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Integrating ChatGPT into Science Lesson Planning in Malaysian Primary Schools: A Mixed-Methods Study

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Abstract

This mixed-methods study examined the integration of ChatGPT into Science lesson planning among teachers in National-Type Chinese Primary Schools (SJKC) in Selangor, Malaysia. Drawing on Constructivist Learning Theory, Differentiated Instruction, and the Technology Acceptance Model (TAM), the study employed a convergent parallel mixed-methods design. Quantitative data were collected from 100 Science teachers through structured surveys, while qualitative data were gathered through semi-structured interviews with 30 teachers. Findings reveal that ChatGPT significantly enhances lesson planning efficiency (78% agreement), creativity (M=4.12), and student engagement (M=4.20). However, challenges persist, including lack of professional development (M=4.05), curriculum alignment difficulties, and infrastructure limitations. Regression analysis identified professional training (β=-0.37, p<.001) and infrastructure availability (β=-0.29, p<.01) as significant predictors of adoption willingness. The study proposes strategies including structured professional development, curriculum-aligned guidelines, and Professional Learning Communities to optimize ChatGPT integration. Implications for teachers, school leaders, and policymakers are discussed.

Keywords: *ChatGPT; artificial intelligence in education; Science lesson planning; differentiated instruction; Malaysian primary schools; mixed-methods*

1. Introduction

1.1 The Broader Context

The world today is witnessing a significant transformation in the educational landscape, driven by the continuous advancement of technology. Artificial intelligence's (AI) rapid spread throughout global education systems has sparked new discussions about the role of teachers, the future of education, and how students' expectations are changing in a technology-prioritizing society (Ayeni et al., 2024). AI can customize learning experiences and process infinite amounts of data, enabling teachers to create individualized learning environments tailored to each student's unique preferences, speeds, and styles (Jones, 2021; Lee, 2019).

In Malaysia, AI is no longer seen as optional enrichment but as a strategic priority aligned with national digital transformation objectives. The MyDigital blueprint aims to incorporate digital tools and resources into classrooms, promoting 21st-century learning skills (Nur

Zarina Othman, 2021). The Malaysia Education Blueprint 2013-2025 emphasizes the integration of technology to enhance teaching and learning outcomes (Ministry of Education, 2013).

In subjects like Science, the need for adaptive learning is urgent. Science requires conceptual understanding, procedural knowledge, and inquiry-based learning. Many students in Malaysian primary schools, including SJKC schools, struggle to grasp abstract scientific concepts. These difficulties are compounded by language diversity, varying proficiency levels in Mandarin, English, and Malay, and resource constraints. The emergence of AI tools helps close this gap by providing teachers with instant lesson plans, differentiated materials, and multilingual explanations to support diverse learners.

ChatGPT, driven by the advanced GPT architecture, offers immense opportunities for teachers seeking to maximize their efforts in lesson planning (Alshater, 2022). Its capacity to produce logical and contextually appropriate text in response to prompts presents opportunities for educators looking to enhance the effectiveness and quality of lesson planning (Costello, 2023).

1.2 Identifying the Research Gap

Despite Malaysia's progress in digital education with programs like MyDigital and the Digital Education Policy, little is known about how AI is actually used in lesson planning. Teachers in SJKC schools frequently balance the demands of the syllabus, high parental expectations, and multilingual instruction. While AI offers a chance to reduce workload pressure, there has been no systematic research on how much teachers trust, understand, and use these tools meaningfully.

Existing literature often generalizes findings across educational settings without considering the unique linguistic, cultural, and pedagogical characteristics of schools like SJKC, where bilingual instruction and differentiated learning needs are common. Most studies focus on the technological capabilities of AI tools without adequately addressing their contextual application in diverse educational environments (Rosli et al., 2022). Furthermore, little research has been conducted into how AI platforms like ChatGPT can be tailored or optimized for lesson planning in multilingual and multicultural environments.

