Innovations in Pedagogy and Technology
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A Qualitative Exploration of Experts' Insights on Data-Driven Instructional Leadership Among Malaysian Pre-Service Teachers

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ABSTRACT

In the era of data-driven education, instructional leadership increasingly requires teachers, particularly those in training, to interpret and use data to enhance teaching and learning. Although data literacy is globally recognised as a core instructional competency, limited focus has been placed on how pre-service teachers are prepared for data-informed leadership, especially in the Malaysian context. This qualitative study explores expert perspectives on the preparation of Malaysian pre-service teachers for data-driven instructional leadership. Semi-structured interviews were conducted with six experienced professionals in teacher education, policy and research. Their expertise in teacher leadership development lends credibility to the findings. Thematic analysis revealed one overarching domain, applying data-driven instructional leadership which comprises three interrelated themes. First, identifying data sources concerns how pre-service teachers are trained to access school-based and digital data, including assessments and institutional records. Second, evaluating data refers to developing skills in interpreting data critically and ethically. Third, applying data focuses on using data for planning, differentiation, and instructional improvement. While experts acknowledged growing awareness of data's instructional value, they also noted gaps in systematic training, practicum integration, and ethical readiness. This study offers empirical insights into the competencies essential for future teachers to lead instruction through data. The findings hold practical implications for curriculum developers, policymakers, and teacher educators seeking to embed data literacy meaningfully within pre-service training.

Keywords: Data-Driven Instructional Leadership; Pre-Service Teacher Education; Data Literacy; Qualitative Study; Malaysian Teacher Preparation

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ARTICLE INFO
Received: 3 May 2025 | Revised: 22 June 2025 | Accepted: 30 June 2025 | Published Online: 12 July 2025
DOI: https://doi.org/10.63385/ipt.v1i2.31

CITATION
Abdul Razak, A.F., Ghani, M.F.A., Radzi, N.M., 2025. A Qualitative Exploration of Experts' Insights on Data-Driven Instructional Leadership Among Malaysian Pre-Service Teachers. Innovations in Pedagogy and Technology. 1(2): 13–28. DOI: https://doi.org/10.63385/ipt.v1i2.31

1. Introduction

The evolving demands of twenty-first-century education require teachers to take on multifaceted roles that extend beyond traditional content delivery. Among these, instructional leadership has emerged as a key competency, enabling teachers to create effective learning environments, enhance student outcomes, and contribute meaningfully to school improvement initiatives [1]. Within this evolving landscape, the ability to engage with educational data has become a core component of instructional leadership. As data systems become more integrated into school practices, data-driven decision-making is no longer limited to administrators or experienced teachers; it is also increasingly expected of pre-service teachers preparing for future leadership roles [2, 3].

Data-driven instructional leadership involves the deliberate and systematic use of diverse data sources from student assessments to institutional records. It is meant to inform pedagogy, guide interventions, and evaluate teaching effectiveness [4]. Although this concept has been widely discussed in the literature on educational leadership and school improvement, much of the focus has been placed on principals and in-service teachers [5]. Comparatively little attention has been given to the ways in which pre-service teachers develop data literacy and decision-making capabilities essential for instructional leadership.

This issue is particularly relevant in the Malaysian context. While policy documents such as the Malaysia Education Blueprint 2013–2025 underscore the importance of data use and evidence-based practices [6], implementation within teacher preparation programmes often falls short of these aspirations [7]. Pre-service teachers frequently face challenges in applying data to inform instructional decisions, largely due to curriculum limitations, insufficient practicum experience, and a lack of structured opportunities to practice data use in authentic school settings [2, 8].

Moreover, although some teacher education programmes include courses on assessment or educational research, these are not always aligned with the practical realities of school-based data use. This disconnect hinders the development of contextualised data literacy, referring to the ability to interpret and act on data within the unique cultural and institutional dynamics of Malaysian schools [9]. This raises a critical pedagogical concern regarding how teacher education programmes can be more effectively structured to support the cultivation of data-informed instructional leadership competencies among pre-service teachers.

This study addresses the aforementioned gap by exploring how expert practitioners conceptualise and promote data use as part of instructional leadership preparation for Malaysian pre-service teachers. Drawing on qualitative data obtained through expert interviews, the study aims to examine how data competencies are defined, supported, and embedded within teacher education programmes. While the findings are situated within the Malaysian context, they may offer transferable insights to other educational systems seeking to enhance data-informed teacher preparation particularly those operating in similarly centralised or policy-driven environments. Nonetheless, cultural, structural, and institutional differences must be considered when interpreting the broader applicability of the results.

To guide the inquiry, the study is framed by the following research questions:

(1) How do expert practitioners define essential data competencies for instructional leadership among Malaysian pre-service teachers?
(2) In what ways do experts perceive the integration of data use within pre-service teacher training?
(3) What challenges and opportunities exist in preparing pre-service teachers to engage with data as future instructional leaders?

2. Literature Review

This section reviews the existing literature related to data-driven instructional leadership in teacher education as follows:

2.1. Instructional Leadership and Data Use in Education

For an extended period, instructional leadership has been recognised as a critical factor in the enhancement of student outcomes and the development of meaningful learning experiences. Its fundamental nature is the capacity to meticulously plan, direct, and assess the teaching and learning process in order to facilitate student success [10, 11]. While this role was previously considered the exclusive responsibility of school principals and administrators, there is now a

growing acknowledgement that teachers themselves particularly those who are profoundly engaged in the day-to-day practices of the classroom, play an equally significant role as instructional leaders[12].

