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Malaysian STEM Teachers' Perceptions and Readiness for AI Integration: The Role of Training and Attitudes in Shaping Instructional Practice

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ABSTRACT

BACKGROUND & CONTEXT

Artificial Intelligence (AI) is rapidly transforming education by enabling personalized learning, real-time feedback, and adaptive instruction. However, AI adoption among Malaysian in-service teachers remains limited, making it crucial to understand their perceptions and readiness for classroom integration.

PURPOSE

The study examines how Malaysian STEM teachers perceive and respond to AI integration, focusing on their readiness, challenges, and influencing factors. Findings aim to guide teacher training and curriculum efforts for effective, responsible AI adoption.

METHODOLOGY

An explanatory mixed-method design was used. A survey of 110 in-service STEM teachers and follow-up interviews explored perceptions of AI in teaching and learning. Convenience sampling was applied during an AI-focused training program.

OUTCOMES

Teachers generally held positive attitudes toward AI's potential in enhancing teaching and assessment but faced issues of limited infrastructure and training. Attitudes and professional development had greater influence on readiness than resources. Cluster analysis revealed three teacher groups with varying confidence and access levels.

CONCLUSIONS

Malaysian STEM teachers are receptive to AI but need stronger infrastructure and ongoing professional support. Differentiated training is essential, as readiness varies widely. Sustaining human expertise remains key for meaningful AI integration.

KEYWORDS

Artificial Intelligence, STEM, Instructional Strategies, STEM Teachers, AI in Education.

Introduction

Artificial Intelligence (AI) application has proliferated in education in developing personalized learning experiences which provide real-time feedback and tailor instruction to individual student needs (Choi et al., 2025; Lin et al., 2023). For instance, ChatGPT (Thanh et al., 2024), Turnitin (Hapsari et al., 2020), and Canva (Hidayati et al., 2024), have human capabilities as intelligent tutoring (Paul & Rohil, 2024), plagiarism detection (Adib et al., 2024), and creative content generation (Calo & Maclellan, 2024), thereby enhancing both teaching efficiency and student engagement (Singh, 2024). Owing to the task specific functionalities function, educational researchers have argued that teachers need to develop informed use of AI. This is known as AI literacy (Zhao et al., 2022) and defined as the ability to create effective prompts and critically analyse AI-generated content across diverse situations (Moura & Carvalho, 2024).

The components represent essential areas that should be integrated into teaching practices to help students develop the skills needed to understand and engage with AI responsibly. As literature regarding the incorporation of AI technologies in science education is emerging, there is a need to conceptualize AI as instructional strategies assistance regarding the epistemic aspects of such incorporation. Such move can guide teachers' curriculum planning and instruction in science education that known to prioritize inquiry.

One global effort to enhance AI literacy, the integration of AI has been described as promising to advance students' science learning. According to Wang (2024), AI helps to refine STEM instructional strategies to be more adaptive to learners by analysing student learning behaviours and processes. Adaptive learning platforms leverage AI and machine learning algorithms to assess cognitive abilities, engagement levels, and performance metrics, customizing educational content to meet individual student needs (Jagtap et al., 2025). Research indicates that students using adaptive learning platforms demonstrate notable improvements in academic performance, engagement, and retention compared to those in traditional learning settings (Hakim et al., 2024; Luo, 2023). Thus, moving forward, learning is expected to be adaptive and highly responsive for personalization approach. Regardless of this advantage, the successful integration of AI depends heavily on in-service teachers' perceptions of AI education and their experiences with AI teacher training programs.

The integration of Artificial Intelligence (AI) is challenging in two ways, first is when the science instruction is designed with integrated task-specific AI, known as instructional teaching assistance (Kim et al., 2025). For instance, AI-powered tools like automated data analysis, predictive modelling, and intelligent tutoring systems that enable students to explore environmental issues with greater depth and accuracy (Khan et al., 2024; Das et al., 2024). Second the challenge surround teachers' professional learning to work with AI for daily teaching and learning activities referred as AI readiness (Ayanwale et al., 2022) or teacher AI competence (Chiu et al., 2025). Understanding teacher's perceptions is crucial because their attitudes, confidence, and willingness to adopt AI tools directly influence how effectively these technologies are integrated into the classroom.

As Artificial Intelligence (AI) begins to find its footing in Malaysian classrooms, its introduction among in-service teachers remains relatively new. Given this early phase of adoption, it is essential to explore how AI is perceived within the country's distinct cultural and educational context. This inquiry offers an opportunity to contribute to a wider understanding of how cultural values may shape educators' responses to technological innovation in schooling. Similar studies can be found in countries such as China (Sujin Lee, 2023), the United States (Bauschard & Quidwai, 2024), and Finland (Vartiainen et al., 2025), where researchers conducted study to understand how policy environments affect educators' readiness and professional development needs in adopting AI technologies in classroom. This study investigates the perspectives of Malaysian STEM teachers who took part in a professional learning initiative designed to introduce AI tools for use in project-based teaching approaches. By examining their insights, the study aims to uncover how these educators interpret the role

of AI in teaching and how ready they feel to embed it in their instructional design. These objectives are explored through two guiding research questions focused on teachers' perceptions and readiness for AI integration in education.

- 1) What are the in-service teachers' perceptions of AI education for teaching in schools?
- 2) What are the difficulties encountered by Malaysian in-service teachers when utilising AI tools in their educational practice?

Literature Review

Teacher training programs play a critical role in preparing teachers to embrace AI as part of their instructional strategies. However, UNESCO reported that the implications of AI in education are still uncertain, and further investigation is necessary (Miao et al., 2021). In-service teachers often face challenges in adapting to technological innovations due to limited access and resources, lack of training and professional development, or uncertainty about pedagogical integration (Paran et al., 2024). The Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975), Theory of Planned Behavior (TPB) (Ajzen 1985, 1991) and technology acceptance model (TAM) (Davis 1989; Davis et al. 1989) is widely used to predict people's behavioural intentions to use new technologies, which in this study is AI for assessment. Studies in diverse educational settings, such as those by Samarescu et al. (2024) and Attach et al. (2024) have shown that teachers' perceptions of AI training programs significantly influence their willingness and readiness to adopt AI in classrooms. Teachers require professional development that is contextual, hands-on, and aligned with curriculum goals for greater confidence (Mehddi et al., 2024). Furthermore, AI-infused training should highlight not just technical usage, but also instructional strategies that align AI applications with student-centered learning, especially within STEM subjects that emphasize critical thinking and problem-solving.

