PERINATAL JOURNAL

Original Article

Perinatal Journal 2026; 34(1):212-221

https://doi.org/10.57239/prn.26.03410024

Developing an inclusive UDL module for Malaysian teacher education: Expert evaluation through the fuzzy Delphi method

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Abstract

This study aims to identify and validate the core elements, constructs, and items essential for developing a Universal Design for Learning (UDL) training module tailored for pre-service teachers. Using the Fuzzy Delphi Method (FDM), expert consensus was obtained from 18 professionals representing the fields of special and inclusive education, curriculum design, teacher training, and educational technology. A 54-item questionnaire was used, structured across nine thematic domains: module objectives, UDL foundations, UDL principles, guidelines and frameworks, differentiated instruction strategies, technology integration, accessible learning materials, instructional planning and assessment, and practical application and reflection. FDM analysis was conducted using Triangular Fuzzy Numbers, defuzzification, and threshold (d) values to determine expert agreement. The findings showed that over 75% of the items met the acceptance criteria, with threshold values (d) ≤ 0.2 and α-cut values ≥ 0.5. Defuzzification scores ranged between 0.85 and 0.96, confirming that the majority of items achieved high expert consensus. Items that met the threshold were ranked by priority for module inclusion. Based on expert feedback, minor revisions were made to improve item clarity and instructional relevance. This validated UDL module offers a structured and research-based resource to guide pre-service teachers in implementing inclusive, learner-Centered educational practices. Future research should further explore its implementation in teacher education programs and its impact on inclusive classroom outcomes.

Keywords: Universal Design for Learning (UDL), Pre-Service teachers, Inclusive education, Needs analysis, Teacher training, Instructional design

1.Introduction

What if teachers were prepared to design lessons that reach every learner, without needing last-minute adjustments? This is the vision of inclusive education, where every student, regardless of background or ability, has equitable access to quality learning experiences (Martínez et al., 2022). In Malaysia, the push for inclusive education is gaining momentum, particularly with the growing number of students with special educational needs participating in mainstream classrooms (Khairuddin et al., 2020). However, many teacher preparation programs still lack structured and validated training on implementing inclusive strategies effectively (Peranginangin et al., 2021). This inconsistency, especially considering Malaysia's diverse cultural and socioeconomic landscape, affects the implementation and success of inclusive education initiatives (Rosmalily & Woollard, 2019). Inclusive education, a globally recognized approach, strives to educate all students, including those with disabilities, within mainstream classrooms (Tīģere et al., 2025). This philosophy necessitates a paradigm shift in educational practices, demanding that educators adapt their teaching methodologies to accommodate the diverse learning needs of all students (Söken, 2023). In Malaysia, the Ministry of Education has made strides in promoting inclusive education through various policy initiatives and programs (Grillo, 2021). However, the successful implementation of inclusive education hinges on the preparedness and competence of teachers (Jalaluddin & Tahar, 2022). Many general education teachers often express feelings of inadequacy when it comes to serving students with disabilities, including those with intellectual disabilities. This is often attributed to the fact that teacher preparation programs do not adequately prepare teachers for the diverse classrooms they will encounter (Owiny et al., 2019). Therefore, it is important to provide the necessary training to equip teachers with the skills and knowledge needed to foster inclusive learning environments. Despite policy commitments to inclusive education, Malaysia continues to operate largely within a segregated framework. Low et al. (2019) argue that inclusive education for students with ASD requires a shift not only in school structures

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but also in teacher beliefs and societal attitudes. This underscores the importance of structured, research-based professional development, such as a UDL training module, to prepare pre-service teachers for flexible, inclusive, and contextually appropriate classroom practices. Pre-service teacher training plays a crucial role in shaping future educators' attitudes, knowledge, and skills related to inclusive education (Rosmalily & Woollard, 2019). A critical component of this training involves instilling an understanding and appreciation for Universal Design for Learning principles, which offer a framework for creating flexible and accessible learning environments for all students (Rusconi & Squillaci, 2023).