Instructional leadership is no longer solely dependent on professional judgement or experience in the data-rich educational environment of today. It is becoming more prevalent to employ concrete evidence, which is frequently referred to as data-informed or data-driven decision-making. This implies that educators and administrators are anticipated to engage with a variety of educational data to inform the design of lessons, the response to student requirements, and the decision-making processes that influence the overall quality of teaching and learning[13].

Educational data can be obtained in various formats, including standardised test scores, classroom-based assessments, attendance records, behavioural reports, and informal student feedback. The primary challenge lies not in the availability of these data sources, but in the ability to interpret and apply them meaningfully. Data-driven instructional leadership involves more than simply collecting information; it requires the capacity to analyse patterns and trends, reflect critically on their implications, and connect these insights to pedagogical strategies and institutional goals[14]. This process requires not only technical proficiency in data management but also a comprehensive understanding of learners and the contexts in which they are situated[15].

In this regard, instructional leadership is transformed into a dynamic process of inquiry, in which educators perpetually enquire, *"What does this data indicate about my students?"* and *"How can I leverage this information to enhance the effectiveness of my learning?"* The transition to a more responsive and accountable paradigm of teaching and leadership in contemporary schools is rooted in this reflective and evidence-based mindset.

2.2. Preparing Pre-Service Teachers for Data Literacy

Despite the increasing centrality of data in educational leadership, a significant number of pre-service teachers still feel inadequate in effectively incorporating data into their teaching practice. Research consistently indicates that these prospective educators may be introduced to the concept of data use during their training. However, they frequently lack the practical skills and confidence to engage with data in meaningful ways upon entering the classroom[16]. One explanation for this discrepancy is that teacher education programs frequently provide courses in subjects such as research methods or assessment; however, these subjects are not always associated with the actual requirements of data use in real school environments[17].

Consequently, numerous pre-service teachers enter their professional roles without a comprehensive comprehension of how to analyse student data, make informed decisions based on evidence, or modify instruction to accommodate the unique requirements of diverse learners[18]. This discrepancy has substantial consequences, particularly in a time when educational accountability and personalised learning are highly regarded.

The deliberate integration of data literacy into the early stages of teacher preparation has been widely recognised as essential for cultivating competent instructional leaders. The ability to work with data is considered as critical as subject matter expertise or pedagogical proficiency, and should therefore be treated as a core professional competency rather than an optional skill[19]. Furthermore, structured engagement with data during practicum placements particularly when supported by mentorship and guided reflection, has been shown to be especially beneficial in fostering data-informed instructional practices among pre-service teachers[20].

However, a persistent impediment continues to exist. The discrepancy between the practical experience of the profession and the knowledge that is taught in coursework. The development of data-related competencies is at risk of being superficial if there is a lack of harmony between theoretical instruction and real-world practice[21]. In theory, pre-service teachers may understand the importance of data. However, they may struggle to apply it in the fast-paced and often complex classroom setting. In order to foster a new generation of educators who are not only reflective practitioners but also confident instructional leaders who are capable of utilising data to enhance student learning, it is essential to bridge this chasm.

2.3. Data-Driven Instructional Leadership in the Malaysian Context

Malaysia has made tremendous progress in reframing its educational priorities in recent years, emphasising quality

teaching, instructional leadership, and data-driven decision-making. These themes are explicitly expressed in national reform papers such as the Malaysia Education Blueprint 2013–2025, which asks for a shift in school leadership and evidence-based learning support [6]. While the legislative landscape demonstrates a commitment to supporting data-driven school leadership, putting this vision into practice is particularly important at the teacher preparation level. However, it remains a complicated and ongoing problem.

Data literacy is increasingly acknowledged as a critical component within teacher education institutions. Both educational scholars and policymakers recognise that future teachers must be prepared not only to deliver instruction but also to lead reform initiatives through the informed use of data. Despite this growing recognition, evidence suggests that the integration of data-related competencies into pre-service teacher training in Malaysia remains underdeveloped. For instance, although the topic of data use is present within teacher education curricula, it is often approached in a fragmented manner, lacking cohesive frameworks or systematic implementation in practical school environments [22].

Furthermore, data-driven methods in Malaysia are influenced by a variety of environmental and cultural factors. In many circumstances, educators particularly those new to the profession, may be more likely to make instructional judgements based on intuition or past experiences rather than official data sources. Institutional restrictions, such as restricted access to relevant school-level data or insufficient data interpretation training, might prevent efforts to build data-driven teaching methods [23]. Furthermore, the hierarchical structure of Malaysian schools, along with the traditionally centralised character of decision-making, might result in circumstances in which pre-service teachers have few opportunities to exercise agency in data usage or leadership. This highlights a gap between national ambitions for teacher empowerment and the realities faced by trainee teachers on the ground.

Given these limitations, there is a clear need for research that extends beyond policy statements to investigate how data-driven instructional leadership is understood, implemented, and nourished at the basic level of teacher development. Understanding expert viewpoints on how pre-service teachers may effectively use data in Malaysian classrooms is critical. Such insights can help to shape more responsive and culturally grounded techniques for integrating data literacy into teacher preparation programs, ensuring that future educators are able to lead with clarity and evidence in varied and dynamic learning contexts.

2.4. Past Studies on Data-Driven Instructional Leadership

An expanding body of research has examined the role of data in instructional leadership, with much of the current literature concentrating on in-service teachers and school leaders. These studies consistently demonstrate that meaningful engagement with data enables educators to refine instructional strategies, personalise learning experiences, and enhance student outcomes. For instance, one study highlighted how school leaders use student performance data to guide curriculum planning and identified professional learning communities as effective platforms for fostering collective data literacy [24]. Similarly, collaborative data practices among teachers have been shown to cultivate shared accountability and support a culture of continuous professional growth [25].