1.3 The Need for the Present Study

This study addresses these gaps by examining how ChatGPT is integrated into Science lesson planning in SJKC schools in Selangor. The multicultural and multilingual environment of Malaysia makes AI adoption more complicated. Although ChatGPT can produce bilingual or multilingual content, teacher judgment is still needed to determine the outputs' quality, accuracy, and cultural relevance. Understanding how teachers perceive the challenges they face is essential for creating responsible and successful AI integration frameworks for Malaysia's primary school ecosystem.

1.4 Research Purpose and Questions

The purpose of this study is to investigate the effectiveness of Science lesson planning, specifically how ChatGPT improves lesson customization, student engagement, and learning outcomes. The study is guided by three research questions:

- How does ChatGPT influence the effectiveness of Science lesson planning in Selangor national-type Chinese schools?
- What challenges do teachers face when integrating AI tools into Science lesson planning, and how can these be addressed?
- What strategies can be developed to optimize the integration of ChatGPT in Science education?

1.5 Significance of the Study

This study is significant because it provides practical insights into how AI tools can be effectively implemented in lesson planning within the Malaysian SJKC context. For educators and school administrators, the findings offer resources and best practices to improve learning outcomes and student engagement. For educational leaders and policymakers, the findings can serve as a crucial guide to support ChatGPT in Science education, influencing decision-making and resource allocation. The study also addresses ethical considerations, ensuring responsible AI integration.

2. Literature Review

2.1 The Evolution of AI in Education

The evolution of AI in education has progressed through three distinct waves. The first wave included administrative automation tools like automatic attendance, grading, and plagiarism detection (Vieriu & Petrea, 2025). The second wave introduced adaptive learning systems like ALEKS, Knewton, and DreamBox Learning that could change task difficulty and provide specific feedback (Wang et al., 2024). The third wave, which started with ChatGPT in 2022, brought generative AI capable of creating original pedagogical content such as lesson plans, explanations, assessment items, and multimodal prompts (Kasneci et al., 2023).

In Southeast Asia, Singapore leads in AI-driven education with national programs like "AI for Everyone" and Smart Nation Schools, where AI tutors and adaptive assessment platforms are being widely tested (Frana, 2024). Indonesia and Thailand have started experimenting with AI-based learning analytics for early detection of learning challenges (Theerawut Tantiathimongkhon & Kriangkrai Satjaharuthai, 2025).

2.2 AI in Lesson Planning

AI's role in lesson planning has emerged as one of its most transformative applications in education. With AI-powered platforms, teachers can now automate significant portions of the lesson planning process (Halaweh, 2023). Research highlights three main advantages: efficiency, creativity, and differentiation. Studies show that teachers save 30-50% of planning time when using AI to create lesson plans, learning objectives, and assessments (Roumeliotis & Tselikas, 2023).

AI tools expose teachers to new pedagogical opportunities by generating inquiry questions, real-world comparisons, activity ideas, and alternate explanations (Alshater, 2022). The ability of AI to rapidly adapt instructional materials to diverse student demands aligns with Universal Design for Learning principles, promoting inclusive approaches in multilingual settings (Wang et al., 2023).

2.3 Personalization Learning through AI

Personalized learning through AI is one of the most revolutionary advancements in modern education. Holmes, Bialik, and Fadel (2023) define personalization in AI-enabled environments as customization of instructional content, pedagogy, and assessment based on each student's unique characteristics. In science education, where students develop reasoning and conceptual knowledge at varying rates, personalization is particularly important. AI-supported science training improves conceptual clarity while reducing misconceptions through targeted explanations, flexible questioning, and real-time feedback (Chen & Xie, 2023).

In bilingual settings like Malaysian SJKC schools, AI-powered personalized learning is especially beneficial. ChatGPT can provide trilingual explanations, translate scientific terms, and automatically modify linguistic complexity (Holmes et al., 2019). This reduces language barriers and promotes deeper conceptual understanding.