In Malaysia, the implementation of AI in classrooms remains at an exploratory stage, particularly among in-service teachers who are navigating the balance between existing pedagogical practice and emerging AI competencies. Cultural (Chang et al., 2024), infrastructural, and policy-related factors (Mohd Jamil et al., 2024) can shape how Malaysian teachers respond to AI integration. While global studies like China (Sujin Lee, 2023), the United States (Bauschard & Quidwai, 2024), and Finland (Vartiainen et al., 2025) offer deeper insights, there is a need to understand how local educators perceive and engage with AI, particularly through structured training programs. Investigating their perceptions provides a foundation for tailoring teacher education initiatives that are culturally responsive and instructionally relevant. Moreover, understanding how teachers interpret the value and challenges of AI tools can help inform the design of future training programs that support effective, ethical, and sustained use of AI in Malaysian schools.

As AI becomes more embedded in classrooms the demand for AI literacy among teachers has increased. AI literacy includes not only technical know-how but also the pedagogical and ethical competencies necessary to evaluate and utilize AI tools effectively in the classroom context (Erkunt, 2023; Stolpe et al., 2024). Teachers must be equipped to formulate purposeful prompts, assess AI-generated outputs, and apply these tools to meet diverse learning needs (Ayanwale et al., 2024). This shift requires a reconceptualization of teachers' roles, from content deliveries to facilitating learning.

In STEM learning, the advantage of AI must be discussed. AI enhances the learning experience by providing data-driven insights, enabling personalized instruction (Sajja et al., 2024), studies like Zhou et al. (2024), Jasmadi et al. (2024), Pandit et al. (2024) examined the impact of generative AI on students' critical thinking and problem-solving skills, highlighting how these technologies can serve as powerful tools to foster deeper cognitive engagement.

Their research shows that the integration of AI tools in education promotes deeper critical thinking by enabling students to interact with complex data and scenarios which lead to problem-solving. This approach equips students with essential problem-solving skills needed to tackle real-world challenges, a competency that is increasingly crucial in an AI-driven era (Kyselova, 2024).

Method

This study employed an explanatory mixed method research design focusing on identifying teachers' perceptions and readiness to integrate Artificial Intelligence (AI) into instructional strategies for environmental STEM project-based learning (PBL) and professional learning. Data were collected through a survey administered during a teacher training program that introduced instructional approaches using AI-generated prompts. Convenience sampling was used to obtain responses from 110 in-service STEM teachers in April 2025. Quantitative data were analyzed using descriptive statistics (mean and standard deviation), Pearson's correlation, and agglomerative hierarchical cluster analysis applying Ward's method with the Squared Euclidean Distance. The cluster analysis enabled the identification of teacher groups with varying levels of readiness and perception. Following this, a qualitative phase was conducted through interviews with three teachers to elaborate on similar themes raised in the questionnaire. This methodological approach provides a systematic analysis of Malaysian STEM teachers' readiness and perspectives toward adopting AI as an instructional tool in culturally situated educational contexts.

Context and Participant

Concerted efforts are being made to propagate AI knowledge to school-aged students through researcher-led programmes to teach them using ChatGPT for instructional design and management in project-based learning. A total of 110 in-service STEM teachers participated in the study are science, physics, chemistry, biology and mathematics teachers at primary and secondary level as part of larger State education's initiative for teachers' professional learning community. The training was funded by James Dyson Foundation and supported by the Johor State Education Department. Table 1 outlines the explanatory sequential design employed in this study, illustrating the integration of quantitative and qualitative phases to provide a comprehensive understanding of teachers' perceptions and experiences with AI in education.

Explanatory Design

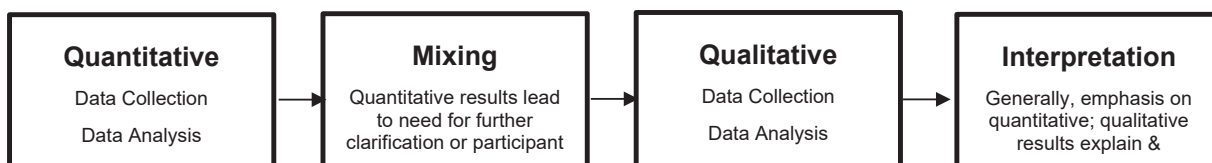


Figure 1 Explanatory Design

The explanatory design in mixed methods research starts with collecting and analysing quantitative data, such as surveys, to identify patterns or trends. Based on those results, the qualitative data was collected, like interviews, to get better understand or explain the findings. This approach helps to clarify the reasons behind the numbers. In the final step, both sets of results are combined with more focus on the quantitative part, while the qualitative findings help give deeper meaning.

Table 1: Demographic information of survey participants

Category		Frequency (N=110)	Percentage (%)
Age	20-29	15	13.6
	30-39	28	25.5
	40-49	46	41.8
	50-59	21	19.1
Teaching Experience	1-3	16	14.5
	4-9	10	9.1
	10-14	14	12.7
	15-19	35	31.8
	20-24	17	15.5
	25-30	16	14.5
	30+	2	1.9
Try AI as an Educational Tool	Yes	80	72.7
	No	30	27.3
Purpose of AI Usage	Teaching	66	77.6
	Assessment	24	28.2
	Activity	60	70.6

The age distribution of participants indicates a predominance of mid-career professionals, with 41.8% falling within the 40-49 age range. This was followed by respondents aged 30-39 years (25.5%), 50-59 years (19.1%), and 20-29 years (13.6%). The distribution reflects of the teaching workforce predominantly consists of mid-career educators, who potentially can balance classroom experience with openness to new pedagogical approaches, such as AI integration. Teaching experience data further supports this survey. A substantial portion of participants (31.8%) reported having 15-19 years of teaching experience, followed by 20-24 years (15.5%), 25-30 years (14.5%), and 1-3 (14.5%). Notably, only 1.9% had more than 30 years of experience, indicating that while experienced teachers were present, most of the respondents consisted of teachers with fewer than twenty years in the teaching profession.