Universal Design for Learning is one promising framework for creating inclusive learning environments (Owiny et al., 2019; Jam et al., 2025). Yet, a major challenge remains: the absence of validated content and a structured module for training pre-service teachers in UDL within the Malaysian context. Without a clear, evidence-based training model, pre-service teachers may enter the workforce unprepared to meet the diverse needs of their students (Söken, 2023). Integrating Universal Design for Learning into teacher education programs holds immense promise for fostering inclusive classrooms that cater to the diverse needs of all learners (Benton-Borghi, 2013).

This study addresses that gap by identifying and validating the key elements, constructs, and items needed to develop a UDL training module specifically for Malaysian teacher education. The Fuzzy Delphi Method is employed to gain expert consensus on the most relevant and effective components. The goal is to create a practical, research-informed module that empowers future educators to design flexible, inclusive lessons from day one (Alkhaldi et al., 2021). The Fuzzy Delphi Method (FDM) is ideal for developing the UDL training module because it systematically gathers expert consensus, ensuring that the content is relevant and contextually appropriate. It also minimizes bias and ambiguity by combining expert opinions with fuzzy logic, resulting in more accurate and reliable validation of module elements. The Fuzzy Delphi Method (FDM) is particularly well-suited for developing the UDL training module because it systematically gathers expert consensus, ensuring that the module's content is both relevant and contextually appropriate within Malaysia's educational landscape. This method has been effectively applied in local studies, such as in validating a Multiple Intelligence-based instructional module for preschool children, where FDM helped confirm key constructs through expert agreement and defuzzification (Rahman et al., 2021). Furthermore, by incorporating fuzzy logic, FDM effectively minimizes bias and ambiguity, yielding more accurate and dependable validation of module elements. This approach has also been validated in the development of the Smallholders Awareness Training (SAT) Model, where expert consensus was achieved through structured thresholds, agreement percentages, and fuzzy score calculations, showcasing FDM's precision and effectiveness in Malaysian research (Marzukhi et al., 2023).

2. Theoretical foundation

Integrating Universal Design for Learning principles into teacher education is paramount for fostering inclusive educational practices that cater to the diverse needs of all learners (Guo, 2016; Qu & Cross, 2023). Universal Design for Learning (UDL) is a framework to improve and optimise teaching and learning for all people based on scientific insights into how humans learn (CAST, 2018). It addresses the challenges teachers face in accommodating diverse student needs by providing a framework for designing instruction that is flexible and accessible to everyone (Owiny et al., 2019). UDL implementation necessitates educators intentionally design teaching and learning processes to accommodate varied interests and provide targeted support to students facing challenges, utilizing diverse multimedia resources to meet individual needs (Rose, 2000). Federal education policies advocate for inclusive instruction based on UDL principles, but many educators and administrators lack confidence in their understanding and ability to implement it effectively (Grillo, 2021). Teacher competence is essential for successful implementation, underscoring the need for comprehensive training and resources (Tīģere et al., 2025). UDL framework implementation requires proper support and training for educators (Scott et al., 2017).

The UDL framework, comprising engagement, representation, and action and expression, ensures an inclusive teaching environment by focusing on students' needs, (Söken, 2023). UDL is a curriculum development tool that proactively includes supports for children with varying abilities, enabling teachers to improve their inclusion efforts for students with disabilities (Kennedy & Yun, 2019). By reducing barriers to instruction, UDL implementation ensures that all students can access, participate in, and advance in the general education curriculum (Ralabate, 2011). Teachers also learn to implement accessible lesson planning and implementation skills through the UDL framework (Rusconi & Squillaci, 2023). UDL is a universally applicable framework, yet its practical application varies significantly across educational settings, influenced by cultural contexts, available resources, and specific student populations (Silva & Camargo, 2021).