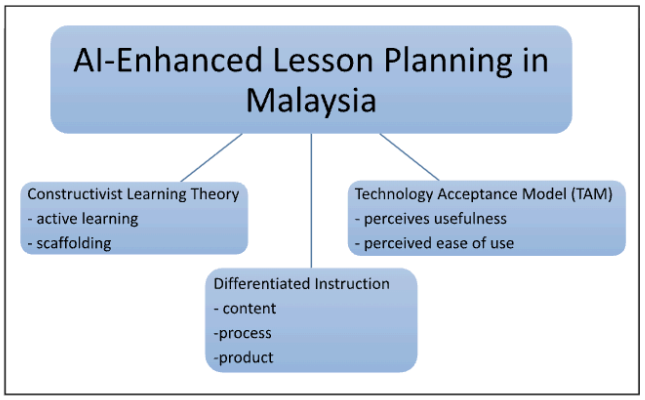
2.4 Theoretical Framework

The theoretical foundation draws upon three interrelated models. **Constructivist Learning Theory** (Piaget, Vygotsky) emphasizes that learners build understanding through experiences and reflection (Rabindran, 2020). ChatGPT facilitates constructivist learning by offering interactive materials, problem-solving tasks, and scaffolding that supports students' Zone of Proximal Development (Md Yusof, 2021).

Differentiated Instruction Theory addresses diverse learning needs by modifying teaching methods, environments, and content. ChatGPT supports differentiation by generating resources in multiple formats and varying complexity levels to accommodate different readiness levels, interests, and learning profiles (Tomlinson & Imbeau, 2023).

The **Technology Acceptance Model (TAM)** posits that perceived usefulness and perceived ease of use predict technology adoption (Davis, 1989). In AI integration, teachers and students are more likely to accept AI tools if they perceive these technologies as improving educational outcomes and being user-friendly (Hu & AlSaqqaf, 2021).

Figure 1 *Theoretical Framework for AI-Enhanced Lesson Planning in Malaysia*



3. Methodology

3.1 Research Design

This study employed a convergent parallel mixed-methods design (Creswell & Creswell, 2023), in which quantitative and qualitative data were collected simultaneously and integrated during analysis. This approach allows for triangulation of findings and provides both breadth and depth in understanding ChatGPT integration.

3.2 Participants and Sampling

The study focused on Science teachers in National-Type Chinese Primary Schools (SJKC) in the Hulu Langat district of Selangor. Participants were selected through purposive sampling for the qualitative component (30 teachers) to ensure rich, relevant data from teachers with firsthand ChatGPT experience. For the quantitative component, 100 teachers were surveyed, providing sufficient statistical power for descriptive and inferential analyses.

3.3 Data Collection Instruments

Semi-structured interviews were conducted with 30 teachers to explore their experiences, challenges, and strategies regarding ChatGPT integration. The interview protocol was developed based on established AI-in-education frameworks and theoretical foundations.

Structured surveys were administered to 100 teachers using Google Forms. The survey included sections on demographic information, influence of ChatGPT on Science lesson planning, challenges in integration, and strategies for optimization, using 5-point Likert scales and open-ended questions.

3.4 Data Analysis

Qualitative data were analyzed using thematic analysis in NVivo, following Braun and Clarke's (2006) six-phase framework. Quantitative data were analyzed using descriptive statistics (frequencies, means, standard deviations) and inferential analysis (regression, ANOVA) in SPSS version 28. Integration occurred at the interpretation stage through triangulation.

3.5 Ethical Considerations

Informed consent was obtained from all participants. Anonymity and confidentiality were maintained through alphanumeric coding. Participants were informed of their right to withdraw at any time. Institutional ethics approval was obtained before data collection.

4. Findings

4.1 Quantitative Results

Research Question 1: Influence of ChatGPT on Science Lesson Planning

Survey results from 100 Science teachers indicated positive perceptions of ChatGPT's impact on lesson planning. On a 5-point Likert scale, 78% of respondents agreed or strongly agreed that ChatGPT improved the overall quality of their Science lesson plans (M=4.12, SD=0.68). Teachers highlighted ChatGPT's ability to increase student engagement (M=4.20, SD=0.65), with engagement consistently rated higher than other factors. Curriculum alignment received a positive rating (M=4.05, SD=0.72), indicating moderate-to-strong agreement that AI-generated content can be modified to comply with DSKP requirements.