While such studies offer valuable insights, their primary focus on experienced practitioners overlooks the developmental needs of individuals in the early stages of teacher preparation. Although the importance of cultivating data-driven competencies from the outset of teacher education is increasingly acknowledged, empirical investigations into pre-service teachers remain limited. Evidence suggests that many teacher candidates lack confidence in data interpretation due to minimal exposure during their training [26]. Additionally, pre-service teachers often understand the theoretical value of data but struggle to translate this understanding into classroom practice without structured mentorship and real-world application opportunities [27].

Empirical research on data-driven instructional leadership among pre-service teachers in Asia particularly in Malaysia, is notably sparse. Studies have found that data utilisation is not consistently embedded in practicum experiences within Malaysian teacher education programmes [28]. Moreover, training tends to prioritise content mastery over leadership development or data application [29]. These findings underscore a persistent gap between national policy aspirations and on-the-ground pedagogical implementation, highlighting the urgency for further investigation into pre-service teachers' readiness to engage with data as emerging

instructional leaders in the Malaysian context.

In summary, the literature highlights the growing importance of data-driven instructional leadership and the imperative to foster data literacy in teacher preparation. However, despite increased international and national emphasis on evidence-based teaching, there remains a paucity of empirical research examining how such competencies are cultivated at the pre-service level particularly within the Malaysian context. Existing studies predominantly centre on in-service teachers, with limited attention given to the formative experiences of prospective educators. Moreover, few studies explore the perspectives of expert practitioners who shape teacher education policies and practices. The current study addresses this gap by examining expert viewpoints on the development of data-related competences among Malaysian pre-service teachers. By focusing on qualitative evidence, the study aims to gain a deeper understanding of how data-driven instructional leadership can be meaningfully conceptualised and integrated into teacher education programmes.

3. Methodology

This section outlines the research methodology employed to explore expert perspectives on data-driven instructional leadership among Malaysian pre-service teachers as follows:

3.1. Research Design

This study employed a qualitative research approach to explore expert perceptions regarding the preparation of Malaysian pre-service teachers for data-driven instructional leadership. Specifically, it adopted the basic qualitative design outlined by Merriam[30], which is particularly suited to investigating context-bound phenomena such as leadership development within teacher education. This approach allows for a thorough analysis of how instructional leadership qualities are interpreted, produced, and experienced by individuals who shape pre-service teacher preparation. As noted by Creswell[31], qualitative inquiry offers a flexible and responsive framework for examining complex educational phenomena that may not conform to rigid methodological constraints. Such adaptability is essential when the goal is to delve deeply into the professional insights of educational specialists, particularly in connection to the changing roles and expectations of future teachers in data-driven instructional leadership.

In this study, six Malaysian panel experts were purposefully selected for in-depth interviews based on their extensive professional experience in teacher education, leadership development, and educational policy. Their expert insights offered rich, contextualised understandings of the competencies, knowledge, and challenges associated with preparing pre-service teachers for data-driven instructional leadership. The qualitative design facilitated the collection of narrative, experience-based data, encompassing both individual reflections and shared perspectives across the expert group. While the sample size may be considered limited, this aligns with qualitative research conventions that prioritise depth over breadth. Merriam emphasises that small, information-rich samples are appropriate when the objective is to obtain interpretive insights from individuals with specialised knowledge[30]. Nonetheless, future studies may consider expanding the participant pool across varied institutional and regional settings to strengthen the transferability and scope of the findings.

3.2. Sampling Technique

Purposive sampling was employed in this study, following the recommendations of Creswell[32], Merriam and Tisdell[33], and Miles and Huberman[34], to ensure the selection of participants with relevant expertise aligned to the study's aims. This approach is particularly appropriate for qualitative research, where the objective is to obtain in-depth insights from individuals with specialised knowledge and experience[35]. Six panel experts were selected based on their extensive professional backgrounds, which included roles as senior lecturers in teacher education institutes, ministry-level policy advisors, and school leaders with over five years of direct experience in pre-service teacher training and leadership development.

These individuals brought diverse perspectives, encompassing curriculum design, practicum supervision, instructional leadership training, and policy implementation in Malaysian teacher education. Such diversity contributed to the richness and complexity of the data collected, allowing for a nuanced exploration of the challenges and expectations surrounding data-driven instructional leadership. Rather than focusing on sample size alone, this study prioritised the depth

and relevance of participant contributions, consistent with the principles of qualitative inquiry [33]. The selected experts were well-positioned to offer meaningful, practice-based reflections that align with the study's objective of examining leadership competencies in the Malaysian pre-service teaching context.

3.3. Sample Study

Purposive sampling was employed, selecting six individuals who could provide relevant insights into the research subject [36]. Experts selected for this phase of the study should have a deep understanding and knowledge of teacher trainee leadership. In addition, the selection of experts should also be based on their qualifications, experience, and expertise in the relevant field [37]. The study involved six experts who were selected using purposive sampling to be interviewed using qualitative methods. A small sample size is considered sufficient in qualitative research when the study's objectives are clearly defined and participants are information-rich [38]. These six experts were selected from important individuals at the policy-making level such as mentioned in **Table 1**.

Table 1. Selection of Expert Panels Based on Level of Involvement and Position.

