ESL Teachers' Perception of Using Artificial Intelligence in Differentiated Instruction

*Tai Jhe Ken, Mohammad Hafiz Zaini, Mohd Khalid Mohamad Nasir

Faculty of Education, National University of Malaysia (UKM)
Email: *tjken1993@gmail.com

Abstract

This study explored Malaysian primary and secondary school ESL teachers' perceptions of using artificial intelligence (AI) to support differentiated instruction (DI). It addressed three objectives: (1) to determine ESL teachers perceived AI's support for DI; (2) to determine ESL teachers' perceptions of AI's support for each principle in DI; (3) to determine whether teaching experience influences ESL teachers perceived AI's support for DI. This study employed quantitative survey design and collected data from 102 respondents through a structured questionnaire. A total of 100 valid responses were analysed after data screening. The instrument was validated by expert reviewers and demonstrated acceptable internal consistency for all constructs (Cronbach's Alpha = 0.88 to 0.91). Descriptive statistics and one-way ANOVA were used to analyse the data. The findings revealed that ESL teachers generally held positive perceptions of AI's support for DI. Among the DI principles, AI was perceived as the most supportive in content differentiation, followed by product, process, and environment differentiations. One-way ANOVA revealed a significant difference in perceived AI's support for DI based on teaching experience. Post hoc results revealed a non-linear trend between perceived AI's support and teaching experience. In short, this study provides a valuable insight into the reality of incorporating AI into differentiated ESL lessons.

Keywords: Artificial Intelligence, Differentiated Instructions, English as a Second Language

Introduction

Artificial intelligence (AI) could be summed up as the capability of a computer system to have a human-like thinking. In other words, AI could undergo the same purposive thought process as a human does. For example, building up the knowledge, analysing data, predicting trends, making decisions, and solving problems. Compared to a human, the thought process could be done in a much faster and efficient manner based on the readily available and newly acquired data. As a result, the capability of AI has brought significant changes to humans' productivity. AI optimises the execution of routinise tasks, eases the tasks' complexity, speeds up time-

consuming processes, and makes a rapid decision accurately. Consequently, the presence of AI brings rapid development in various sectors and fields.

The development of AI has thus changed the educational landscape, especially in the teaching of English as a second language (ESL). The change is not just upon the introduction of AI and AI-integrated technology into the classroom. It has developed to an extent where the ecosystem of ESL teaching and learning has been affected (Anggun, 2024; Bonner et al., 2023; Lazzat, 2024; Nur Mazliyana et al., 2024; Rizqi, 2023). This phenomenon has recurred in many non-English speaking countries, especially Malaysia. The ecosystem, which includes the teaching method, learning process and learning experience in an ESL classroom, has been leveraged to a point where it becomes more dynamic, interactive and personalised than before.

According to Muhammad et al. (2024) and Anggun (2024), the integration of AI can be summarised into five key roles, which are designing teaching and learning contents, delivering the contents, conducting assessments and evaluation, giving feedback, and lastly providing supports. These roles highlight AI's potential to function as an adaptable partner for teachers throughout the entirety of teaching and learning cycle. Strategic utilisation of AI not only enhances the overall effectiveness of ESL teaching and learning process, but also empowering teachers to customise their lessons even efficiently than before. Reiss (2021) predicted that the advent of AI would significantly expand and simplify the pathways for personalisation of teaching. With its capabilities, AI can assist teachers in tailoring teaching materials to align with pupils' interest and proficiency levels, offering personalised feedback, or suggesting multiple formats of assessment to meet the diverse needs of pupils (Anggun, 2024; Mananay, 2024; Nur Mazliyana et al., 2024). By leveraging AI's capabilities, teachers are empowered to create an inclusive and engaging learning environment that is relevant to the individual pupils' needs in classrooms. In other words, AI has the potential to enhance the practice of differentiated instruction in the ESL classroom.

Problem Statements

There is a limited study exploring the incorporation of AI in DI from the perspective of ESL teachers in the local context. Existing studies have highlighted teachers' familiarity and competency with DI, identified several challenges associated with DI's implementation, and proposed innovative approaches to enhance the differentiated lesson's effectiveness. Notably, some teachers have taken the initiative to incorporate AI into their differentiated practice while showing its potential to meet diverse pupils' needs in the classroom. However, the initiative remains unexplored and adding to the significant gap in understanding AI's capability in supporting teachers in differentiated ESL classrooms. By addressing this gap, valuable insights can be gathered on how AI can be leveraged in navigating DI's complexities while also reflecting the practical realities of ESL classrooms.

The alignment of AI with DI principles is an area that needs further exploration, especially in ESL classrooms. Current studies often highlight the general application of AI in education, but they rarely examine AI's role in supporting DI's principles such as content, process, product, and environment within the ESL context. For example, Muhammad Izzat & Fariza (2024) provided a valuable insight into teachers' self-perceptions of their competency in using AI tools and integrating them into differentiated classrooms. Also, Nurul & Azlina

(2024) identified the most frequently applied DI principle among ESL teachers. However, neither studies investigated the strategies employed nor the support offered by AI's in aligning with the differentiated principles. Hence, exploring this alignment from ESL teachers' perspective is crucial to maximise AI's potential in differentiated ESL classrooms.

In depth data is needed to conduct tailored training programmes for teachers in incorporating AI into differentiated ESL classroom practices. Existing studies, such as Lazzat (2024), Muhammad Izzat & Fariza (2024) and Nurul & Azlina (2024) highlight the demand for targeted professional development to empower teachers with the necessary skills for incorporating AI and DI effectively. This is supported by Stumbrienė et al. (2023) as there is no similarity in terms of technological skill levels that teachers might possess. Bearing this in mind, gathering detailed insight could bring to light the teachers' specific needs, current practices, and the challenges as to ensure the programmes would address real-world ESL classroom dynamics. Muhammad Izzat & Fariza (2024) proposed future research that emphasises on teachers' perceptions towards AI in DI through various lens, such as subject specificity and teaching experience. Detailed data on these aspects would assist in shaping the training programmes from being too general or disconnected from the practical realities of differentiated classrooms.