Regarding exposure to AI in education, the findings reveal that a significant majority of respondents (72.7%) had prior experience using AI tools in their teaching practices. Among the 85 teachers who reported previous AI use, most integrated AI into instructional delivery (77.6%) and classroom activities (70.6%). However, only 28.2% utilized AI for assessment purposes. This trend highlights a growing engagement with AI for enhancing teaching and learning but also emphasizing the relatively limited application of AI in student evaluation processes.

Data Source

Post Program Survey

The survey instrument consisted of 32 questions, adapted from validated instruments from Moura and Carvalho (2024) and Alshorman (2024) surveys. A meta-construct development process was conducted to synthesize and organize relevant variables into five coherent constructs: (1) perceived competence in AI, (2) access to resources, (3) professional development and training, (4) attitudes towards AI in education, and (5) perception of assessment as learning using AI. The questionnaire is adopted from Moura and Carvalho (2024) for the constructs perceived competence in AI, access to resources, professional

development and training, and attitudes towards AI in education, while the construct perception of assessment as learning using AI is adopted from Alshorman (2024). Participants responded to the items using a four-point Likert scale: *strongly disagree*, *disagree*, *agree*, and *strongly agree*.

The analysis focus on descriptive and inferential statistics to determine the overall trends and relationships in the data using the Statistical Package for the Social Sciences (SPSS) 29.0 program. Descriptive analysis was conducted to calculate mean and standard deviation for each of the five constructs in the survey, providing a general overview of STEM teachers' perceptions of AI in education. Meanwhile, inferential analysis using Pearson's correlation was employed to examine the strength and direction of relationships between the constructs, with the aim of identifying the dominant factor that influences in-service STEM teachers' perceptions towards AI integration in their instructional practices.

Cluster Analysis

The technique of agglomerative hierarchical clustering was applied to examine patterns in teachers' perceptions of AI integration. Ward's method was used as the clustering approach, with the Squared Euclidean Distance serving as the similarity measure. Since the survey constructs were measured on different scales, the data were standardized before analysis. The optimal solution was determined based on the hierarchical clustering output, and the distribution of teachers across clusters was generated using SPSS 29.0.

Interview

After the survey, series of interview were conducted to understand teachers' perceptions on (a) professional development and training and access to resource, (b) perception of assessment as learning using AI and attitudes towards ai in education and (c) perception of assessment as learning using AI and access to resource. Three teachers voluntarily agreed be interviewed via Google Meet, and there was no monetary compensation to join the research. The interview questions focus on elaborating the findings obtained from the survey. Based on The Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB) and technology acceptance model (TAM) the questions focus on getting answer about the interconnected factors influencing teachers' intentions and actual behaviour towards adopting and effectively integrating AI-powered tools to develop instructional strategies in Malaysian education context.

Analysis

The objective of the paper was to gain insight into Malaysian teachers' perceptions about the integration of Artificial Intelligence in Education within their teaching practices. The research questions aim to explore teachers' perspectives regarding the potential benefits and challenges associated with AI.

Quantitative Findings

The quantitative findings include both descriptive and cluster analyses. Descriptive analysis was carried out to calculate the mean and standard deviation for each construct, providing an overview of teachers' perceptions and readiness towards AI integration. To further identify patterns in the responses, cluster analysis was performed using Ward's method with the Squared Euclidean Distance as the similarity measure. The data were standardized before analysis, and the dendrogram produced through SPSS 29.0 shows how teachers were grouped into clusters based on similarities in their perceptions.

Descriptive Analysis

The quantitative findings below are firstly presented the overall mean and standard deviation for the five main constructs examined in the study.

Table 2: Overall Mean and Standard Deviation for Five Constructs

Constructs	Overall Mean	Overall Standard Deviation
Perceived Competence in AI	2.99	.443
Access to Resources	2.75	.593
Professional Development and Training	2.87	.466
Attitudes Towards AI in Education	3.06	.486
Perception of Assessment as Learning using AI	3.06	.383

At the initiation of the survey, teachers were asked about their prior exposure to AI to gauge their level of familiarity with the concept of AI as shown in Table 2. Since the results indicate that approximately 72.2% of teachers reported utilizing AI, this highlights the increasing integration of AI in STEM education and educators' willingness to incorporate AI educational tools as teaching approaches. Hence, teachers' Perceived Competence in AI indicating a generally positive self-assessment of their foundational understanding and skills related to AI in education with the overall mean score was 2.99 (SD = .443).

To assess the infrastructural support available for AI integration in science education, teachers were surveyed on their access to various AI-related resources. As shown in Table 2, the overall mean score was 2.75 (SD = .593), indicating a moderate level of agreement regarding the availability of adequate tools, infrastructure, and support systems. This perception is particularly relevant given that a significant portion of respondents were experienced educators, 41.8% were aged 40-49 and 31.8% had 15-19 years of teaching experience, suggesting that their assessments are likely substantial classroom practice. Furthermore, with 72.7% of teachers reporting prior use of AI in education, the moderate access to resources highlights potential gaps between educators' willingness to adopt AI tools and the institutional support necessary to sustain efforts effectively.

Moreover, to examine teachers' access to professional development related to AI in education, participants were asked to rate their experiences with training, support, and learning opportunities. As presented in Table 2, the overall mean score was 2.87 (SD = .466), indicating a moderately positive perception of the availability and quality of professional development in AI. This suggests that while many teachers perceive some level of support in developing their AI-related competencies, there remains room for improvement in ensuring that training is comprehensive, subject-specific, and contextually relevant to their classroom needs.