Participant ID	Position of the Experts	Affiliation	Area of Expertise	Years of Experience
Respondent 1	Director of Teacher Education	Institute of Teacher Education Campus	Educational leadership, Teacher professional development	18 years
Respondent 2	Senior Lecturer in Leadership Field	Public University	Instructional leadership, Leadership in education policy	15 years
Respondent 3	Deputy Rector	Institute of Teacher Education	Curriculum development, Pre-service teacher education	20 years
Respondent 4	Principal Assistant Director	Teacher Education Division, MOE	Teacher training programmes, Leadership module design	16 years
Respondent 5	Principal Assistant Director	Ministry of Youth and Sports	Youth leadership development, Programme coordination	14 years
Respondent 6	Student Affairs Officer	Institute of Teacher Education	Student development, School-based practicum support	12 years

3.4. Data Collection and Instruments

The interview is the primary data collection method used in this study. Prior to conducting the interviews, the researcher engaged in significant preparation and planning, as emphasised by Merriam [39], to ensure the rigour and quality of the data collection procedure. The interviews followed a semi-structured interview protocol that was evaluated and approved by a panel of experts, including linguists and pre-service teacher leadership specialists. The interview protocol was designed to investigate the preparation of pre-service teachers for instructional leadership and was divided into three main sections: (a) Opening questions, which introduced the study, provided participants with background information, and sought their informed consent to participate in the research; (b) Key questions, which explored the participants' perspectives on the three core themes related to data-driven instructional leadership; and (c) Closing questions, which allowed participants to share final reflections, raise additional points, or clarify earlier statements. The interviews were recorded with an audio recording device and thorough field notes. The audio recordings from each interview were transcribed verbatim. The transcripts were then distributed to the participants for member verification, allowing them to examine, edit, or clarify their comments to ensure correctness and authenticity. The iterative method improved the data's credibility and reliability. This study uses a well-developed interview process and rigorous data collection techniques to ensure that the insights obtained are complete, reliable, and clearly connected with the study's aims, which are to investigate pre-service teacher preparation for instructional leadership.

3.5. Data Analysis Procedures

Data analysis is a critical phase in qualitative research, as it ensures that findings are firmly grounded in the evidence

collected. In this study, thematic analysis was employed to explore how pre-service teachers can be effectively prepared for data-driven instructional leadership. The researchers applied a constant comparative approach, systematically classifying, coding, and comparing data to identify meaningful patterns and relationships among emerging categories. This iterative process allowed for the refinement of themes that accurately reflected the perspectives and contextual understandings shared by the expert participants [40].

The analysis began with verbatim transcription of all interviews, which were subsequently verified for accuracy and clarity. Using ATLAS.ti 23, the researchers performed open coding to capture significant patterns and concepts from the data. These open codes were then clustered into broader categories known as axial codes, representing recurring and conceptually linked elements across participant responses. Further refinement of these codes resulted in three overarching themes: (1) establishing a conducive learning environment, (2) guiding instructional activities, and (3) structuring teaching and learning based on the institution's direction. To enhance trustworthiness and validity, the researchers triangulated data across interviews and developed discovery summary forms for each session. These forms served as concise syntheses of emerging themes, ensuring that the final analysis was rigorous, reflective of participants' perspectives, and grounded in a coherent interpretive framework.

3.6. Validity & Reliability

Two important procedures were taken to guarantee the legitimacy and dependability of the interview process: pilot studies and expert reviews. While pilot tests gauged the efficacy of the protocol in producing significant answers, experts offered comments on the content and interview technique. These evaluations guided changes to the interview questions thereby improving relevance and clarity. The amended questions were given to participants before the actual interviews to make sure they completely grasped the background and expectations, therefore enhancing the correctness of their answers and hence the general validity and dependability of the study.

3.7. Ethical Consideration

Ethical procedures were strictly observed throughout the research process. Prior to data collection, informed consent was obtained from all participants. They were provided with a detailed explanation of the study's aims, procedures, and their right to withdraw at any time without consequence. Confidentiality and anonymity were assured by using non-identifiable codes (e.g., Respondent 1, Respondent 2) and by securely storing all interview transcripts and related materials. These ethical safeguards were implemented to uphold the rights and dignity of participants, in accordance with standard research ethics protocols.

4. Research Findings

This section presents the findings from interviews with six experts in Malaysian teacher education, focusing on how pre-service teachers are prepared for data-driven instructional leadership. The analysis identified three main areas of competency: identifying data sources, evaluating data, and applying data in teaching. These areas show how pre-service teachers move from basic data awareness to using data to support classroom decisions. The findings also highlight several challenges that limit effective data use, such as limited practice opportunities and lack of mentorship. Finally, the experts shared practical strategies to help overcome these barriers and strengthen data use in teacher training programmes.

4.1. Identifying Data Sources

Across participants, there was strong consensus that pre-service teachers must first be taught how to recognise, access, and manage various educational data sources. Schools, as noted by several respondents, already contain abundant data, yet such resources are frequently underutilised due to a lack of awareness.

As Respondent 3 observed, *"Schools are already rich in data, but teachers may not be aware of what is available."* This suggests a fundamental need to build awareness about the types of data accessible within school environments.

Respondent 1 added, *"Trainee teachers need to identify those that are relevant and of high quality... from school practicum, operational data, or even data from colleagues at other schools."* This points to a broader conceptualisation of data, one that includes peer collaboration, teaching reflections, and contextual records, not just formal test scores.

Respondent 2 offered further clarity: *"A good leader needs to master the data... to conduct a SWOT analysis and*

make informed decisions." This illustrates that data sourcing is not just a technical task but a strategic one, forming the basis for instructional planning and leadership.

Technological skills were also deemed crucial. According to Respondent 1, *"They should use modern technology like IT sensors or customer relationship systems... and learn about storage in databases or cloud systems."* This quote underscores the need to pair data identification with digital competencies.