Research Objectives
The study's objectives are:
1. To determine ESL teachers' perception of AI's support for differentiated instruction.
2. To determine ESL teachers' perception on AI's support for each principle of differentiated instruction.
3. To determine if there is a significant difference in ESL teachers' perceived AI support for differentiated instruction based on their teaching experience.

Research Questions
The research questions are:
1. What is ESL teachers' perception of AI's support for differentiated pedagogy?
2. What is ESL teachers' perception on AI's support towards each principle of differentiated pedagogy?
3. Is there a significant difference in ESL teachers' perceived AI support for differentiated instruction based on their teaching experience?

Literature Review
Differentiated Instruction in ESL Classroom
Since 2019, the Ministry of Education (MOE) has abolished class streaming in schools (Zurina et al., 2021). The decision has resulted in a heterogenous classroom that comprises of pupils with a wide range of proficiency levels, abilities, and individual needs within the same learning environment (Nurul & Azlina, 2024). Even though this decision has been made to promote inclusivity and equitability, it has brought significant challenges for teachers. One reason is that the traditional "one-size-fit-all" pedagogy is no longer sufficient as it risks benefitting only a certain group of pupils while neglecting the others within a classroom. Thus, differentiated instruction (DI) has been introduced as one of the strategies to support teachers in managing and meeting the diverse needs of their pupils (Fatin & Muhammad, 2022; Zurina et al., 2021).

Through DI, teachers can adjust their instructional methods based on the pupils' diverse abilities, learning styles, and individual needs within a heterogenous classroom.
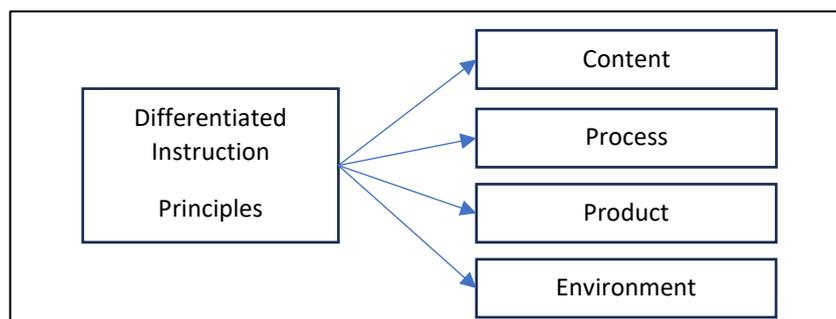

Diagram 5.1: Differentiated instruction principles (Tomlinson, 2014; Zurina et al., 2021)

Tomlinson (1999) pioneered DI to ensure that every pupil can engage with and benefit from any learning experiences. According to Tomlinson (1999), the core principles of DI involve modifying the content, process, product, and environment. In short, content refers to the input given to the pupils; process describes the activities that facilitate pupils' grasp and comprehension of the input; product is the mechanism for pupils demonstrating what they have learned; and lastly environment refers to the atmosphere in which the learning takes place.

Zurina et al. (2021) believes that DI is an easily adaptable pedagogy that promotes equality in learning. Even so, only three principles of DI are often employed in practice, which are content, process, and product (Fatin & Muhammad, 2022; Nur Hanisah & Syawal, 2023). This observation is reinforced by Nurul & Azlina (2024) study within the ESL context, in which more than 90% of the respondents reported of differentiating their lesson by the three principles and environment is the least differentiated. One plausible reason is that the adaptation of content, process, and product often involve observable processes and physical adjustments. For example, modifying reading materials, adding additional wait-time into the speaking activities, or offering two assessment methods with different difficulty levels. In other words, these observable and tangible adjustments make it easier for teachers to gauge and respond effectively to the diverse needs of their pupils.

On the other hand, ESL teachers might give less emphasis on differentiation by environment as the principle is often associated with physical classroom elements. Examples are desks layout, lighting, or dedicated spaces such as reading corners and self-study areas. This is illustrated through Zurina et al. (2021) definition of DI's principle of environment. By framing it that way, it supports the idea that teachers perceive environment as something physical, observable, and furniture-like in the classrooms. This may explain the reason of it being less adapted in DI by ESL teachers. The teachers may perceive the principle as less impactful or more cumbersome to implement compared to addressing the instructional contents and strategies directly. Even so, a learning environment extends beyond the physical elements. Going back to Tomlinson (2001), the learning environment should foster a sense of belonging where the pupils feel welcomed, respected, heard, and supported while moving towards a successful and equitable learning experience. In other words, a well-designed learning environment for a differentiated classroom begins by meeting the psychological

needs by creating a supportive and inclusive learning experience. Then, the environment is further enhanced by well-considered physical elements.

A study by Nurul & Azlina (2024) demonstrates that Malaysian ESL teachers generally have a solid understanding of DI and understand its importance in creating inclusive language learning experiences. Other than bridging the gaps in learning, ESL teachers also believe that DI increases engagement among pupils with different proficiency levels. However, despite having a good theoretical knowledge, many teachers reported some challenges in translating the knowledge into practice effectively. The challenges are reflected in findings from several past local studies, which are summarised in Table 5.1.