Furthermore, to explore teachers' attitudes towards the use of AI in education, participants were asked to rate their agreement with statements regarding AI's potential impact and challenges in science teaching. The overall mean score was 3.06 (SD = .486), indicating a generally positive attitude towards AI integration. This suggests that teachers are largely optimistic about AI's role in enhancing instructional quality and supporting student learning, while remaining mindful of concerns related to maintaining the human element in education.

To evaluate teachers' perceptions of assessment as a learning tool facilitated by AI, participants were asked to rate their agreement with statements on AI's capabilities in personalizing learning and improving assessment accuracy. As shown in Table 2, the overall mean score was 3.06 (SD = .383), indicating a generally positive perception of AI's potential to enhance both the personalization and efficiency of student assessment. This suggests that educators recognize AI as a valuable tool to support differentiated learning and more targeted instructional interventions.

Table 3: Perceived Competence in AI

Items	M	SD
1. I understand the basic concepts of AI relevant to education.	3.00	.428
2. I am confident in my ability to use AI tools for teaching science.	2.95	.437
3. I can easily learn new AI tools that are introduced for educational purposes.	3.03	.459
4. I feel prepared to troubleshoot minor issues with AI technology in the classroom.	3.04	.405
5. I am able to evaluate the effectiveness of AI tools in enhancing science learning.	2.90	.487
6. I am comfortable explaining the benefits and limitations of AI to my students.	3.00	.406
7. I can integrate AI teaching tools with traditional teaching methods effectively.	2.98	.469
Overall	2.99	.443

The item with the highest mean ($M = 3.04$, $SD = .405$) was *“I feel prepared to troubleshoot minor issues with AI technology in the classroom,”* suggesting that participants are relatively confident in handling basic technical challenges. This was closely followed by the item *“I can easily learn new AI tools that are introduced for educational purposes”* ($M = 3.03$, $SD = .459$), which reflects a sense of adaptability and willingness to engage with emerging technologies. However, the lowest-rated item was *“I am able to evaluate the effectiveness of AI tools in enhancing science learning”* ($M = 2.90$, $SD = .487$), suggesting that while teachers are comfortable using AI, assessing its pedagogical impact remains a challenge. This may be explained by a lack of exposure to AI evaluation frameworks or limited opportunities for reflective practice in this area. It is also worth noting that participants generally reported being comfortable explaining AI to students ($M = 3.00$, $SD = .406$) and integrating it with traditional methods ($M = 2.98$, $SD = .469$), highlighting a moderate level of practical confidence in AI application within instructional strategies.

Table 4: Access to Resources

Items	M	SD
8. I have access to adequate AI resources for teaching science.	2.85	.528
9. My school/Ministry of Education provides sufficient hardware for utilising AI in the classroom.	2.60	.706
10. I have access to a variety of AI software and applications designed for education.	2.81	.516
11. My school provides the necessary technical support for using AI tools.	2.74	.585
12. I have a reliable internet connection in the classroom to support AI activities.	2.72	.679
13. The AI teaching resources available to me are up-to date and relevant.	2.90	.468
14. I have the necessary instructional materials to complement AI tools in science teaching.	2.64	.631
Overall	2.75	.593

In relation to Access to Resources, the overall mean score was 2.75 (SD = .593), reflecting a moderate perception among in-service STEM teachers regarding the availability and adequacy of infrastructure and tools needed to support AI integration in teaching. The highest-rated item was *“The AI teaching resources available to me are up-to-date and relevant”* (M = 2.90, SD = .468), suggesting that while teachers recognize the quality of content, access to these resources may not be consistent or widespread. The lowest-rated item was *“My school/Ministry of Education provides sufficient hardware for utilising AI in the classroom”* (M = 2.60, SD = .706), indicating a significant barrier at the institutional level concerning equipment provision. Similarly, items related to internet connectivity (M = 2.72, SD = .679) and technical support (M = 2.74, SD = .585) were also rated relatively low. These findings suggest that despite a general awareness of the value of AI resources, the physical and digital infrastructure necessary to implement them effectively remains insufficient. It is likely that these constraints affect the extent to which teachers can apply AI-based tools meaningfully in their instructional strategies.

Table 5: Professional Development and Training

Items	M	SD
15. I have received training on how to use AI in teaching.	2.52	.617
16. Ongoing professional development in AI is available to me.	2.71	.548
17. I am encouraged by my school to attend workshops or conferences about AI in education.	3.05	.403
18. The professional development I receive is tailored to my subject area and grade level.	2.97	.344
19. I am satisfied with the level of training provided for AI integration into the curriculum.	2.86	.459
20. I actively seek out new learning opportunities related to AI.	3.01	.439
21. The training I received has been practical and applicable to my teaching context.	2.95	.392
Overall	2.87	.466

For the construct of Professional Development and Training, the overall mean score was 2.87 (SD = .466), suggesting a moderately positive perception among in-service STEM teachers toward the training opportunities available for AI integration. The highest-rated item was *“I am encouraged by my school to attend workshops or conferences about AI in education”* (M = 3.05, SD = .403), indicating that institutional support for professional development is a key strength in promoting AI-related capacity building.

Similarly, respondents showed a proactive stance, with high agreement on *“I actively seek out new learning opportunities related to AI”* (M = 3.01, SD = .439) and *“The professional development I receive is tailored to my subject area and grade level”* (M = 2.97, SD = 0.344). These responses highlight a growing commitment among educators to personalize their AI learning journey to meet classroom needs. However, the lowest-rated item, *“I have received training on how to use AI in teaching”* (M = 2.52, SD = .617), suggests that while support and self-motivation are evident, there remains a gap in structured and systematic training delivery. This disconnect may explain why overall satisfaction (M = 2.86, SD = .459) and perceptions of practical application (M = 2.95, SD = .392) did not reach stronger agreement. It can be inferred that expanding access to practical, content-specific AI training remains a critical area for improvement in equipping teachers with the skills necessary for effective AI integration.