Table 1: Key Quantitative Trends in Teachers' Use of ChatGPT

Category	Key Finding	Evidence
Pedagogical effectiveness	Teachers perceive ChatGPT as improving lesson quality	78% agreement
Student engagement	ChatGPT-supported activities increase participation	M=4.20
Curriculum alignment	Teachers can adapt AI-generated content to DSKP	M=4.05
Differentiated instruction	AI helps support different learning styles	65% agreement
Instructional efficiency	ChatGPT reduces lesson preparation time	β=0.41

Regression analysis revealed that efficiency (β=0.41, p<.01), creativity (β=0.28, p<.05), and engagement (β=0.22, p<.05) all positively predicted teachers' overall lesson effectiveness, explaining approximately 62% of the variation (R^2=0.62).

Research Question 2: Challenges in ChatGPT Integration

Lack of professional training and development opportunities was the most significant challenge identified (M=4.05). Time limitations ranked second (M=3.90), with teachers noting that while ChatGPT speeds up drafting, it also requires more thorough review. Adaptation of ChatGPT outputs to meet diverse learner needs was the third significant challenge (M=3.78).

Table 2: Regression Analysis of Factors Influencing Adoption Willingness

Predictor Variable	Beta (β)	Significance	Interpretation
Professional training availability	-0.37	p<.001	Lack of training significantly reduces adoption willingness
Infrastructure availability	-0.29	p<.01	Limited internet access and resources negatively influence adoption
Accuracy concerns	-0.12	n.s.	Not a statistically significant predictor

The variables explained 55% of the variation in adoption willingness, highlighting that structural barriers, not attitude ones, are the biggest obstacles.

Research Question 3: Strategies for Optimizing Integration

Teachers strongly endorsed enabling conditions for ChatGPT integration. Professional development and training received the highest rating (M=4.31), followed by time allocation for meaningful use (M=4.27), and clear guidelines and instructional structures (M=4.22). Regression analysis showed that collaboration (β=0.38, p<.001) was the most significant factor influencing teaching efficiency, followed by PD training (β=0.32, p<.001) and time allocation (β=0.17, p<.01). These variables collectively accounted for 68% of the variation in perceived teaching effectiveness.

Table 3: Teachers' Perceptions of Enabling Conditions and Strategies

Enabling Condition	Mean (M)	Strategies
Professional development training	4.31	Provide regular AI workshops, prompt engineering training, curriculum alignment support
Time allocation for AI lesson planning	4.27	Allocate protected planning time, reduce administrative workload
Clear guidelines and structures	4.22	Develop institutional guidelines, provide prompt templates, create curriculum-aligned frameworks

4.2 Qualitative Findings

Thematic Analysis of Teacher Interviews

Theme 1: Efficiency. Participants frequently mentioned how ChatGPT made creating science lesson plans faster. Teacher 8 stated: "It helps structure lessons logically without

excessive mental energy, simplifies workload during busy periods, and allows teachers to generate lesson ideas in minutes." Teacher 10 mentioned: "It significantly reduces the time spent brainstorming activities and content ideas."

Theme 2: Innovation. ChatGPT significantly fosters innovation by providing teachers with creative ideas and varied approaches. Teacher 17 commented: "It makes me think beyond the textbook. For example, I got a suggestion to compare water evaporation to sweat drying after sports, and my students immediately related to it." Teacher 21 added: "I used ChatGPT to create interactive science activities in a game format. It made revisions much more fun and competitive."

Theme 3: Structural Support. ChatGPT provides significant structural support by helping teachers organize ideas and ensure logical content progression. Teacher 5 shared: "It can help teachers stick to frameworks like the 5E model (Engage, Explore, Explain, Elaborate, Evaluate), ensuring no important phases are skipped." Teacher 14 stated: "ChatGPT acts as a template generator, providing all the key components necessary for a lesson plan, including objectives, materials, tasks, and assessments."

Challenges in Integration

Lack of Professional Development and Training. Teacher 4 reflected: "I only know the very basic functions of ChatGPT. Without proper training, I feel like I am not using it to its full capacity." Teacher 11 admitted: "Sometimes I am unsure how to phrase my prompts correctly, so the answers are not always relevant. Training on how to 'talk' to ChatGPT would help a lot."