Table 5.1
DI *challenges mentioned in local past studies.*

Challenges	Fatin & Muhammad (2022)	Nur Hanisah & Syawal (2023)	Nurul & Azlina (2024)
Time-intensive planning and preparation	√	√	√
Limited idea for DI	√	√	
High teacher workload	√		√
Classroom management and large classroom sizes		√	√
Shortage of teaching and learning materials		√	
Complexity of the syllabus		√	
Wide learning gaps between pupils		√	
Irregular pupils' attendance		√	
Limited instructional time			√
Limited fund			√

There are several recurring challenges have been highlighted from the past studies in implementing differentiated instruction. A significant challenge is the amount of time required for planning and preparing the lessons. Tailoring the strategies and teaching resources can be both mentally and physically demanding. The challenge is exacerbated by a lack of ready-made teaching and learning materials which forces the teachers to create resources from scratch. Additionally, limited ideas for integrating DI exacerbates the challenge as teachers struggle on how to effectively innovate and tailor their lessons while striving to address the diverse pupils' needs.

Another noteworthy challenge is the heavy workload faced by the teachers. Many teachers within a school teach multiple classes while juggling other professional responsibilities and administrative tasks simultaneously. This immense workload makes it difficult for teachers to allocate additional time and energy to implement DI effectively. Moreover, this challenge is further extended by large classroom sizes. With more pupils in a classroom, greater attention is needed to manage the pupils' behaviour while maintaining an organised and conducive learning environment.

These challenges highlight the need for practical solutions that can support teachers in implementing DI effectively. One emerging solution is through the integration of AI technology in DI (Anggun, 2024). With vast information pool and unique capabilities, AI shows potentials in alleviating some of the DI challenges especially in the context of ESL classrooms. Not just that, AI in classroom helps in fostering an inclusive learning environment that supports the implementation of DI (Damyanov, 2024).

AI's Capabilities in Supporting ESL Differentiated Instruction
AI has the potential in supporting teachers to implement differentiated instructions in ESL classrooms. It offers innovative ways of overcoming the challenges commonly associated with DI within the context of ESL classrooms. AI is driven by some subsets such as Natural Language Processing (NLP) and Machine Learning (ML) that empower the technology with some unique capabilities. In the context of language learning, NLP and ML are more than enough to make AI a powerful tool in supporting the teaching and learning process (Mananay, 2024). Together, NLP and ML offer the capabilities that empower teachers to design, adopt and deliver lessons aligned with DI's principles efficiently while meeting the diverse needs of the pupils in ESL classroom.

NLP provides AI the capability to process and comprehend human language. Not just that, it facilitates a more natural sounding communication between human and AI in real-time. This capability is befitting in ESL classrooms as pupils often require personalised feedback in their language mastery. NLP allows AI to systematically analyse pupils' language inputs, such as vocabulary, grammar, and pronunciation. Interestingly, AI could analyse pupils' language input in multiple formats, including typed text, handwritten notes, and audio. Based on the analysis, AI could provide immediate feedback to correct errors or reinforce pupils' acquisition of the language target. Indirectly, this fosters an interactive and responsive language learning environment that is tailored to the pupils' individual needs. To a certain extent, this capability addresses the challenge of providing individualised attention and feedback, especially in large classrooms.

Beyond real-time interaction and feedback, NLP enhances AI's capacity to develop teaching and learning materials that are not only aligned with the curriculum requirement, but also consistent and accurate in terms of language use (Muhammad et al., 2024). This benefits ESL teachers by reducing the time and effort required to develop materials that are up to the language standard. Furthermore, NLP has been enhanced with the development of Large Language Model (LLM) (Zubiaga, 2024). It takes advantage of the vast dataset and empowering AI to generate contextually rich and customised teaching materials based on the requirements and criteria given by the teachers (Bonner et al., 2023). For example, a set of quiz questions related to a children story, a short three-paragraph reading passages about three endangered animals, and even a role-playing script for a given scenario. In other words, AI helps in alleviating the challenges of limited resources and creating resources from scratch. Resources that are generated by AI are practical and ready for classroom implementation.

Similarly, ML provides AI the capability of self-adapting through the never-ending process of data and patterns learning. AI can efficiently analyse vast amount of data and continuously update its memory. With this adaptability, AI can accurately analyse and gauge the pupils' strengths, weaknesses, and needs (Rizqi, 2023). Thus, AI can personalise and tailor

activities and learning contents to suit the current needs of pupils. For instance, a study by Valencia & Suyansah (2024) shows that low proficiency pupils shown improvements after using AI-generated reading materials that were tailored to their level. By prompting AI with the necessary information, AI could gauge the pupils' proficiency level and personalise the materials to address their language level. This proves that ML-driven AI could help pupils to progress at a pace that suits their learning needs to some extent. Also, this also address certain DI challenges of related to materials creation and preparation, wide learning gaps between pupils, and even factors related to large classroom sizes.

Moreover, the strength of ML lies on its real-time adaptability. It creates dynamic feedback that continuously improves instructional strategies and teaching resources. For example, AI can detect a pupil struggling with spelling and recommend targeted interesting exercises such as interactive quizzes or fill in the blanks. Meanwhile, high performing pupils are suggested with sentence-building tasks supported by image generation and visual feedback. In a mixed-method study by Abrar (2024), ChatGPT was utilised to conduct a grammar intervention by drawing insights from pupils' interest questionnaires and text samples. The findings demonstrated that the AI-generated task was not only highly suitable to the pupils' proficiency levels, but also increased their motivation and engagement in Swedish ESL classrooms. Additionally, the study highlights the possibility of facilitating flexible pupil groupings. Although Abrar (2024) used fixed groupings for its AI intervention, the outcome shows the advantage of AI's real-time adaptability in tailoring materials to meet specific group needs. Indirectly, this shows that AI could support flexible groupings by allowing teachers to reorganise the pupils based on their progress and the tailored materials or activities. Thus, by automating the analysis of pupils' learning needs and generating suitable materials, AI promotes flexible groupings and address the challenges associated with managing diverse proficiency levels within a classroom. Also, AI helps to reduce the time and effort teachers spend on planning and implementing DI.