Respondent 6 highlighted the urgency of adapting to digital realities: *"To nurture students nowadays, we should be able to use data. If we don't adapt, we'll end up in a rather boring learning process."* This reinforces the view that data sourcing must be aligned with the expectations and behaviours of today's learners and digital ecosystems.

Table 2 provides a summary of the elements associated with the theme Identifying Data Sources, as derived from expert interviews.

Table 2. Items of Theme 1 Derived from the Expert Interview.

	Theme 1: Identifying Data Sources
1.	PST diversifies data for school decision-making (Example: Classroom assessment data, student database application data and counseling data to improve student learning)
2.	PST stores data according to specific categories (Example: Personal data category and academic data category)
3.	PST is concerned with the latest digital developments (Example: Artificial Intelligence)
4.	PST collects student performance data using various research methods with the permission of the Ministry of Education (Example: Questionnaires and interviews)
5.	PST plans lesson plan based on post-teaching reflection data
6.	PST identifies student strengths using various data
7.	PST identifies student deficiencies using various data
8.	PST uses assessment data to plan a lesson (Example: Summative and formative assessment)
9.	PST improves their own competence by mastering data sources
10.	PST adheres to Digital Ethics for data security
11.	PST diversifies data to make informed decisions
12.	PST resolves student issues by taking past experiences into account
13.	PST goes to the field to identify issues at the institution

Table 2 presents the items associated with Theme 1: Identifying Data Sources, as derived from expert interviews. This theme captures the foundational competencies pre-service teachers (PSTs) are expected to acquire in order to engage meaningfully with data during their instructional leadership development. The items illustrate a broad and evolving understanding of what constitutes relevant data in the educational context, extending beyond traditional assessments to include digital records, reflections, field observations, and contextual insights.

Experts emphasised that pre-service teachers must be able to diversify their data sources to inform school-level decision-making, drawing from classroom assessments, digital student databases, and even counselling records. This diversification is crucial for understanding student needs holistically. Furthermore, PSTs are expected to categorise and manage data effectively, reflecting not only technical skill but also an awareness of ethical responsibilities, such as adhering to digital security standards.

Another key insight highlighted in the table is the integration of modern technologies into data practices. PSTs are encouraged to remain responsive to emerging digital trends, such as artificial intelligence, and to use research tools like surveys and interviews to collect data under proper institutional approval. Additionally, the table reveals how PSTs are encouraged to identify both student strengths and learning gaps, thereby supporting the design of differentiated and targeted instruction. Items also show how reflection and past experiences serve as valuable sources of informal data to refine practice.

4.2. Evaluating Data

The second subdomain identified relates to the analytical skillset required to assess the quality, relevance, and instructional value of data. Participants consistently emphasised that pre-service teachers must move beyond superficial data awareness to develop evaluative judgement.

Respondent 2 articulated this need clearly: *"Teachers must be able to read achievement data... identify weaknesses, and set targets."* This reflects the importance of using data

to diagnose learning gaps and set measurable instructional goals.

Similarly, Respondent 1 proposed expanding analytical literacy: *"We teach them to make predictions, cluster data, and do pattern recognition... and then visualise it with dashboards or graphics."* This reflects a need for data interpretation that is both analytical and communicative, enabling teachers to share insights effectively.

Respondent 5 raised an important concern about structure: *"Enriching data requires guidelines... because sometimes when we overly enrich the data, there are no guidelines."* This highlights the risk of overwhelming pre-service teachers with data complexity unless clear protocols and scaffolding are in place.

Respondent 4 pointed out the importance of precision in interpretation: *"Analyzing test results helps trainee teachers modify lesson plans to focus on groups that need more attention."* This demonstrates how data evaluation can lead to instructional improvement when interpreted correctly.

Echoing this, Respondent 6 noted the broader digital ecosystem: *"Everything we say or search is linked to data... we must train teachers to detect patterns like AI systems do."* This suggests that modern teachers must not only read data but understand its logic and responsiveness in real-time.

The findings on evaluating data align with the key elements outlined in Theme 2, as summarized in **Table 3** below.

Table 3. Items of Theme 2 Derived from the Expert Interview.

	Theme 2: Evaluating Data
14.	PST documents the data for future use
15.	PST adapts best practices from other schools for application
16.	PST stores academic data using high-tech applications
17.	PST stores school data using high-tech applications
18.	PST presents student achievement data by applying simple statistical methods (Example: Graph)
19.	PST has a user-friendly data storage location
20.	PST assesses student performance using a variety of data
21.	PST analyzes data and information related to the latest teaching theories
22.	PST is proactive in learning data processing methods

Table 3 presents the items related to Theme 2: Evaluating Data, which represents the intermediate phase in the development of data-driven instructional leadership among pre-service teachers (PSTs). This theme focuses on how PSTs assess, organise, and interpret educational data in ways that support instructional decisions. The act of evaluating data involves more than recognising information; it requires reflective thinking, technological literacy, and an understanding of pedagogical relevance.

The items in this table demonstrate that PSTs are expected to engage in deliberate and systematic data practices, including documenting data for future use, assessing student performance from multiple sources, and examining the relevance of data through the lens of current teaching theories. One of the notable practices is the use of simple statistical methods, such as graphs, to display student achievement clearly. This approach helps PSTs make informed decisions and communicate insights effectively within school settings.

Furthermore, the findings highlight the growing emphasis on digital competence. PSTs are encouraged to store data using advanced technological tools, ensuring that information is secure, well organised, and easily retrievable. The development of user-friendly data storage systems also reflects the need for platforms that support frequent and confident use by teacher trainees.

