attitudes toward the various dimensions of the AI-ZPD model, including Technology, Pedagogical Alignment, Interaction and Collaboration, Teacher Professional Role and Autonomy, Student Impact, and Assessment Support?

3.2. Study hypothesis

H1: Teachers who have received prior training in AI or constructivist/ZPD strategies report higher readiness to implement the AI-ZPD educational model.

H2: Teachers' digital literacy and prior use of educational technology positively predict their perception of the model's effectiveness in enhancing student learning.

H3: Teachers' belief in student-centered learning and assessment practices significantly predicts their acceptance of the AI-ZPD model.

4. Methodology

This study adopts a mixed-methods approach, integrating both qualitative and quantitative research methodologies. In this study 50 teachers were involved as presented in Table 1. The sample was distributed evenly in terms of teaching experience as almost half of the respondents (46%) had 16 years and above teaching experience. The rest 30% were of experience 1-5 years, 18% 11-15 years and 6% 6-10 years experience. Such distribution suggests that both the early-career and the veteran teachers contributed to the data set, and the percentage of highly experienced teachers is quite high.

Years of Experience	Frequency	Percentage
16+ years	23	46.0%
1–5 years	15	30.0%
11–15 years	9	18.0%
6–10 years	3	6.0%
Total	50	100%

Table 1: Years of Teaching Experience (N = 50)

Table 2 shows that the previous usage of AI tools in the educational process, 42% of the respondents stated that they had used AI-based educational tools, 32% said probably, and 26% had no experience whatsoever. Such AI familiarity contributes to having a balanced view of the attitudes towards the AI–ZPD instructional model.

Years of Experience	Frequency	Percentage
16+ years	23	46.0%
1–5 years	15	30.0%
11–15 years	9	18.0%
6–10 years	3	6.0%
Total	50	100%

Table 2. Previous Experience with AI Educational Tools (N = 50)

Table 3 presents that there was also a representation of different grade levels by the participants. Slightly higher than half (54%) had taught other grades not just Grades 1012. Of the mentioned grades, 20% of them were teaching Grade 12, 14 percent teaching Grade 10, and 12 percent teaching Grade 11.

Grade Level	Frequency	Percentage
Other Grades	27	54.0%
Grade 12	10	20.0%
Grade 10	7	14.0%
Grade 11	6	12.0%
Total	50	100%

Table 3. Previous Experience with AI Educational Tools (N = 50)

Overall, the participants form a diverse and representative group of educators, varying in experience level, exposure to AI tools, and grade levels taught. This diversity strengthens the relevance and generalizability of the findings.

5. Results and Discussion

Descriptive statistics were computed for each of the six dimensions by averaging the item scores within each subscale. Table 4 summarizes the mean (M) and standard deviation (SD) for each dimension.

Dimension	Mean (M)	Standard Deviation (SD)
Technology	3.18	1.28
Pedagogical Alignment	3.11	1.21
Interaction & Collaboration	3.12	1.32
Teacher Professional Role	3.10	0.86

Dimension	Mean (M)	Standard Deviation (SD)
Student Impact	3.13	1.21
Assessment Support	3.16	1.23

Table 4: Descriptive Statistics for the Six Attitudinal Dimensions (N = 50)

5.1.1 Overall pattern of responses

In each of the dimensions, the mean scores were concentrated slightly higher than the neutral point of the scale. Table 5 presents the section scores were in the range of M =3.10 to M=3.18 on the five points scale, which meant moderate positive attitudes toward the AI-ZPD model. The means of the items in the different parts of the entire item were between 3.00 and 3.32, which indicates that the teachers were inclined to agree to most of the statements slightly, but not in the extreme mean.

Dimension	Mean (M)	Standard Deviation (SD)	Cronbach's α
Technology	3.18	1.28	0.951
Pedagogical	3.11	1.21	0.948
Interaction	3.12	1.32	0.987
Teacher Role	3.10	0.86	0.679
Student Impact	3.13	1.21	0.973
Assessment	3.16	1.23	0.986

Table 5. Descriptive Statistics and Reliability Coefficients for the Six Dimensions (N = 50)

5.1.2 Technological dimension

Table 6. shows the scale of Technology has been composed of four questions that show perceptions of the ease of use and usefulness of the AI tools (e.g., ease of use, confidence in integration, helpful feedback, and classroom efficiency). The mean of this dimension was = 3.18 (SD =1. 28). This shows that the average teachers leaned to agree that AI tools can be used and are useful, but respondents varied widely on this point as indicated by the standard deviation that is big in nature.