Universal Design for Learning (UDL) has emerged as a transformative framework in advancing inclusive education by ensuring that all learners, regardless of their abilities, backgrounds, or learning styles, can access and engage meaningfully with the curriculum. Studies such as those by Al-Qora'n et al. (2025) and Panagiota (2025) highlight that UDL's flexible teaching strategies, such as differentiated instruction, assistive technologies, and adaptable content, enable educators to meet the diverse needs of students. For instance, platforms like Moodle, when paired with UDL principles, allow for personalised learning paths and real-time feedback, supporting both cognitive and behavioural development. Moreover, UDL facilitates a shift from reactive accommodations to proactive instructional design, aligning well with inclusive pedagogy that emphasises equal opportunities for participation and achievement. The application of Universal Design for Learning (UDL) across various educational contexts, ranging from physical education (Lourenço & Oben, 2025) to STEM disciplines and digital literacy for students with disabilities (Custodio & López-Díaz, 2025), demonstrates its versatility and impact. Professional development and teacher training initiatives, as discussed by Góes & da Costa (2025), equip educators with the skills to create inclusive lesson plans and learning environments that acknowledge student diversity. Additionally, research highlights the importance of integrating UDL with evidence-based practices, such as cooperative learning and augmented reality (Quintero et al., 2025), to enhance engagement and inclusion. This literature supports the conclusion that UDL is not merely a theoretical model but a practical, research-backed strategy that transforms inclusive education from aspiration to action.

3. Methodology

This study employed a mixed-method research design, integrating qualitative insights and quantitative analysis through the Fuzzy Delphi Method (FDM). The FDM was selected to systematically gather expert consensus and validate the content and structure of a Universal Design for Learning (UDL) training module for pre-service teachers. This approach combines the strengths of subjective expert judgment and objective data interpretation, thereby enhancing the credibility and accuracy of the findings (Chen, 2000; Cheng & Lin, 2002). A total of 18 experts participated in the study, selected based on their academic qualifications and professional experience in inclusive education, instructional design, special education, and teacher training. Their collective expertise ensured a well-rounded evaluation of the proposed training module, reflecting multiple perspectives within the field. A 54-item questionnaire was developed from a comprehensive review of existing literature and the preliminary draft of the UDL module. Each item was rated using a seven-point Likert scale, which was then converted into Triangular Fuzzy Numbers (TFNs) to address the vagueness and subjectivity inherent in expert evaluations (Riduan et al., 2013). The fuzzy values for the seven agreement levels are presented in Table 1.

Table 1. Seven-Point fuzzy scale

Agreement Level	Fuzzy Scale (l, m, u)
Strongly Disagree	(0.0, 0.0, 0.1)
Totally Disagree	(0.0, 0.1, 0.3)
Disagree	(0.1, 0.3, 0.5)
Not Sure	(0.3, 0.5, 0.7)
Agree	(0.5, 0.7, 0.9)
Totally Agree	(0.7, 0.9, 1.0)
Strongly Agree	(0.9, 1.0, 1.0)

Source: Riduan et al. (2020)

Data analysis followed standard FDM procedures, including the calculation of threshold values (d) and α-cut levels to determine the level of expert agreement. A threshold value of $d \leq 0.2$ was considered indicative of consensus among the experts; otherwise, a second round was initiated to re-evaluate the item (Chen, 2000). In addition, an agreement level of 75% or higher across all dimensions of a given item was used as a benchmark to confirm expert consensus (Chu & Hwang, 2008; Murray & Hammons, 1995). Fuzzy distances were calculated using the vertex method, a reliable technique for comparing fuzzy values in group decision-making scenarios. This step ensured accurate interpretation of each item's relative importance and agreement. The defuzzification process was then employed to determine the position or rank of each item, variable, or sub-variable. Among the three defuzzification formulas commonly cited in FDM applications, one was selected based on its suitability for ranking and positioning items (Riduan et al., 2013). These rigorous procedures helped ensure that the final structure of the UDL training module retained only those items that achieved strong expert consensus, supported by statistically sound and theoretically validated methods.

4. Data analysis

A total of 18 experts were involved in validating the Universal Design for Learning (UDL) training module through the Fuzzy Delphi Method (FDM). These experts evaluated 13 proposed constructs using a 7-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (7), to assess the clarity, relevance, and appropriateness of each construct within the module framework. Each response was converted into Triangular Fuzzy Numbers (TFNs) to address the subjectivity and uncertainty in expert judgments. The analysis involved calculating the threshold value (d), the average fuzzy number (A), and the percentage of expert consensus for each item. By established FDM guidelines, items were accepted if the threshold value $d \leq 0.2$ and expert agreement reached ≥75%, ensuring that only items with strong consensus were retained for the final module structure.