Unreliable Digital Infrastructure. Teacher 27 explained: "Sometimes the Wi-Fi in school is very weak, and I can't access ChatGPT at all. At home it's fine, but in school I often have to rely on my phone." Teacher 16 added: "We only have one shared desktop in the science laboratory. It's not practical for all teachers to use ChatGPT whenever they need it."

Content Accuracy and Reliability. Teacher 8 shared: "The facts are usually correct, but sometimes the explanation is too general or not aligned with the way our syllabus phrases it." Teacher 22 noted: "I once got an example about snowstorms when teaching weather. That doesn't apply here, so I had to adapt it to monsoon rain."

Strategies for Optimization

Professional Development. Teacher 19 suggested: "If the school can organize workshops, even short sessions, we will feel more confident using ChatGPT properly." Teacher 25 explained: "Some of my colleagues are already good at using ChatGPT. If they could share their techniques, it would save time for everyone."

Guidelines and Templates. Teacher 12 stated: "If we had clear guidelines that show how ChatGPT can be aligned with our syllabus, it would make adoption much easier."

Peer Collaboration. Teacher 8 observed: "If a group of us could test different ways of using ChatGPT and then share our experiences, it would benefit everyone, not just individuals."

4.3 Triangulation of Findings

Triangulation confirmed strong alignment between survey and interview data on efficiency and creativity, reinforcing the conclusion that ChatGPT enhances lesson planning by saving time and inspiring innovative teaching ideas. However, the process also revealed an important divergence: while survey responses suggested that curriculum alignment was largely acceptable, interviews painted a more complex picture. Teachers frequently described the need to manually edit or adapt ChatGPT's outputs to ensure compliance with the Malaysian science syllabus.

For Research Question 1, both interviews and surveys confirmed that ChatGPT supports efficiency, creativity, and student engagement in lesson planning, though concerns remained about curriculum alignment requiring manual adjustment. For Research Question 2, both data sources highlighted systemic challenges such as insufficient training, unreliable internet access, and content accuracy issues. For Research Question 3, teachers identified strategies like targeted training, time allocation, and clear guidelines, with interviews placing stronger emphasis on peer collaboration through Professional Learning Communities.

5. Discussion

5.1 Summary of Key Findings

This study found that ChatGPT positively impacts planning efficiency, personalization, and student engagement when integrated into Science lesson planning in SJKC schools. Teachers reported that the planning process takes 30-50% less time due to ChatGPT's assistance, consistent with international evidence (Kaddouri et al., 2025). The results align with the Technology Acceptance Model (TAM), with teachers acknowledging high levels of Perceived Usefulness and Perceived Ease of Use.

ChatGPT enables customized instruction and content delivery, allowing teachers to tailor resources to different proficiency levels, cognitive readiness, and language backgrounds. This aligns with Constructivist Learning Theory and Differentiated Instruction principles. The tool's ability to generate bilingual and trilingual content is particularly valuable in SJKC contexts, reducing teachers' burden and increasing conceptual clarity for students.

Teachers reported that ChatGPT expanded their pedagogical ideas through novel Science activities, inquiry-based tasks, analogies, and real-world examples. This aligns with the SAMR Model, particularly at the Modification and Redefinition levels, where technology enables new forms of instructional design.

5.2 Discussion in Relation to Literature

The findings corroborate international studies demonstrating AI's role in enhancing lesson planning efficiency and creativity. Studies in China and Singapore report similar findings where AI enhanced efficiency and creativity but required localized curriculum adaptation

(Tan et al., 2022). This situates the present study within a broader regional narrative, confirming that while ChatGPT has cross-contextual potential, its success depends heavily on contextualized policy frameworks and teacher readiness.

The challenges identified—lack of training, curriculum misalignment, and infrastructure limitations—echo findings from other Southeast Asian contexts (Rosli et al., 2022). The TPACK framework provides insight into why teachers struggle to integrate ChatGPT outputs with the Malaysian science syllabus, revealing gaps between technology, pedagogy, and content knowledge.