Table 6: Attitudes Towards AI in Education

Items	M	SD
22. I believe that AI can enhance the quality of science education.	3.09	.460
23. I am excited about the potential of AI to personalize learning for my students.	3.08	.431
24. I think that AI can help me to be a more effective teacher.	3.08	.452
25. I am open to experimenting with AI in my teaching practice.	3.07	.443
26. I believe that AI can support critical thinking and problem-solving skills in science.	3.07	.443
27. I feel that AI will become an essential part of education in the future.	3.10	.468
28. I am concerned about AI replacing human elements in teaching.	2.90	.663
Overall	3.06	.486

As for teachers' Attitudes Towards AI In Education, the findings reflected a generally positive outlook, with an overall mean score of 3.06 (SD = .486). The item *"I feel that AI will become an essential part of education in the future"* recorded the highest agreement (M = 3.10, SD = .468), indicating that most participants recognize AI as a significant and inevitable element in the evolution of educational practices. Closely following this were items that reflect enthusiasm and openness, such as *"I believe that AI can enhance the quality of science education"* (M = 3.09, SD = .460) and *"I am excited about the potential of AI to personalize learning for my students"* (M = 3.08, SD = .431).

Participants also expressed confidence in AI's capacity to support teaching effectiveness and student skill development, as seen in the responses to *"I think that AI can help me to be a more effective teacher"* (M = 3.08, SD = .452) and *"I believe that AI can support critical thinking and problem-solving skills in science"* (M = 3.07, SD = .443). These findings suggest that teachers are not only aware of AI's instructional advantages but are also willing to explore and integrate AI into their pedagogical routines.

However, a slightly more measured perspective was evident in the item *"I am concerned about AI replacing human elements in teaching"* (M = 2.90, SD = .663). Although the score remained above the midpoint, the relatively lower mean and higher standard deviation suggest varying levels of concern among participants regarding AI's role in diminishing human interaction in education. This points to the importance of framing AI as a complementary tool rather than a replacement for the teacher's role in the classroom.

Table 7: Perception of Assessment as Learning using AI

Items	M	SD
1. AI can help personalize student learning.	3.05	.354
2. AI can help identify areas where students need more help.	3.06	.365
3. AI can help assess student performance more efficiently and accurately.	3.06	.390
4. AI can help create personalized educational content for each student.	3.07	.422
Overall	3.06	.383

For teachers' perceptions of AI in the context of assessment as learning, the overall responses were highly positive, yielding a mean score of 3.06 (SD = .383). The item *"AI can help create personalized educational content for each student"* scored the highest (M = 3.07, SD = .422), suggesting that teachers recognize AI's potential in customizing learning materials to suit

individual student needs. Similarly, the belief that “*AI can help assess student performance more efficiently and accurately*” also received strong agreement ($M = 3.06$, $SD = .390$), highlighting teachers’ confidence in AI’s capacity to support more effective evaluation practices.

In addition, teachers responded positively to the statement “*AI can help identify areas where students need more help*” ($M = 3.06$, $SD = .365$), reflecting their awareness of AI’s diagnostic utility in targeting student learning gaps. The item “*AI can help personalize student learning*” ($M = 3.05$, $SD = .354$) also garnered high agreement, reinforcing the perception that AI can meaningfully contribute to differentiated instruction and learner-centered environments.

Overall, the consistent mean values across all items in this construct point to a shared understanding among in-service STEM teachers that AI offers valuable support not only for content delivery but also for guiding learning progress through more personalized and responsive assessment practices.

Table 8: The scale of Pearson’s Correlation Coefficient (Selvanathan et al., 2020)

Scale of Correlation Coefficient	Value
$0 < r \leq 0.19$	Very Low Correlation
$0.2 \leq r \leq 0.39$	Low Correlation
$0.4 \leq r \leq 0.59$	Moderate Correlation
$0.6 \leq r \leq 0.79$	High Correlation
$0.8 \leq r \leq 1.0$	Very High Correlation

Table 9: Correlations Between Constructs

Observed Variables	Perceived Competence in AI	Access to Resources	Professional Development and Training	Attitudes Towards AI in Education	Perception of Assessment as Learning using AI
Perceived Competence in AI	1	.			
Access to Resources	.500**	1			
Professional Development and Training	.500**	.559**	1		
Attitudes Towards AI in Education	.351**	.200*	.418**	1	
Perception of Assessment as Learning using AI	.405**	.183	.482**	.627**	1

The Pearson’s correlation analysis was conducted to examine the strength and direction of relationship between constructs, with the objective of identifying the most influential factor shaping in-service STEM teachers’ perceptions of AI integration into instructional strategies. The analysis revealed the “*Attitudes towards AI in Education*” had the strongest positive correlation with the “*Perception of Assessment as Learning using AI*” ($r = .627$, $p < .001$), suggesting that teachers’ openness and perception towards AI are crucial in shaping their instructional outlook. This is consistent with the mean scores in Tables 6 and 7, where attitudes

towards AI showed an overall positive rating of 3.06 (SD = .486), and perception of assessment as learning using AI had an equivalent overall mean of 3.06 (SD = .383). The alignment in these high means suggests that optimistic attitudes towards AI contribute to recognizing its potential in enhancing formative assessment practices.

This was followed by “Access to Resources” and “Professional Development and Training” ($r = .559$, $p < .01$). This suggests that teachers who reported better access to AI-related resources also tended to perceive more availability and quality in professional development opportunities. This relationship is supported by the mean scores in Tables 4 and 5, although access to resources scored moderately at an overall mean of 2.75 (SD = .593), professional development and training scored slightly higher with a mean of 2.87 (SD = .466). The moderate but aligned means indicate that access to resources and training are interrelated yet could both benefit from further enhancement to better support teachers in AI integration.

In contrast, “Access to Resources” recorded a low correlation with “Perception of Assessment as Learning using AI” ($r = .183$, $p = .055$), and was not statistically significant at the 0.05 level, indicating that resources availability alone does not strongly impact perception unless paired with training and positive attitudes. This lower correlation may reflect that even though access to resources was rated moderately low ($M = 2.75$, $SD = .593$), it does not strongly influence teachers’ beliefs about AI’s capacity to personalize learning and improve assessment accuracy, which were rated higher ($M = 3.06$, $SD = .383$). This discrepancy could imply that teachers may recognize the potential benefits of AI in assessment regardless of current resource limitations, possibly due to exposure through training or positive attitudes. These correlations collectively emphasize the critical role of mindset and professional development over mere infrastructural access in encouraging AI adopting among Malaysian in-service STEM teachers.