The integration of NLP and ML showcases AI's potential in supporting teachers to implement DI in ESL classrooms, particularly through content and process differentiations. Additionally, AI contributes to product differentiation by facilitating pupils to present their learning product in various innovative formats. In ESL learning, teachers can utilise AI tools to produce teaching materials in various formats. Then, it follows that pupils can also leverage AI tools to create learning products such as storyboards and presentations slides, composing role-playing scripts and poems, or producing video essays with voiceovers. AI tools provide pupils the options to showcase their learning based on their individual strengths, interests and creative preferences. Ventura & Lopez (2024) also shares the similar view where the adoption of educational technology such as AI has made it easy for pupils to create presentations and projects, provided that they possess the necessary digital literacy skills. Moreover, AI tools can offer real-time tailored suggestions. This ensures that pupils of all proficiency levels can effectively complete their products while building confidence in their language mastery. In view of that, AI tools indirectly support teachers in reducing the time and effort needed in preparing and guiding pupils for the product-creation process. Instead of guiding pupils step-by-step through every detail, teachers can leverage AI generated templates, ideas, or rubrics that are aligned with the lesson objectives to provide structured scaffoldings. During the lesson, teachers can better allocate their time and effort in refining pupils' products or offering targeted feedback to certain pupils. In a way, AI helps teachers to

implement product differentiation by addressing some challenges such as limited time preparing for lessons, heavy workload, and large classrooms sizes to some extent.

AI shows potential in addressing the challenges of implementing DI in ESL classrooms by providing valuable support for content, process, and product differentiation. Bonner et al. (2023) sees AI as a support system in designing and adapting tailored materials, streamlining teaching strategies, giving personalised feedback in meeting diverse pupils' needs. Although differentiation by environment is less explored, AI has the potential to enhance inclusivity by fostering tailored learning experience that reflect pupils' individual needs. Other than that, AI helps in organising classroom layout such as dynamic seating arrangements based on the group's characteristics and needs. In other words, environment differentiation could also be the extension of other DI principles and helping to alleviate teachers' challenges in managing large and diverse classrooms.

Factors to be Considered in Integrating AI for DI
Despite AI's potential, several factors must be addressed to ensure effective integration of AI for DI. First, the availability of infrastructure and devices are the basis for integrating AI into the classrooms successfully. Without consistent internet connectivity and an adequate number of suitable devices, ESL teachers face challenges in utilising AI to support DI. However, the disparities in access are especially pronounced in rural schools, where limited resources could exacerbate into major educational gaps in this increasingly technological era (Idawarna et al., 2022; Lazzat, 2024). Over the recent years, Malaysian Ministry of Education has taken commendable actions to improve internet connectivity and device access for schools nationwide. Even so, the gaps remain to an extent and pose ongoing challenges to an equitable exposure and integration of AI.

Second, the utilisation of AI has become a more prominent feature in education. It causes some concerns to emerge such as ethical consideration and the risk of over reliance (Lazzat, 2024; Mananay, 2024; Salbihana et al., 2024). There are teachers who trust the analysed outputs of AI more than their own personal judgement. This might stem from the belief that AI could outperform human reasoning by rapidly processing vast amount of data rapidly and systematically provide the desired outputs. Conversely, other teachers reported that relying on AI in the classroom might overshadow their roles in planning and executing the lessons (Lazzat, 2024). To an extent, relying on AI might diminish the human elements needed in fostering an inclusive learning environment that supports differentiated learning through social interactions.

Third, the challenge of cost associated with AI tools is not a pressing matter as most AI tools offer free or affordable basic features. While these features may be limited, they are sufficient for simple tasks like generating text-based reading material, basic comprehension quizzes, or designing simple visual aids. Nur Mazliyana et al. (2024) highlights the free and affordability of AI tools make them even more accessible to teachers, particularly for schools that have no extra funding for subscription. Even so, the accessibility may limit the potential of AI tools in providing greater customisation and support for implementing DI. Thus, there is a need to promote equitable access to full version of AI tools so that teachers could harness AI tools' potentials to bridge the gap within differentiated ESL classrooms.

Fourth, the effective integration of AI into differentiated ESL classrooms relies heavily on the teachers' readiness and skills. Some teachers may feel unprepared as they are not familiar with AI tools and their capabilities. Others struggle with confidence, whether they have the sufficient skills to implement AI effectively in classroom settings (Lazzat, 2024). Such uncertainties may cause persistent self-doubt that might potentially undermine teachers' readiness significantly over time, especially due to the fact that rapid evolution of AI technology could make the gap between AI's advancement and teachers' skills may become wider. A major contributing factor to this challenge is the lack of adequate and targeted trainings for teachers (Muhammad Izzat & Fariza, 2024; Nur Mazliyana et al., 2024). Although there are some workshops and trainings have been conducted, they might not sufficiently address the evolving technological demands or meet the diverse needs of teachers in different locations. This highlights the needs for tailored professional development programmes that focus on the practical application of AI in differentiated ESL classrooms. The programme should focus on real-world applications, especially to empower ESL teachers in be guiding, monitoring and refining AI outputs to align with the curriculum and DI pedagogical principles.

Methodology
Research Design
This study employed a quantitative survey design to explore Malaysian ESL teachers' perceptions of using artificial intelligence (AI) in differentiated instruction (DI). A structured questionnaire was used as the main data collection instrument. The questionnaire was designed to get insight on teachers' perceptions of implementing AI in DI and how AI supports the principles of DI. As highlighted by Muhammad Izzat & Fariza (2024), questionnaire was chosen due for its convenience in terms of management and distributions to the sample within the time and cost constrain of this study.