Another important item in this theme is the adaptation of best practices from other schools. This indicates that PSTs are trained not only to evaluate their own classroom data, but also to benchmark and draw insights from external sources. The inclusion of proactive learning in data processing methods illustrates that evaluation is seen as an evolving skill, one that requires continuous effort and intellectual engagement.

4.3. Applying Data

The most complex theme to emerge was the practical application of data for decision-making in instructional leadership. Respondents noted that this stage is where many pre-service teachers struggle, often due to a lack of real-world

practice and mentorship.

Respondent 3 explained, *"If he wants to conduct extra classes, he can base it on student achievement data."* This exemplifies using evidence to plan targeted instructional interventions.

Respondent 4 elaborated further: *"By using data to make decisions, trainee teachers can demonstrate leadership in lesson planning and classroom management."* This confirms that applying data is an active leadership behaviour, not a passive act of reporting.

Respondent 2 stressed the importance of this step: *"The skill of reading data is important... but for what? To make decisions and plan appropriate interventions."* Here, the goal is not just comprehension but transformation which means turning insights into action.

Respondent 1 illustrated a full-cycle approach: *"After collecting and analysing the data, we ask them to make decisions based on that data... and share it with others."* This reflects an expectation that teachers take ownership of data use and contribute to a collaborative learning culture.

Finally, Respondent 6 contextualised the necessity of adaptive teaching: *"If we don't adapt to the current situation, students will disengage. We need to meet them where they are, with technology and relevance."* This affirms that the application of data is vital not only for instruction, but for maintaining student engagement and leadership legitimacy in modern classrooms.

The findings on applying data correspond closely with the key elements outlined in Theme 3, as summarized in **Table 4** below.

Table 4. Items of Theme 3 Derived from the Expert Interview.

	Theme 3: Applying Data
23.	PST uses data to solve student learning issues
24.	PST reflects on supervision data to improve teaching techniques
25.	PST makes decisions based on valid data
26.	PST predicts future events based on valid data
27.	PST shares academic data with fellow PSTs (Example: Student attendance)
28.	PST shares academic data with students (Example: Examination results)
29.	PST is rational in making decisions because they are guided by valid data.
30.	PST applies the SWOT analysis method based on authentic data from the school environment
31.	PST improves student performance based on their academic data
32.	PST shares input on the importance of data enrichment schools to make decisions in teacher competency development programs
33.	PST makes decisions using the latest data
34.	PST applies higher-order thinking skills in decision-making because they are guided by valid data.

Table 4 presents the items associated with Theme 3: Applying Data, which represents the most advanced stage in the development of data-driven instructional leadership among pre-service teachers (PSTs). This theme focuses on the capacity to translate data insights into concrete instructional decisions and leadership actions. It reflects the practical application of data to improve teaching quality, solve classroom challenges, and support school level planning. The items in this table show that PSTs are expected to use data not only to diagnose learning problems but also to develop solutions tailored to specific student needs. For example, PSTs are encouraged to solve student learning issues, improve performance, and make instructional decisions based on valid and current data. This points to a growing culture of evidence based practice within teacher preparation.

Reflection also emerges as a key strategy in this theme. PSTs are encouraged to reflect on supervision data to revise teaching approaches and adapt techniques. This underscores the importance of using feedback and performance metrics not as static reports but as tools for professional growth. The data application process is further enhanced by the use of structured tools such as SWOT analysis, which allows PSTs to analyse school based data to inform strategic planning. Sharing data is another dimension of this theme. PSTs are trained to communicate academic data with both peers and students, fostering a transparent and collaborative environment. This practice helps promote collective responsibility for learning outcomes while also encouraging data discussions among beginning teachers. Decision making, as reflected in multiple items, is expected to be rational, timely,

and informed by valid sources. Several respondents emphasised the need for PSTs to predict future trends, respond to immediate instructional challenges, and engage in higher order thinking when interpreting data. These competencies reflect the integration of analytical reasoning, professional judgment, and leadership mindset.

4.4. Challenges in Applying Data for Instructional Leadership

While the findings demonstrate a progressive framework for developing data-driven instructional leadership competencies, several expert respondents underscored persistent challenges that limit pre-service teachers' ability to translate data into meaningful instructional decisions. These challenges fall into three major categories: limited practical exposure, insufficient mentorship, and overwhelming data complexity.

One of the most commonly cited issues was the lack of real-world application opportunities during teacher training. As Respondent 2 remarked, *"Many trainee teachers only handle data during assignments or simulated scenarios, but not in real classroom settings where decisions carry weight."* This disconnect results in a superficial engagement with data that does not build the confidence or agility needed for leadership roles. Respondent 4 similarly pointed out that *"unless they are guided during practicum, many of them won't know what to do with the data they collect."* This reinforces the necessity of structured, mentored practicum experiences where pre-service teachers can use actual student data under expert supervision.

A second barrier involves limited support structures and feedback mechanisms. Experts noted that while teacher education programs may introduce data tools and technologies, they often do not offer sufficient scaffolding or sustained mentorship to guide decision-making. Respondent 5 explained, *"We give them the technology and data but not the mentoring that helps them make sense of it all in context."* This gap is particularly problematic when pre-service teachers are expected to navigate complex, ambiguous, or incomplete data sets without adequate support.

A third significant concern relates to data complexity and overload. As Respondent 1 observed, *"They don't always know how to filter what matters… and may become overwhelmed by the quantity and variety of data available."* Without proper training in data prioritisation and strategic use, pre-service teachers may either avoid data use altogether or engage in tokenistic practices.