Based on the correlation analysis above, there are three key focuses were identified for qualitative data collection. These are: 1) Access to Resources, 2) Teacher’s Attitudes Towards AI in Education, 3) Perception of Assessment as Learning using AI. At this stage, the aim is to identify the difficulties encountered by Malaysian in-service teachers when utilising AI tools in their educational practice.

Cluster Analysis

Figure 2 presents the dendrogram generated through agglomerative hierarchical clustering using Ward’s method with the Squared Euclidean Distance as the similarity measure. The dendrogram shows the gradual clustering of all 110 in-service teachers who participated in the study. The vertical axis represents the rescaled distance of dissimilarity at which cases merge, while the horizontal axis lists the individual respondents. By examining the level of fusion across the dendrogram, an optimal solution of three clusters was identified, representing distinct patterns of teachers’ perceptions and readiness towards AI integration.

The first cluster is formed at a relatively low rescaled distance, indicating that the teachers grouped within this cluster hold highly similar perceptions of AI. Their close merging suggests a homogeneous group, most likely reflecting teachers who share comparable levels of confidence and readiness to use AI tools in their instructional practices. In contrast, the second cluster emerges at a moderate distance, capturing a broader and more heterogeneous set of teachers. The position of this cluster indicates that while these respondents share some common perspectives, there is also greater variation within the group, reflecting a mix of readiness levels and attitudes towards AI integration. The third cluster appears at a higher rescaled distance, separating from the others more distinctly. This suggests that the teachers in this group hold perceptions that are considerably different from the other two clusters, potentially representing those who are either strongly enthusiastic about AI adoption or, conversely, more skeptical and less prepared to integrate AI into their classrooms.

Taken together, the three-cluster solution highlights the diversity of teacher perceptions regarding AI integration. While one cluster reflects a relatively uniform and positive orientation,

another shows mixed readiness, and the third represents a divergent group with distinct perspectives. This variation underscores the importance of tailoring professional development to address the specific needs of different teacher groups rather than assuming a uniform trajectory of AI readiness across the teaching population.

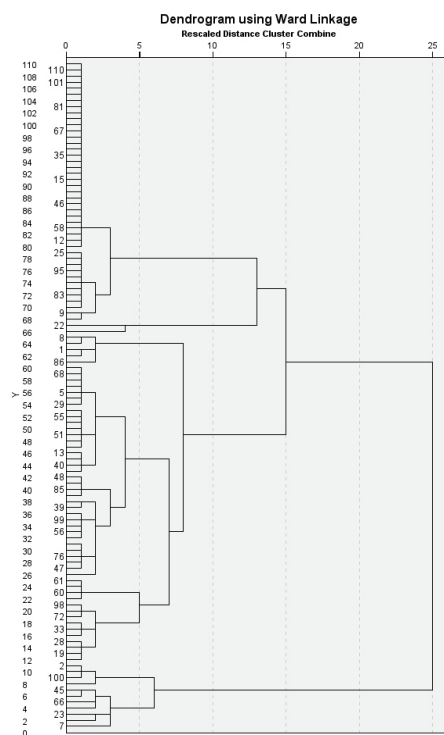


Figure 2 Dendrogram of cluster analysis using Ward Linkage

Qualitative Findings

The interviews were conducted with three teachers from diverse background to further elaborate the correlation findings above. The statistical analysis indicates, there are three relationships require an explanation, which are (a) professional development and training and access to resource, (b) perception of assessment as learning using AI and attitudes towards ai in education and (c) perception of assessment as learning using AI and access to resource. Coding of teachers' interview responses resulted into three main findings related to access to resource, teachers' attitude and perceptions.

Access to Resources

Teachers statement frequently gave evidence of limited access to resources. their experiences in integrating AI tools within their teaching practice and the kinds of support or facilities available in their respective schools. Access in their terms represented by constant highlight for infrastructure limits.

"Generally speaking, I can say that almost all schools are unable to provide adequate infrastructure. This may be due to budget constraints or a lack of funding sources, which often have to come from the PTA or other external sources." (T1)

"If the school provides all the necessary tools and training, then it would be great and it makes the teacher's work easier and faster". (T2)

Both teachers T1 and T2 explained due to this situation, most teachers most teachers and students unable to participate fully in the learning process of using AI. Hence, most teachers agree that it does impact their perception towards using AI in class for assessment. One of the teachers T3 has taken initiative to develop their own assessment tool using MIT App Inventor. This shows creative problem-solving for access and a proactive approach to improve student learning, especially in Physics. Which explain teachers in Malaysia is capable for finding solution due to the limited infrastructure resources.

"We did our own innovation using MIT App Inventor to assess students' Physics tasks but it's not accessible on Google Play yet. So yes, access is an issue." (T3)

Since the MIT App Inventor is not scalable or commercial tools, it prevents those tools from being effectively implemented in classrooms. Teachers can design tech-based tools but unable to solve problem related to technical barriers (like app publication, platform limitations, or approval policies).

Meanwhile, teachers place great emphasis on the role of AI for greater access in teaching and learning. This kind of attitude is generally produced when teacher T3 judge the outcomes of the behaviour directed for using AI.

"Honestly, I don't think there's one AI tool that can solve all our school problems. There's no one-size-fits-all. The creativity of the teacher still matters." (T3)

Hence, fragmented access to artificial intelligence (AI) infrastructure limits broader adoption and places a heavy burden on individual schools or teachers to develop and maintain their own solutions. The infrastructure referring by teachers here include reliable internet connectivity, updated computer labs, access to licensed AI software, and adequate digital devices for both teachers and students. Based on this, it can it is understandable that access for resources demands for teachers' adaptability towards new knowledge, new tools and evolving pedagogical practices that integrate AI meaningfully into the curriculum.