Sampling
To ensure the questionnaire reached the suitable population, a purposive sampling technique was utilised. This technique allowed the study to target respondents who met this criterion, which is currently teaching English at the primary and secondary school level in Malaysia. By focusing to the criterion-met respondents, the study ensures that the findings are directly relevant to the context of ESL teaching in primary and secondary schools. Thus, a total of 102 ESL teachers took part in the study. The size of the sample is deemed feasible and adequate for conducting a reliable descriptive and inferential statistical analysis (Mendenhall et al., 2013). In other words, the sample size ensured a sufficient statistical power for this study to explore relationship between variables.

Instrumentation
The main data collection tool is the structured questionnaire. The questionnaire was designed to be aligned with the study's objectives. The questionnaire was divided into three sections:

Section A: 7 items
This section gathered ESL teachers' demography profiles, such as ESL teaching experience, school type, and frequency of integrating DI in ESL classrooms. This section provided a context for exploring the relationship between the demographic factor and the teachers' perceptions.

Section B: 5 items
This section explored ESL teachers' perception of integrating AI into DI. It focused on AI's usefulness in supporting DI. Also, some of the items in this section were designed to see if integrating AI could alleviate some of the identified challenges in implementing DI in ESL lessons.

Section C: 12 items
This section gathered the teachers' perception on how AI supports the four key principles of DI: content, process, product, and environment.

A 5-point Likert scale was used for Section B and Section C. Aybek & Toraman (2022) findings shows that 5-point Likert scale works better as it provides better reliability and convenience than the other scales in eliciting the samples' perceptions. The table below shows the meaning for each point.

Table 6.1
5-point Likert Scale description by McLeod (2023).

5-point Likert Scale	Meaning
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

The items in Section B and Section C were adapted from two past studies: Muhamad Izzat & Fariza (2024) and Nurul & Azlina (2024). The first study investigated the perceptions of teachers in integrating AI into DI classrooms, which focuses on various subjects and not specifically ESL. Meanwhile, the second study provided insight into ESL teachers' perceptions in implementing DI, including the strategies they used and the challenges they faced. The validated instruments, findings, and discussion from the two past studies were used as the foundational references in developing the questionnaire items. By synthesising both past studies, the questionnaire items were developed and refined to reflect the context of Malaysian primary and secondary school ESL teachers and their perceptions of using AI in DI. In this way, relevant and practical items could be developed to address the study's objectives.

Validity and Reliability
A face validation process was conducted to validate the questionnaire. A panel of five experts were informally sought to review the instrument through WhatsApp due to the time-constraint and geographical location. The experts reviewed the questionnaire in terms of its clarity, relevance, and alignment with the study's objectives. The feedback received from the panels was mostly positive. Table 6.2 shows the list of panels.

Table 6.2
List of panels and their expertise.

Expert panels	Expertise
Expert 1	• An ESL teacher with seven years of experience • Head of English subject panel at an SK in Kuantan
Expert 2	• An ESL teacher with 21 years of teaching experience • Head of English subject panel at an SJKC in Lahad Datu
Expert 3	• An ESL teacher with seven years of teaching experience • Head of English subject panel at an SK in Tawau • A district-level MOBIM and innovation mentor
Expert 4	• An officer in *Pejabat Pendidikan Daerah Kinabatangan* • Has experience in handling remedial programmes
Expert 5	• An officer in *Jabatan Pendidikan Negeri Labuan* • Well versed in educational technology, including AI in education

Apart from the validity test, a pilot test involving 30 responses was conducted. Cronbach's Alpha values indicated good internal consistency for all constructs. As shown in Table 6.3, the obtained values were ranging from 0.88 to 0.91.

Table 6.3
Cronbach's Alpha value for each construct.

Constructs	Alpha Cronbach's Value	Number of Items
AI's Support	.890	5
Differentiation by Content	.906	3
Differentiation by Process	.911	3
Differentiation by Product	.882	3
Differentiation by Environment	.889	3

Data Collection Procedure
The questionnaire was distributed online through Google Form web application. This was to ensure ease of access for the respondents. It also allowed them to complete the questionnaire at their own convenience without being influenced greatly by geographical factor.

The Google Form link was disseminated through WhatsApp in both personal messages and relevant WhatsApp groups to reach the intended respondents. The link was accompanied with clear instructions, alongside the assurance of anonymity and confidentiality. The data collection spanned over a period of four weeks with follow-up reminders being periodically sent to encourage more participations.

Data Analysis
A total of 102 responses was collected through the online questionnaire. However, upon thorough checking, two responses (42nd and 58th respondents) were excluded as the respondents selected "Never" for items assessing their frequency of applying DI into their ESL teaching practises.

Statistical Package for the Social Sciences (version 26) was utilised to analyse the data collected through the questionnaire. This study employed both descriptive and inferential

analyses to address the study objectives. Table 6.4 shows the data analysis conducted to address each objective.

Table 6.4
Analysis conducted to answer each research question.

Research Questions	Analysis Conducted
1	The five items in Section B were grouped to form the AI's Support on DI construct. Descriptive analysis was conducted to obtain the mean and standard deviation for the construct.
2	The items in Section C were grouped into four constructs based on the principles of differentiated instruction. Descriptive analyses were conducted to obtain the mean and standard deviation for each principle.
3	A one-way ANOVA was conducted to determine the differences in perceived AI's support on DI based on ESL teachers' teaching experience. Tukey HSD post hoc test was used to identify significant pairwise differences.

This study adapted the mean score interpretation proposed by Hussain (2022). The interpretation scale as shown in Table 6.5 provided a clear guideline for categorising the level of agreement based on the respondents' mean scores.