Item No.	Item Description (Abbreviated)	M	SD
Item 1	AI tools in the model are easy to use	3.10	1.23
Item 2	I feel confident integrating AI tools	3.08	1.28
Item 3	AI systems provide helpful feedback	3.32	1.38
Item 4	AI tools improve class efficiency	3.20	1.55

Table 6. Technology Dimension (Items 1–4)

5.1.3 Pedagogical alignment

Table 7. presents the pedagogical dimension comprised five items that evaluated the magnitude to which the AI -ZPD model is compatible with the constructivist teaching approaches and promotes the ZPD-oriented teaching (e.g., student-centred learning, project-based and inquiry learning, identification of the ZPD, scaffolding, and designing of ZPD-fitted lessons). The average point of this dimension was M = 3.11 (SD = 1.21). The responses of teachers with the model had generally positive results particularly in terms of how well the model fitted in their teaching philosophy, but the findings indicated rather low than high ratification.

Item No.	Item Description (Abbreviated)	M	SD
Item 5	The model enhances student-centred learning	3.14	1.33
Item 6	Constructivist strategies align with my philosophy the model supports	3.12	1.24
Item 7	identifying students' ZPD	3.02	1.34
Item 8	Scaffolding in the model helps students achieve more	3.08	1.29
Item 9	I can design ZPD-aligned lessons using the model	3.20	1.28

Table 7. Pedagogical Alignment (Items 5–9)

5.1.4 Interaction and collaboration

Table 8 shows the interaction & Collaboration scale included five items that explained how AI -ZPD model could facilitate interaction between students and students as well as students and teachers, communication, cooperative tasks, academic discussions, and establishment of collaboration in the classroom setting. The average of this dimension was M =3.12 (SD=1.32). Such results indicate a relatively positive attitude that the model has the potential of enhancing productive interaction and cooperation in the classroom.

Item No.	Item Description (Abbreviated)	M	SD
Item 10	The model increases effective student interaction	3.04	1.37
Item 11	AI tools improve communication with students	3.08	1.34
Item 12	Collaborative tasks support peer assistance	3.12	1.36
Item 13	AI-supported activities enhance academic discussions	3.20	1.30
Item 14	Interaction opportunities create a collaborative environment	3.16	1.26

Table 8. Interaction & Collaboration (Items 10–14)

5.1.5 Teacher professional role and autonomy

There were five items that evaluated the perceptions of teachers concerning the impact of the AI-ZPD model on their professional role and autonomy, i.e., it is believed that the model supports and not the replacement of the teacher, having control on lesson planning and instructional choices, being a facilitator, promoting the goal of higher-order learning, and having worries about the possible limitations of professional autonomy (reversed coded). Table 9 presents the average in this dimension was M = 3.10 (SD = 0.86). This was the least variable subscale of all which suggests the relative consistency in the perception of teachers under the model with regard to their professional role. The mean of the scores indicates that in general the teachers see AI as a helpful resource but do not threaten their work but there are still certain concerns regarding the autonomy.

Item No.	Item Description (Abbreviated)	M	SD
Item 15	The model supports my role as a teacher	3.18	1.03
Item 16	I maintain control of lesson planning and decisions	3.14	1.02
Item 17	AI enhances my role as a facilitator	3.12	1.05
Item 18	The model allows focus on higher-order goals	3.04	0.96
Item 19	I worry AI may reduce my professional autonomy (reversed)	3.00	1.03

Table 9. Teacher Professional Role & Autonomy (Items 15–19) (Note: Item 9 was reverse-coded)

5.1.6 Student impact

Student Impact dimension was used to understand the expectations of the teachers about the impact that the AI ZPD model would have on the learners such as improvements in engagement, enhanced problem-solving and critical thinking, more learner independence, greater motivation in their ZPD, and more equitable and personalised learning opportunities. Table 10 shows the average grade was M = 3.13 (SD = 1.21), which implied that teachers as whole thought that the model would positively influence learning on students especially facilitating the development of deeper learning and differentiated support.

Item No.	Item Description (Abbreviated)	M	SD
Item 20	AI increases student engagement	3.08	1.28
Item 21	Students improve in problem-solving & critical thinking Students become	3.18	1.25
Item 22	more independent learners	3.18	1.22
Item 23	Students are more motivated within their ZPD	3.16	1.21
Item 24	The model supports equitable and personalized learning	3.18	1.25

Table 10: Student Impact (Items 20–24)

5.2. Assessment support

The Assessment Support scale consisted of eight items dealing with formative assessment, accuracy of AI-supported feedback, differential assessment pathways, tracking student progress, identifying learning gaps within the ZPD, making real-time instructional adjustments, fostering student self-reflection, and supporting alternative assessment forms such as projects and portfolios. Table 11 shows the dimension yielded a mean score **of M = 3.16 (SD = 1.23).** Among the six dimensions, Assessment Support appeared slightly more positively evaluated, suggesting that teachers particularly recognize the potential of AI to enhance ongoing assessment processes and individualized feedback.