Teacher's Attitudes Towards AI in Education

Questions towards teachers' attitude focus on identifying their perceptions and readiness to integrate AI into classroom practices. Despite varying degrees of familiarity and confidence, all participants expressed great interest in exploring AI applications if appropriate support was provided like Teacher T2 and T3. Both are physics teachers with over 10 years of teaching experience and has never received formal training on using AI for teaching and learning.

"I'm interested in joining workshops... but in terms of confidence, maybe not so much. Age is a factor, and I'm considered a veteran. Still, I'm open to learning." (T2)

"I really like learning new things that can improve my teaching and learning instructions and student involvement in activities." (T3)

This suggests that while age and self-efficacy may influence their AI literacy, they do not significantly deter interest in professional development towards AI in education. Attitude is strongly link with their perception to use AI for assessment, which explains that this attitudes link with teachers' behavioural intention to use AI for assessment. Factors for their behavioural attentions was discussed by Teacher T3 as a matter of student engagement and instructional enhancement, suggesting that the perceived usefulness of AI drives their willingness to adopt it in assessment practices.

Perception of Assessment as Learning using AI

Questions regarding teachers' perceptions focused on how they conceptualise the role of AI in supporting assessment as learning within their classroom contexts. Across the interviews, teachers demonstrated a generally positive view of AI's potential to enhance student engagement, foster self-assessment, and promote reflective learning.

"I asked students to use AI to generate product images based on their project ideas. It helped them reflect on their creativity and improve their designs." (T3)

Teacher T3 perceived AI as an enabler for student-centred learning, where technology supports rather than replaces cognitive engagement and also emphasized that AI can be a powerful tool for promoting critical thinking when used to complement classroom instruction.

"For checking grammar or simple answers, maybe AI is okay. But to know how a student is really thinking or what effort they put in? That still depends on us." (T1)

"Sometimes the AI suggests marks or feedback, but I must double-check. It's just a starting point, not the final says." (T2)

These responses highlighted that teachers are willing to experiment with AI in assessment, especially when it enhances student engagement or streamlines feedback. However, Teacher T1 and Teacher T2 stressed that human interpretation is crucial, particularly in diverse Malaysian classrooms where student expression and cultural nuance play key roles in learning. Overall, the findings suggest that teachers are open to using AI to complement their assessment strategies but remain critical of its limitations. They appreciate AI's role in facilitating reflection and engagement, but they continue to view teacher agency as essential in ensuring assessments remain meaningful, context-aware, and aligned with real learning outcomes.

Professional Development and Training

During the interviews, teachers were enquired about the types of professional development and training they deemed crucial for enhancing their confidence and proficiency in using AI into classroom activities. All participants acknowledged that their capacity to adopt AI tools would be greatly enhanced if continuous, relevant, and hands-on training opportunities were made available. Teachers such as T2 and T3, who had some exposure to AI through personal initiative, expressed a clear desire to further their understanding through formalised professional learning.

"If workshops are offered, I think my confidence in using AI will increase. It's about gaining new knowledge." (T2)

Teacher T2 viewed that professional development is not only about technical skills, but also about building confidence and pedagogical strategies.

"Before letting students use ChatGPT, I had to explain clearly what we expected from them. Teachers need to be trained on how to give that direction." (T3)

"Honestly, I'm not trained in AI. I just use what I know and try to find what works. There's no formal training provided by the school." (T1)

The absence of structured training presents a significant barrier to AI integration in schools, a finding strongly illuminated by the Theory of Planned Behavior (Ajzen 1985, 1991). This lack of institutional support directly undermines teachers' *perceived behavioral control*, as the availability of resources like professional development is positively correlated with their confidence and capability to implement new technologies. Consequently, even if teachers possess a positive attitude towards AI, the reliance on self-directed exploration, as reported by teachers T2 and T1, signifies a low sense of control that weakens their behavioural intentions.

This gap between positive attitudes and practical implementation explains why engagement with AI remains experimental and fragmented. The resulting dependence on personal initiative, rather than systematic guidance, not only limits the scalability and pedagogical effectiveness of AI integration but also underscores that comprehensive professional development is pivotal for building the necessary control and preparedness for its systematic adoption in the classroom.

Discussion

The findings indicate a predominantly positive and optimistic outlook among in-service teachers regarding the integration of artificial intelligence (AI) in education. Quantitatively, a substantial majority of surveyed teachers (approximately 72.2%) reported prior engagement

with AI, underscoring a prevailing readiness to incorporate AI educational tools into their pedagogical approaches. This positive disposition is further evidenced by a mean score of 3.06 (SD = 0.486) concerning teachers' attitudes towards AI integration, reflecting optimism regarding AI's potential to enhance instructional quality and student learning. Concurrently, teachers exhibited a positive perception of AI as a learning tool, with a mean score of 3.06 (SD = 0.383) pertaining to AI's capabilities in personalizing learning and refining assessment accuracy. These quantitative results align with contemporary literature advocating for AI's transformative potential in education. For instance, Hwang & Tu (2021) highlighted how AI-powered tools facilitate personalized learning pathways and adaptive assessments, addressing individual student requirements.

A key finding from the Pearson's correlation analysis highlights the strongest positive relationship between "Attitudes towards AI in Education" and "Perception of Assessment as Learning using AI" ($r = .627, p < .001$). The strong correlation suggests that teachers' openness and positive views toward AI play an important role in shaping how they see its use in teaching, especially for formative assessment. The high average scores for both factors also indicate that positive attitudes help teachers recognize AI's potential to improve assessment practices.

The cluster analysis adds further depth to these insights, revealing three distinct teacher profiles. The first cluster represented teachers with consistently positive readiness, the second captured a more mixed group with varying levels of confidence and resource access, and the third comprised teachers with divergent perspectives, either strongly supportive or more hesitant toward AI integration. This pattern demonstrates that adoption is not uniform across the teaching population and that training strategies must be differentiated to accommodate diverse readiness levels. These findings are consistent with Uzun (2025), who identified three distinct awareness clusters among pre-service teachers (low, moderate, and high) and emphasized that teachers' engagement with AI varies considerably and that differentiated professional development is necessary to ensure equitable and sustainable adoption.