Table 6.5
Adapted 5-point Likert scale mean score interpretation

Interval	Interval	Midpoint	Interpretation
1-(1 + 0.80)	1-1.80	1.40	Very low level of agreement
1.81-(1.81 + 0.80)	1.81-2.61	2.21	Low level of agreement
2.62-(2.62 + 0.80)	2.62-3.42	3.02	Moderate level of agreement
3.43-(3.43 + 0.80)	3.43-4.23	3.83	High level of agreement
4.24-(4.24 + 0.80)	4.24-5.04	4.64	Very high level of agreement

Source: Hussain (2022)

Ethical Consideration
Ethical consideration is important in any studies being conducted. In this study, the participants were given a clear and concise explanation of the study's purpose before responding to the questionnaire. The explanation was written within the introductory message that accompanied the questionnaire link. Also, the respondents were assured that their participation was completely voluntary.

In terms of consent, it is implicitly obtained as the respondents completed the questionnaire willingly after reading the introductory message. This was another way of respecting the respondents' autonomy without being intrusive towards their participation. Moreover, no personal information was collected in the questionnaire, including email addresses. This ensured complete anonymity without any traceable data linked to the individual responses. The data was stored securely and used solely on cloud for academic purposes.
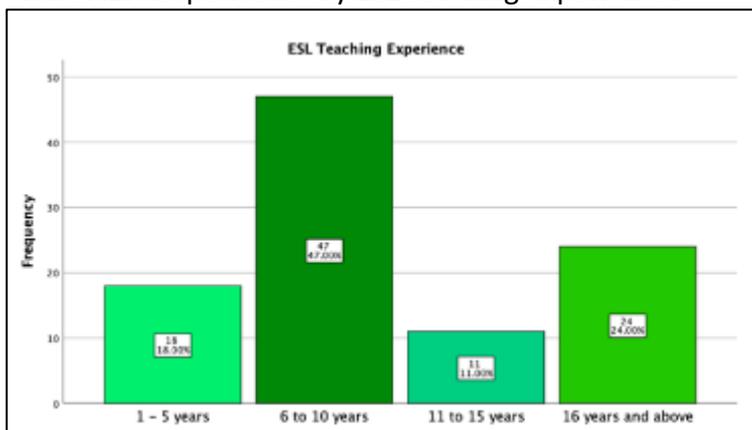
Findings

*Demographic Analysis*

Chart 7.1: Respondents by gender.
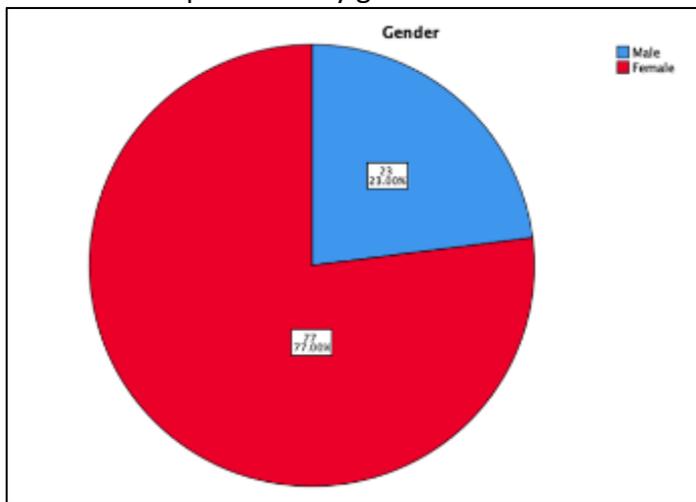
A total of 100 responses were analysed. 23 (23%) were male ESL teachers while 77 (77%) of them were female ESL teachers.

Chart 7.2: Respondents by ESL teaching experience.

Out of the 100 respondents, 18 (18%) of them reported having one to five years of ESL teaching experience. Most of them (n = 47, 47%) have six to ten years of teaching experience, 11 (11%) with 11 to 15 years of experience. The remaining 24 (24%) teachers have 16 years or more teaching experience.

Chart 7.3: Respondents by frequency of integrating DI into ESL lessons.
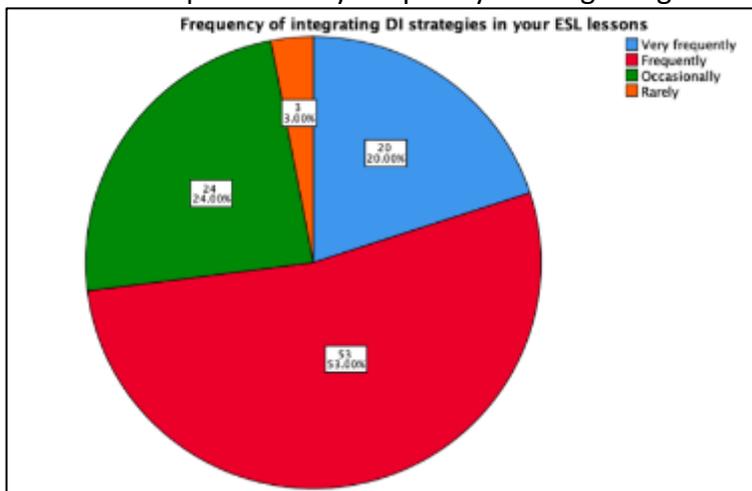
In terms of integrating DI strategies into their ESL lessons, more than half of the teachers (n = 53, 53%) reported using DI strategies frequently. Also, 20 (20%) of them integrate DI strategies very frequently. Meanwhile, 24 (24%) of them reported using DI occasionally, and a small percentage of 3% (n = 3) rarely integrate DI into their ESL lessons.

Question 1:
What is ESL teachers' perception of AI's support in differentiated pedagogy?

Table 7.1
ESL teachers' general perceptions of AI's effectiveness and support in DI.

Constructs	N	Mean	Std. Deviation
AI's Support	100	3.93	.66

Descriptive analysis was conducted to determine ESL teachers' perception of AI's effectiveness and support in implementing DI in ESL lessons. The construct recorded a high mean score of 3.93 ($SD = 0.66$).