Item No.	Item Description (Abbreviated)	M	SD
Item 25	The model supports continuous formative assessment	3.14	1.25
Item 26	AI-supported feedback improves assessment accuracy	3.18	1.27
Item 27	The model enables differentiated assessment	3.16	1.23
Item 28	Easy tracking of student progress	3.10	1.26
Item 29	AI identifies learning gaps within the ZPD	3.12	1.20
Item 30	I can adjust teaching in real time based on analytics	3.14	1.21
Item 31	AI-supported assessment enhances student reflection	3.18	1.24
Item 32	The model supports alternative assessments (projects, portfolios)	3.20	1.23

Table 11: Student Impact (Items 25–32)

5.3. Correlations among dimensions of the ai–ZPD model

Pearson correlation coefficients were computed between the mean scores of the six dimensions. Table 12 presents the correlation matrix. All correlations were positive and strong, with off-diagonal coefficients ranging from r = 0.84 to r = 0.94.

The Student Impact dimension was strongly associated with Interaction & Collaboration (r = 0.93), Assessment Support (r =0.94), Technology (r = 0.90), and Teacher Role (r = 0.90). These strong associations suggest that when teachers believe the AI–ZPD model enhances interaction, supports assessment, and respects their professional role, they are also more likely to expect positive learning outcomes for students. In other words, perceptions of student benefits are tightly linked to perceived improvements in classroom processes and teacher support.

The Pedagogical dimension showed very strong correlations with Assessment Support (r = 0.92) and Student Impact (r = 0.89). This pattern indicates that teachers who perceive the model as aligned with constructivist pedagogy and ZPD-based instruction are also those who appreciate its ability to provide rich, formative assessment data and to support differentiated learning pathways.

The technology dimension was positively related to all other dimensions, with correlations ranging from r =0.87 to r = 0.90. Teachers who viewed AI tools as easy to use and beneficial tended to also perceive higher interaction, stronger assessment support, and greater student impact. The correlation between Interaction & Collaboration and Teacher Role was particularly strong (r = 0.89), implying that teachers who see the model as fostering collaborative and interactive learning environments also feel that their professional role is enhanced rather than diminished.

Dimension	1. Technology	2. Pedagogical	3. Interaction	4.Teacher Role	5.Student Impact	6. Assessment
1. Technology	1	0.872	0.880	0.861	0.898	0.898
2. Pedagogical	0.872	1	0.861	0.835	0.886	0.915
3. Interaction	0.880	0.861	1	0.892	0.927	0.899
4. Teacher Role	0.861	0.835	0.892	1	0.898	0.914

5. Student Impact	0.898	0.886	0.927	0.898	1	0.939
6. Assessment	0.898	0.915	0.899	0.914	0.939	1

Table 12: Correlation Matrix of the Six Dimensions (N = 50)

5.4. Hypotheses Testing

This section presents the statistical findings related to the tested hypotheses concerning teachers' attitudes toward the AI-ZPD instructional model. Six key dimensions of attitude were measured and analyzed using mean scores: Technology, Pedagogical Alignment, Interaction and Collaboration, Teacher Professional Role, Student Impact, and Assessment Support. In addition, an Overall Acceptance index was calculated by averaging the scores of these six dimensions to provide a comprehensive measure of teachers' general acceptance of the model.

H1: Prior AI Exposure and Readiness to Implement the AI–ZPD Model

A one-way ANOVA tested whether prior AI-tool experience influenced teachers' overall acceptance of the AI–ZPD model. Although teachers with prior AI experience showed higher descriptive acceptance (Yes: $M = 3.26$; Maybe: $M = 3.20$) than those without experience (No: $M = 2.83$), the differences did not reach statistical significance, $F(2,47) = 0.64$, $p = 0.53$. Thus, H1 was not supported.

H2: Prior Technology Use and Perceived Effectiveness

Teachers with AI experience tended to report higher Student Impact and Assessment Support scores than those without experience. However, because the omnibus ANOVA did not reach significance ($p = 0.53$), H2 receives descriptive but not statistical support.

H3: Student-Centred and Assessment Beliefs as Predictors of Acceptance

Strong positive correlations indicated that Pedagogical Alignment ($r = 0.94$, $p < .001$) and Assessment Support ($r = 0.97$, $p < .001$) were highly associated with the Model. Thus, H4 was strongly supported. A multiple regression model tested whether prior AI experience and years of teaching experience predicted Model. The model was not significant, $F(3,46) = 0.59$, $p = 0.63$, $R^2 = 0.04$. Neither predictor significantly explained variance in model acceptance. This suggests that demographic variables are weak predictors compared to attitudinal beliefs themselves.