5.3 Discussion in Relation to Theory

The findings substantiate Constructivist Learning Theory by demonstrating that ChatGPT facilitates student-centered approaches through interactive suggestions, diverse examples, and immediate scaffolding resources. The tool enables teachers to create lessons around investigation, questioning, and hands-on reasoning—hallmarks of effective Science learning.

Differentiated Instruction Theory is supported by ChatGPT's ability to produce multiple versions of the same Science concept at varying difficulty levels. Teachers noted that the AI could on-the-spot generate materials for advanced, intermediate, and struggling learners, which is particularly valuable in mixed-ability SJKC classrooms.

The Technology Acceptance Model (TAM) explains teachers' adoption patterns. High Perceived Usefulness was evident, but Perceived Ease of Use was undermined by limited training, inaccuracies, and technical issues. This illustrates the importance of addressing both psychological and practical aspects of technology acceptance.

5.4 Implications

For Teachers: AI literacy is crucial. Teachers need to learn how to create good prompts, check truth and relevance, and be aware of ethical issues. ChatGPT will not replace professional judgment; teachers will become evaluators, adapters, and decision-makers. Professional Learning Communities (PLCs) can facilitate peer learning and collective inquiry.

For School Leaders: Administrators should provide structured, ongoing AI-centered professional development and ensure digital infrastructure readiness. Clear internal policies on data privacy, content verification, and academic integrity are essential. Leaders should create environments that support risk-taking, teamwork, and creativity.

For Curriculum Designers: Curriculum authorities should revise support documents to cover AI-based differentiation, inquiry-based learning, and formative assessment strategies. AI-related abilities should be incorporated into the syllabus to promote digital literacy and ethical technology use.

For Policymakers: National guidelines should address data protection, algorithmic bias, and responsible AI use. Frameworks must include criteria for verifying AI outputs against DSKP standards. Teacher autonomy should be preserved, with AI positioned as a supportive tool rather than a replacement for professional judgment.

5.5 Limitations

Several limitations should be acknowledged. The study's geographic scope is limited to SJKC schools in Selangor's Hulu Langat district, restricting generalizability. The reliance on self-reported data may introduce social desirability bias. The cross-sectional design captures perceptions at a single point in time. The sample may overrepresent tech-savvy educators, potentially omitting insights from less digitally proficient teachers. The absence of classroom observation limits understanding of real-world AI integration. Finally, the rapid evolution of AI technologies means findings may become outdated as platforms update.

5.6 Recommendations for Future Research

Longitudinal studies should investigate the enduring impacts of ChatGPT on pedagogy and learning. Student perspectives may yield insights into classroom engagement. Investigating other school types and subjects will enhance understanding of AI's educational capabilities. Research should examine how language adaptation, cultural norms, and geographical contexts shape ChatGPT's usability and perceived value in diverse Malaysian school settings. Studies incorporating classroom observations, peer assessments, or student feedback alongside surveys would provide more holistic views of AI's practical effects.

6. Conclusion

This mixed-methods study examined the integration of ChatGPT into Science lesson planning in SJKC schools in Selangor, Malaysia. Findings reveal that ChatGPT significantly enhances lesson planning efficiency, creativity, and student engagement. Teachers reported substantial time savings, improved lesson structure, and increased ability to differentiate instruction for diverse learners. However, challenges persist, including lack of professional development, curriculum alignment difficulties, and infrastructure limitations.

The study contributes to the growing body of literature on AI in education by providing context-specific evidence from Malaysian multilingual primary schools. The findings align with Constructivist Learning Theory, Differentiated Instruction, and the Technology Acceptance Model, demonstrating that ChatGPT can facilitate student-centered, personalized, and inclusive pedagogy when supported by appropriate institutional frameworks.

For ChatGPT to realize its full potential in Malaysian primary science education, systemic support is essential. This includes structured professional development, clear implementation guidelines, robust digital infrastructure, and ongoing research into long-term impacts. By addressing these systemic issues, ChatGPT may transform from a helpful tool into a driving force for innovative teaching and learning in Malaysian classrooms.

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