Question 2:
What is ESL teachers' perception on AI's support towards each principle of differentiated pedagogy?

Table 7.2
ESL teachers' Perceived AI Support on each principle of DI.

Constructs	N	Mean	Std. Deviation
Content differentiation	100	3.94	.70
Process differentiation	100	3.71	.72
Product differentiation	100	3.86	.73
Environment differentiation	100	3.72	.73

Among the four principles of DI, AI is seen as providing the greatest support for content differentiation with a mean score of 3.94 ($SD = 0.70$). Following this is product differentiation with a mean score of 3.84 ($SD = 0.73$). Notably, both process and environment differentiations obtained nearly identical mean score of 3.71 ($SD = 0.72$) and 3.72 ($SD = 0.73$) respectively with slightly higher standard deviation scores.

Question 3:
Is there a significant difference in ESL teachers' perceived AI support for DI based on their teaching experience?

Table 7.3
Descriptive statistics of Perceived AI Support on DI by Teaching Experience groups.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 – 5 years	18	4.1778	.61697	.14542	3.8710	4.4846	3.00	5.00
6 to 10 years	47	4.0809	.63473	.09259	3.8945	4.2672	2.00	5.00
11 to 15 years	11	3.6545	.66987	.20197	3.2045	4.1046	2.20	4.40
16 years and above	24	3.5667	.56773	.11589	3.3269	3.8064	2.40	4.60
Total	100	3.9280	.65967	.06597	3.7971	4.0589	2.00	5.00

Table 7.4
Levene's Test of Homogeneity of Variances for Perceived AI Support on DI by Teaching Experience.

		Levene Statistic	df1	df2	Sig.
Effectiveness_Support_mean	Based on Mean	.163	3	96	.921
	Based on Median	.006	3	96	.999
	Based on Median and with adjusted df	.006	3	84.223	.999
	Based on trimmed mean	.121	3	96	.948

Table 7.5: One-way ANOVA summary table for Perceived AI Support on DI across Teaching Experience groups.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.177	3	2.059	5.356	.002
Within Groups	36.904	96	.384		
Total	43.082	99			

Table 7.6
Tukey HSD post hoc comparisons for Perceived AI Support on DI across Teaching Experience groups.

(I) ESL Teaching Experience	(J) ESL Teaching Experience	Mean Difference (I–J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
1 – 5 years	6 to 10 years	.09693	.17186	.942	–.3524	.5463
	11 to 15 years	.52323	.23729	.129	–.0972	1.1436
	16 years and above	.61111*	.19332	.011	.1056	1.1166
6 to 10 years	1 – 5 years	–.09693	.17186	.942	–.5463	.3524
	11 to 15 years	.42631	.20767	.176	–.1167	.9693
	16 years and above	.51418*	.15555	.007	.1075	.9209
11 to 15 years	1 – 5 years	–.52323	.23729	.129	–1.1436	.0972
	6 to 10 years	–.42631	.20767	.176	–.9693	.1167
	16 years and above	.08788	.22575	.980	–.5024	.6781
16 years and above	1 – 5 years	–.61111*	.19332	.011	–1.1166	–.1056
	6 to 10 years	–.51418*	.15555	.007	–.9209	–.1075
	11 to 15 years	–.08788	.22575	.980	–.6781	.5024

*. The mean difference is significant at the 0.05 level.

A one-way ANOVA was used to determine the impact of teaching experience on perceived AI support towards DI in ESL lessons. The ANOVA was statistically significant, indicating that the level of teaching experience influenced ESL teachers' perceptions of AI support in DI; $F(3, 96)$ = 5.36, $p < 0.01$, η^2 = 0.14.

Post hoc analyses with Tukey's HSD (α = 0.05) revealed ESL teachers with one to five years of teaching experience (M = 4.18, SD = 0.62) and those with six to ten years of teaching experience (M = 4.08, SD = 0.63) reported significantly higher perceptions of AI's support for DI compared to the teachers with 16 years and above (M = 3.57, SD = 0.57). The mean difference between the one to five years and 16 years and above was 0.61, p = 0.01 [95% CI = 0.11 to 1.12]. The mean difference between the six to ten years and 16 years and above was 0.51, p = 0.01 [95% CI = 0.11 to 0.92]. No other pairwise comparisons reached statistical

significance, including comparisons involving ESL teachers with 11 to 15 years of teaching experience.

Discussion

AI's Support on DI Principles

The overall mean score for each differentiated principle shows that AI is optimistically agreed upon as a valuable tool in supporting differentiated classrooms. Among the four principles, content differentiation reported the highest mean score. This indicates that AI benefits ESL teachers greatly through the creation and modification of tailored materials to suit pupils' varied proficiency levels. This aligns with past literatures that highlighted AI's capabilities to personalise instructional materials and adapt them to diverse pupils' needs (Abrar, 2024; Bonner et al., 2023; Muhammad et al., 2024; Rizqi, 2023). Most importantly, this reflects AI's ability to address some DI challenges, such as the constraints of time, resources, heavy workload, and varied learning gaps within a single learning environment.

Product differentiation follows next. This suggests that ESL teachers value AI's support in facilitating pupils to showcase their understanding through creative learning products. This is consistent with Ventura & Liezel (2024) findings where AI tools assisted pupils in creating learning products easily by replacing the traditional and labour-intensive methods (Jaca, 2024). Moreover, AI reduces the time and effort required for teachers to prepare detailed templates or guides for pupils to produce their own learning products. Additionally, AI alleviates the teachers' mental burden and stress of individually guiding each pupil in completing their learning products. This can be incomparably overwhelming especially in a large classroom. Thus, this highlights' AI's support in making the product differentiation process more simplified, efficient, and less overwhelming.