Qualitative data supported these positive attitudes by showing that teachers were genuinely enthusiastic about exploring AI applications. Even among experienced educators, such as a "veteran" teacher (T2) who expressed willingness to learn despite acknowledging age-related confidence issues, an openness to professional development was evident. Another participant (T3) revealed AI's perceived capacity to augment student engagement and optimize teaching and learning facilitation (PdPc). Positive attitudes towards AI integration among both students and faculty in the Philippines have been identified as a key factor influencing the intention to use AI tools in academic settings, as evidenced by Robinos et al. (2024). However, the qualitative findings also showed that teachers were aware of AI's current limitations, especially in handling complex assessment situations. Teacher T3's observation, "Honestly, I don't think there's one AI tool that can solve all our school problems. There's no one-size-fits-all. The creativity of the teacher still matters," highlighted an important view that recognizes the essential role of human teaching expertise. This balanced view resonates with the cautionary arguments presented by Selwyn (2019) who stressed the enduring importance of human agency and pedagogical judgment amidst technological advancements in education.

Despite the generally favourable perceptions of AI, both quantitative and qualitative analyses revealed notable challenges, particularly concerning infrastructural support and access to resources. Quantitatively, the survey indicated only a moderate level of agreement regarding the availability of adequate AI-related tools, infrastructure, and support systems, with an overall mean score of 2.75 (SD = 0.593). This "moderate" access is particularly salient given the significant representation of experienced educators among the respondents (41.8% aged 40-49, 31.8% with 15-19 years of experience), suggesting their assessments are grounded in extensive classroom practice. The observed discrepancy between teachers' high willingness to adopt AI (72.7% prior AI use) and the limited availability of resources suggests an important gap in the system that could hinder effective and widespread use of AI.

The Pearson's correlation analysis also revealed a moderate positive relationship between "Access to Resources" and "Professional Development and Training" ($r = .559$, $p < .01$). This indicates that teachers who reported better access to AI-related resources also tended to perceive more availability and quality in professional development opportunities. While access to resources scored moderately ($M = 2.75$, $SD = .593$) and professional development slightly higher ($M = 2.87$, $SD = .466$), their aligned suggest that both areas are connected and need to be improved together to better support teachers in using AI.

The qualitative interviews clearly supported these concerns about access to resources. Teachers explicitly noted that "insufficient access to AI-ready tools and infrastructure could hinder effective implementation" (T2). The example of a teacher (T3) creating an AI solution for Physics tasks using MIT App Inventor shows not only the lack of available resources but also the heavy burden on individual schools or teachers to develop their own solutions when commercial tools are not easily accessible. This finding is consistent with broader challenges encountered by educational institutions in deploying novel technologies. For example, Almethen (2024) reported the lack of proper infrastructure and limited technical support are major barriers to adopting AI in schools across different regions. This study also found that uneven access to AI infrastructure makes it harder to expand and sustain AI initiatives over time.

Interestingly, "Access to Resources" recorded a low and statistically insignificant correlation with "Perception of Assessment as Learning using AI" ($r = .183$, $p = .055$). This suggests that resource availability alone does not strongly influence teachers' beliefs about AI's capacity to personalize learning and improve assessment accuracy, even though these perceptions were rated higher ($M = 3.06$, $SD = .383$). This discrepancy implies that teachers may recognize the potential benefits of AI in assessment regardless of current resource limitations, possibly due to exposure through training or positive attitudes. This finding collectively emphasizes the critical role of mindset and professional development over mere infrastructural access in encouraging AI adoption among Malaysian in-service STEM teachers.

Furthermore, challenges were observed in the provision of professional development pertaining to AI. The quantitative data indicated a mean score of 2.87 ($SD = 0.466$) for professional development, suggesting a moderately positive perception of its availability and quality. While some level of support for teacher training is acknowledged, there is still much room for improvement. Training needs to be more comprehensive, subject-specific, and tailored to the real needs of teachers in the classroom. This kind of targeted professional development is essential to help teachers gain the skills they need to use AI effectively. Duque et al. (2024) stressed the importance of ongoing, customized training programs that go beyond technical skills and focus on how to use AI thoughtfully in teaching. Interview insights, especially from teachers who noted AI's limitations in assessing complex thinking and emotions, highlight the need for training that addresses deeper teaching issues and critical reflection on AI use, not just its technical operation. As articulated by T1, "For checking grammar or simple answers, maybe AI is okay. But to know how a student is really thinking or what effort they put in? That still depends on us." This view reinforces the ongoing importance of teacher expertise in handling complex assessments and fully understanding student learning. This reinforces the argument posited by Kushal (2023) that human oversight and teaching expertise are essential to ensure that AI is used ethically and effectively in education, especially in complex areas like assessment where human judgment and cultural understanding are crucial.

Conclusions

In conclusion, the findings of this study highlighted the generally positive and open attitudes of Malaysian in-service STEM teachers toward the integration of AI in education, particularly in its application for personalized learning and formative assessment. While optimism and prior exposure to AI suggest readiness to adopt such tools, the successful and sustainable implementation of AI in classrooms continues to face systemic challenges, including limited

access to resources, infrastructural gaps, and inadequacies in professional development. Importantly, the cluster analysis revealed three distinct teacher profiles with varying levels of readiness and perception, demonstrating that adoption is not uniform across the teaching population. Notably, the study showed that teachers' beliefs about AI's educational value are shaped more by their attitudes and training than by resource availability. Qualitative insights reinforce the importance of human expertise, emphasizing the irreplaceable role of teacher judgment in complex assessment contexts and the need for thoughtfully designed, subject-specific, and contextually relevant professional development. Therefore, a balanced approach that combines infrastructural support with differentiated pedagogical capacity-building is essential to ensure ethical, effective, and context-sensitive integration of AI into educational practice.

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