6. Conclusion

This study investigated teachers' attitudes toward an instructional model that integrates Artificial Intelligence with the Zone of Proximal Development (AI–ZPD). Findings revealed moderately positive perceptions across all dimensions, indicating a general openness to AI-supported, constructivist teaching. Although prior AI experience did not significantly predict teachers' readiness to implement the model, strong correlations showed that teachers' beliefs in student-centred pedagogy and formative assessment are the most powerful determinants of acceptance. The results highlighted the successful adoption of AI-enhanced ZPD practices relying less on demographic or background factors and more on teachers' instructional beliefs and pedagogical orientations. The study contributed to the deployment of the AI–ZPD framework to underscore the importance of professional development and the effective integration of AI tools based on constructivist strategies and assessment literacy in enhancing teaching and learning.

Acknowledgment: The research leading to these results has received no Research Grant Funding.

Author contribution: All authors have contributed, read, and agreed to the published version of the manuscript results.

Conflict of interest: The authors declare no conflict of interest.

References

[1]. Alkishri, W., Yousif, J. H., Al Husaini, Y. N., & Al-Bahri, M. (2025). Conversational AI in Education: A General Review of Chatbot Technologies and Challenges. Journal of Logistics, Informatics and Service Science, 12(3), 264-282.

[2]. Al-Zaabi, A., & Yousif, J. (2025). Investigate the Effectiveness of Virtual Reality as an Educational Tool for Children with Autism: A Technical Analysis Review. In Integrating Artificial Intelligence, Security for Environmental and Business Sustainability: Volume 2 (pp. 867-881). Cham: Springer Nature Switzerland.

[3]. Chen, X., Xie, H., Zou, D., & Hwang, G.-J. (2020). Application and theory gaps during the rise of artificial intelligence in education. Computers and Education: Artificial Intelligence, 1, 100002. https://doi.org/10.1016/j.caeai.2020.100002

[4]. Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. Journal of Research on Technology in Education, 42(3), 255–284. https://doi.org/10.1080/15391523.2010.10782551

[5]. Hogan, K., & Pressley, M. (1997). Scaffolding student learning: Instructional approaches & issues. Brookline Books.

[6]. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.Holmes, W., & Tuomi, I. (2022). State of the art in AI in education. OECD Education Working Papers, 292, 1–57. https://doi.org/10.1787/19939019

[7]. Howard, S. K., Chan, A., & Yang, J. (2019). Teachers' technology adoption: A research synthesis. Australasian Journal of Educational Technology, 35(4), 113–132. https://doi.org/10.14742/ajet.5683

[8]. Ifenthaler, D., & Yau, J. Y.-K. (2020). Utilising learning analytics for study success: Reflections on current empirical findings. International Journal of Learning Analytics and Artificial Intelligence for Education, 2(1), 1–10.

[9]. Luckin, R. (2017). Towards artificial intelligence-based assessment systems. Nature Human Behaviour, 1(3), 0028. https://doi.org/10.1038/s41562-016-0028

[10]. Nye, B. (2015). Intelligent tutoring systems by the numbers: A meta-analysis of effectiveness. International Journal of Artificial Intelligence in Education, 25, 1–35. https://doi.org/10.1007/s40593-014-0020-7

[11]. Shaffer, D. W. (2018). Quantitative ethnography. Cathcart Press.

[12]. Shabani, K. (2016). Applications of Vygotsky's sociocultural approach for teachers' professional development. Cogent Education, 3(1), 1–10. https://doi.org/10.1080/2331186X.2016.1252177

[13]. Shute, V. J. (2008). Focus on formative feedback. Review of Educational Research, 78(1), 153–189. https://doi.org/10.3102/0034654307313795

[14]. Teo, T. (2019). Modelling teachers' readiness to adopt technology. Interactive Learning Environments, 27(1), 107–121. https://doi.org/10.1080/10494820.2018.1504307

[15]. Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

[16]. Williamson, B., & Eynon, R. (2020). Historical perspectives on AI and education: Learning analytics, algorithmic governance, and the emergence of digital education platforms. Learning, Media and Technology, 45(3), 1–16. https://doi.org/10.1080/17439884.2020.1745804

[17]. Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. International Journal of Educational Technology in Higher Education, 16(1), 1–27. https://doi.org/10.1186/s41239-019-0171-0

[18]. Yousif, J. H. and Dawood Alhamdani (2025). Artificial intelligence revolution for enhancing modern education using zone of proximal development approach. Applied Computing Journal, 386-398.

[19]. Yousif, J. (2021). Social and Telepresence Robots a future of teaching. Artificial Intelligence & Robotics Development Journal, 1(1), pp 58-65, January 2021, https://doi.org/10.52098/airdj.202124.