ESL teachers perceived AI's support in both process and environment differentiations as less prominent. However, this does not imply that AI offers no support at all as the overall mean score for both remain within the range of optimistic agreement. In the context of process differentiation, teachers consistently agreed that AI supports them in modifying teaching methods and providing immediate feedback. However, being the item with the lowest mean score, teachers showed variability in their perceptions of grouping pupils flexibly. Similarly, in the context of environment differentiation, AI was perceived as less capable of fostering inclusive learning environment. One reason for these perceptions is that AI lacks the nuanced understanding of pupils that teacher possess. Elements such as pupils' social attitudes, preferences, interpersonal dynamics, and affective needs are difficult for AI to interpret or address. These factors require emotional intelligence and empathy which AI cannot provide due to the lack of innate emotions (Jaca, 2024; Oritsegbemi, 2023). This limitation explains why AI's support in these areas feels less significant compared to the other aspects of differentiation. While AI effectively manage individualised tasks, it struggles to address the interpersonal and emotional complexities needed for flexible groupings and inclusive learning environments. These findings highlight the importance of the teachers' human intervention in making human connection that is crucial in both process and environment differentiations. AI should serve as a supporting toll rather than a replacement of the teachers' role in these aspects of differentiations.

Statistically Significant Difference
The one-way ANOVA analysis revealed a statistically significant difference in ESL teachers' perceived AI support for DI based on their teaching experience. This suggests that teachers' teaching experience plays a role in shaping how they view AI's support in implementing DI. Interestingly, the significant difference appears to be non-linear. As the experience of teaching increases, the perceived AI support for DI tend to decrease. This implies that more experienced teachers tend to be less optimistic in integrating AI technology in supporting their DI as compared to those with less ESL teaching experience.

Post hoc analysis using Tukey's HSD test further revealed that the only statistically significant difference occurred between ESL teachers with one to ten years of teaching experience and those with 16 years and above. Teachers with one to ten years of experience reported comparatively high mean scores perception of AI's support for DI, while the most experienced group recorded the lowest mean score. This reinforces the earlier observation of a non-linear trend, where perception of AI's support declined as teaching experienced increased. In other words, it could suggest a potential reluctance among more experienced teachers to adopt AI in DI. Two plausible reasons may explain this. First, much experienced teachers may prefer to rely on their well-established pedagogical knowledge and strategies. They have developed certain confidence and comfort in using their pedagogical methods that have been built up over the years. To them, the current pedagogical methods at hands are more reliable and effective. Second, it might take longer to build experienced teachers' confidence and skills in adopting AI into DI. Having many years of teaching experience does not imply that they would be digitally blind (Halimah & Wibowo, 2023). However, as digital immigrant teachers, they might show some reluctance in adopting the latest technologies as they are less familiar with rapidly evolving tools like AI. Even so, the reluctance does not reflect a complete rejection of technology but rather a need for more time to understand and utilise AI to its potential. Naturally, the process of adoption may take longer for these teachers as they navigate the complexities of integrating unfamiliar AI tools into their already established and reliable teaching pedagogy.

Moreover, Alridge & Witherspoon (2023) suggest that experienced teachers, especially the veterans, are generally willing to learn and adopt latest technology into their pedagogy. However, they often face challenges in resolving technical issues during the usage. The challenges can fully hinder their confidence and readiness to fully integrate technology into their pedagogy effectively. These technical issues may act as a barrier that slows down their progress and prevents them from fully leveraging AI to support their DI.

Suggestions
The findings suggest some practical suggestions. First, tailored professional development programmes should be tailored based on ESL teachers' teaching of experience and digital familiarity. Particularly, experienced teachers learn best from mature teaching sessions and peer-inspired learning moments (Du & Gao 2022). Follow-up support should be given from time to time to ensure continuous learning as well as to address any challenges that arise over time.

Second, providing a clear and practical guide on integrating AI in DI is crucial. Such a guide could be aligned with each principle of DI and include examples of AI tools that can be

applied for each. This could help teachers to visualise how AI can meaningfully support their instructional processes while also meeting the diverse needs of the learners. A contextualised framework with real-world classroom scenarios would enhance the relevance and usability of the guide.

Limitations and Future Studies

This study has a few limitations. One, the findings from this study cannot be generalised due to the small sample size of 100 ESL teachers. Future study should involve a broader and more diverse sample to capture broader perspective on the implication of incorporating AI into DI.

Two, the study relied on self-reported data through questionnaires, which may have introduced some bias into the responses (Salters-Pedneault, 2023). Future study should adopt a mixed-method approach to provide a more comprehensive understanding of teachers' perceptions and experiences.

Three, this study solely focused on the teachers' perceptions which might leave some valuable aspects unexplored such as the actual classroom practice, pupils' insights and outcomes. Future study should examine on how AI impacts the pupils' learning experience and achievements in differentiated classrooms.

Lastly, the teaching experience in this study was defined by the years of teaching. There is a probability that teaching experience may not be aligned with the actual age of ESL teachers (Booth, 2021). This could influence the teachers' perceptions and further investigation is required.

Conclusion

This study contributes both theoretically and contextually to the field of AI integration in education, especially in supporting DI within the ESL context. Theoretically, this study deepens current understanding by framing AI as a tool that aligns with DI principles as seen through the lens of ESL teachers' perceptions. The insights help bridging the gap between AI's technological capabilities and established pedagogical strategies. Contextually, the study offers valuable local perspectives from the Malaysian ESL setting as empirical evidence on AI in DI remains limited. The findings reveal how teachers with different levels of teaching experience perceive AI support and highlight the practical realities that they face when integrating AI tools in the classroom. This offers a more grounded view of AI's role in actual teaching environments. In conclusion, this study not only reinforces AI's potential to support DI, but also fills a contextual gap by providing evidence that can inform future practice, teacher training, and research.

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