4.5. Overcoming Barriers to Data-Driven Instructional Leadership

In addition to identifying the core themes of data use, experts in this study also proposed several targeted strategies to overcome the barriers pre-service teachers face in applying data effectively. These insights form a sub-theme titled *Overcoming Barriers to Data-Driven Instructional Leadership* and emphasise the need for structural and pedagogical support throughout teacher training.

Several participants highlighted the importance of integrating data tasks directly into practicum experiences. According to Respondent 2, *"We need to embed data activities during practicum, with clear learning outcomes and a session to reflect on what they've done with the data."* This recommendation reflects the view that real-world engagement with data must be accompanied by purposeful learning design to reinforce its relevance.

Another key strategy proposed was mentorship. Respondent 1 explained, *"Pair them with senior mentors who can show how to use data in lesson planning. It's not enough to just learn theory but they need to see it in practice."* This reflects a broader consensus among participants that pre-service teachers benefit significantly from guided modelling of data practices within authentic instructional settings.

Experts also advised a graduated approach to training. Respondent 4 noted, *"Start simple. Don't overload them. Use basic tools first, then build complexity as they get more confident."* This comment suggests that scaffolding data literacy which begins with accessible tools and progressively introducing more complex analysis, is crucial for building competence without overwhelming learners.

To facilitate decision-making, some experts proposed the use of structured protocols. Respondent 5 suggested, *"Give them templates for interpreting the data and making decisions. That way they won't feel lost."* Such tools were seen as instrumental in guiding novice teachers through the data analysis process and translating findings into actionable steps.

Beyond instructional tools, the cultural framing of data in schools was also seen as a significant influence. As Re-

spondent 6 asserted, *"We need to show them that data is not just for reporting but it's for improving teaching. That mindset makes a big difference."* This highlights the need to foster a positive data culture that encourages innovation and support rather than compliance.

Collectively, these expert perspectives underscore that the successful transition from data awareness to meaningful application requires a deliberate, multi-layered approach. It is not enough to expose pre-service teachers to data; rather, institutions must provide the scaffolding, mentorship, and cultural conditions necessary to cultivate confident, evidence-based instructional leaders.

5. Discussion

This study explored expert perspectives on the preparation of Malaysian pre-service teachers for data-driven instructional leadership, focusing on three core competencies: identifying, evaluating, and applying data. The findings demonstrate a developmental progression that aligns with the aspirations of teacher education programmes while highlighting persistent challenges in translating theoretical knowledge into classroom practice. These insights offer a nuanced contribution to ongoing discussions about how data literacy is conceptualised, enacted, and embedded within pre-service teacher education.

One of the central contributions of this study is its redefinition of data literacy as an integral dimension of instructional leadership. While data literacy has often been framed as a technical skill limited to administrative or assessment-related tasks, it is increasingly recognised as a form of professional judgement and agency [2]. The expert participants in this study reinforced this position, emphasising that data use in teaching must be both reflective and strategic. This aligns with existing research that positions data-informed practices as tools for teacher empowerment and learning improvement [41, 42]. The study therefore supports the view that data-related competencies should not be siloed but rather integrated into broader pedagogical and leadership development frameworks.

Each theme presented in the findings of identifying, evaluating, and applying data contributes to this broader understanding. The process of identifying data sources, for example, extends beyond simply locating information to include understanding digital trends and ethical data management. The evaluation theme further expands this perspective by emphasising the importance of analytical interpretation and the development of data judgement skills. Application, the most complex theme, illustrates the transformation of insight into instructional action, with experts highlighting the necessity of decision-making frameworks, mentorship, and scaffolded training to facilitate this progression.

The study also revealed a consistent gap between theoretical instruction and its practical application, particularly within the context of teaching practicum. Although topics such as educational research and assessment are included in teacher education curricula, they are often delivered in ways that are disconnected from the practical realities of schools. Experts expressed concern that pre-service teachers frequently lack the readiness to engage in data-informed instruction during their practicum experiences. This issue is supported by findings which highlight that novice teachers often struggle to translate theoretical knowledge of data use into concrete instructional strategies [43]. Furthermore, the development of data competencies has been shown to depend heavily on guided, contextualised, and practice-based learning experiences [44]. The present study affirms the necessity of embedding structured data tasks, collaborative planning opportunities, and reflective supervision within the practicum to strengthen pre-service teachers' capacity for data-driven instructional leadership. This is especially important in the Malaysian context, where educational reforms are often ambitious but inconsistently implemented at the institutional level [45].

Another significant dimension identified by the study is the ethical and evaluative use of data. While digital tools and platforms for data collection and analysis are becoming more prevalent, the need for professional judgement, ethical awareness, and reflective interpretation remains paramount. Experts advocated for the inclusion of digital ethics in pre-service training, citing concerns about student privacy, data misuse, and algorithmic bias. These observations align with cautionary perspectives that highlight the risks of unchecked data use in schools and underscore the need for ethical decision-making in data practices [46]. Embedding ethical considerations into teacher education is therefore vital in preparing educators for responsible leadership in increasingly data-saturated environments.

The discussion must also recognise the influence of cultural context on how instructional leadership through data is understood and practiced in Malaysia. Unlike Western models that often prioritise accountability and performance outcomes[47], Malaysian experts in this study highlighted values such as relationship building, reflective practice, and institutional responsiveness. Leadership through data was portrayed not simply as an individual skill but as a socially embedded process influenced by school culture and community engagement. This perspective aligns with growing calls to decolonise leadership frameworks and to situate them within specific cultural and policy environments[48]. The Malaysian perspective thus contributes a valuable counterpoint to dominant paradigms and illustrates the importance of localised leadership models.

Conceptually, the study proposes a three-stage framework of identifying, evaluating, and applying data that can guide the development of data-driven instructional leadership in pre-service teacher education. This model provides a practical scaffold for designing curricula and activities that progressively build competence. Empirically, the study contributes regionally grounded insights from Malaysia, a context underrepresented in the global literature. The expert narratives reveal both shared concerns, such as the theory-practice divide and uniquely contextualised understandings shaped by cultural, institutional, and policy factors.

Ultimately, the study advocates for a paradigm shift in how data use is approached in teacher preparation. Rather than being treated as a discrete content area, data literacy should be embedded across pedagogical training, reflective practice, and leadership development. Preparing future educators to lead through data is not only a pedagogical imperative but a strategic investment in building adaptive, resilient, and contextually responsive education systems.

6. Implications

The findings of this study hold critical implications for multiple stakeholders involved in teacher education. For curriculum designers, the study underscores the importance of embedding data literacy as a cross-disciplinary competency throughout teacher education programmes, rather than treating it as a standalone module. This integration should be accompanied by measurable learning outcomes such as the ability of pre-service teachers to interpret, visualise, and apply student data across various instructional contexts. Effectiveness can be gauged through pre and post intervention assessments of data literacy, performance-based tasks, and reflective journals during coursework.

For teacher educators and practicum mentors, the study reinforces the importance of modelling data-informed decision-making and creating structured opportunities for pre-service teachers to engage with data meaningfully. This includes guided data analysis exercises, feedback on data interpretation, and collaborative planning sessions linked to observable classroom outcomes. The effectiveness of such practices can be evaluated through practicum performance rubrics, mentor observations, and student teaching portfolios that document how data is used to improve instructional strategies and address learner needs.

At the policy level, the study repositions data utilisation not as a peripheral administrative task but as a central dimension of instructional leadership. This reconceptualisation suggests that national teacher standards and institutional quality assurance frameworks should explicitly define data literacy as an ethical, professional, and strategic competence. Policymakers can monitor the success of this initiative by incorporating data-related indicators into teacher certification criteria, accreditation processes, and longitudinal tracking of teaching effectiveness.

Ultimately, evaluating the success of these implications requires both formative and summative assessment mechanisms, including self-assessments, mentor evaluations, and institutional reviews that assess the extent to which pre-service teachers demonstrate reflective, ethical, and context-responsive data practices.

7. Conclusions

This study examined how Malaysian pre-service teachers are being prepared to utilise data as part of their instructional leadership. Drawing from expert interviews, the findings revealed that data use is a developmental competency comprising three interrelated stages: (1) identifying relevant data sources, (2) evaluating and interpreting data meaningfully, and (3) applying data to support pedagogical decision-making. These processes are not merely technical but are embedded in professional judgement, reflective thinking,

and culturally responsive leadership practices. Experts emphasised the importance of ethical awareness, digital competence, and the integration of real-world data practices into practicum training to ensure the readiness of future educators.

Significantly, the study highlighted that many pre-service teachers face challenges in bridging theory and practice, particularly in applying data meaningfully within authentic instructional settings. Limited exposure to data tools, lack of structured guidance during practicum, and insufficient emphasis on digital ethics were noted as key barriers. Nevertheless, the findings suggest that when data use is scaffolded throughout training and supported by mentorship, structured tasks, and institutional culture, pre-service teachers are more likely to engage with data confidently and effectively.

In light of these findings, several recommendations are proposed. First, curriculum design should integrate data literacy across various teacher education courses rather than isolating it within standalone modules. Second, structured opportunities for engaging with school-based data should be embedded into practicum placements, enabling pre-service teachers to apply data in real instructional contexts. Third, teacher training must include explicit content on data ethics, privacy, and responsible communication. Fourth, targeted professional development should be provided for teacher educators and mentors to build their capacity in modelling data-informed leadership. Finally, teacher competency standards and education policy should be updated to position data use as a critical skill for instructional leadership.

Future research may explore how pre-service teachers themselves perceive and experience data use during their training, and how these competencies are sustained and evolved once they enter the profession. Longitudinal studies could further assess the impact of data-driven preparation on classroom practices and student learning outcomes, thus contributing to a more robust, evidence-based framework for teacher education in the digital age.

Author Contributions

Conceptualization, A.F.A.R. and M.F.A.G.; methodology, A.F.A.R.; software, A.F.A.R.; validation, A.F.A.R., M.F.A.G. and N.M.R.; formal analysis, A.F.A.R.; investigation, A.F.A.R.; resources, A.F.A.R.; data curation, A.F.A.R.; writing—original draft preparation, A.F.A.R.; writing—review and editing, M.F.A.G.; visualization, A.F.A.R.; supervision, M.F.A.G.; project administration, M.F.A.G.; funding acquisition, M.F.A.G. All authors have read and agreed to the published version of the manuscript.

Funding

This work received no external funding.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Research Ethics Committee of University of Malaya (protocol code UM.TNC 2/UMREC and 28 October 2024).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data supporting the findings of this study are not publicly available due to privacy and ethical restrictions. Access to the anonymised interview transcripts may be granted by the corresponding author upon reasonable request and with appropriate institutional approval.

Acknowledgments

The authors wish to extend heartfelt appreciation to the article's reviewers who generously contributed their time and insights to this study. Their participation was instrumental in shaping the findings. The authors also gratefully acknowledge the support and encouragement received from colleagues at the Faculty of Education, University of Malaya, throughout the course of this research. Special thanks are extended to the research supervisors for their invaluable guidance, constructive feedback, and continuous support, which greatly enriched the quality and direction of this study.

Conflicts of Interest

The authors declare no conflict of interest.

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