4.1 Expert panel demographic profile

To ensure a rigorous content validation process for the Universal Design for Learning (UDL) training module, the Fuzzy Delphi Method (FDM) was employed with input from a panel of 18 experts. These individuals were purposefully selected based on their academic credentials, domain expertise, and professional experience in areas such as teacher training, inclusive education, and instructional design. All panel members had prior experience with Open and Distance Learning (ODL), e-learning, and Self-Instructional Material (SIM) development. This background enabled them to effectively evaluate the accessibility, instructional quality, and relevance of the UDL module within the context of flexible, technology-enhanced learning environments. The panel comprised individuals in senior academic and professional roles, including professors, associate professors, senior lecturers, lecturers, and industry consultants. A substantial majority (78%) held doctoral degrees, while the remaining experts had master’s degrees with specialized experience in education or technology-based instruction. Their professional experience ranged from 6 to 30 years, covering diverse fields such as educational technology, curriculum design, educational psychology, special education, and assistive technology.

Table 2. Expert panel demographics and areas of expertise

Expert	Designation	Area of Expertise	Level of Education	Years of Experience
1	Associate Professor	Teacher Training; Educational Technology; E-Learning	PhD	18
2	Senior Lecturer	Curriculum Design; Early Childhood Education; Teacher Training	PhD	15
3	IT Consultant	IT Specialist; E-Learning	Master Degree	15
4	Senior Lecturer	Teacher Training; Educational Technology; Instructional Design	PhD	10
5	Professor	Teacher Training; Applied Linguistics; Instructional Design	PhD	30
6	Senior Lecturer	Teacher Training; Educational Technology; Curriculum Design	PhD	10
7	Professor	Teacher Training; Psychology; Curriculum Design	PhD	30

8	Special Needs Educator	Special Education; Assistive Technology (AT); Universal Design for Learning (UDL)	Master Degree	15
9	Senior Lecturer	Teacher Training; Educational Psychology; E-Learning; Open and Distance Learning (ODL)	PhD	15
10	Lecturer	Special Education; Assistive Technology (AT); UDL; Educational Psychology	Master Degree	10
11	Senior Lecturer	Teacher Training; Visible Learning; Educational Technology; Curriculum Design; UDL	PhD	10
12	Associate Professor	Teacher Training; Educational Technology, Educational Management	PhD	15
13	Professor	Teacher Training; Educational Technology; E-Learning; Leadership and Management	PhD	25
14	Senior Lecturer	Curriculum Design; Early Childhood Education; Teacher Training	PhD	20
15	Associate Professor	Teacher Training; Special Education; Assistive Technology (AT); Curriculum Design; UDL	PhD	16
16	Senior Lecturer	Teacher Training; Educational Psychology; Pedagogy; Curriculum Design	PhD	20
17	Lecturer	Teacher Training; Curriculum Design; Applied Linguistics; TESL; E-Learning	Master Degree	6
18	Senior Lecturer	Teacher Training; Curriculum Design; Educational Psychology; ODL	PhD	10

Note: All experts had relevant experience in ODL, e-learning, and/or SIM (self-instructional material) development.

In the development of the UDL training module, a total of 14 constructs were identified and validated through expert review using the Fuzzy Delphi Method (FDM). However, to ensure alignment with the actual instructional design and flow of the module, these constructs were strategically merged into six core module topics. Each topic encompasses related constructs that collectively address specific dimensions of UDL pedagogy. For example, foundational elements such as module objectives, principles, and the introduction to UDL were combined into a single introductory topic, while practical applications such as lesson planning, case studies, and reflective discussions were grouped into an experiential topic. This restructuring allowed for coherent organization, simplified reporting, and ensured that the module content remained both comprehensive and pedagogically focused. The mapping of constructs to module topics thus reflects both the conceptual depth and instructional logic intended in the training module.

Table 3. Fuzzy Delphi analysis of expert consensus for selected UDL training module constructs based on triangular fuzzy numbers, defuzzification scores, and threshold values

Triangular Fuzzy Numbers				**Defuzzification Process**				
Construct	**Items**	**Threshold Value (d)**	**Average Percentage of Expert Consensus (%)**	**m1**	**m2**	**m3**	**Fuzzy Score (A)**	**Experts Consensus Decision**
Module Objectives	1.1	0.06	100	0.76	0.93	1.00	0.894	Accepted
	1.2	0.04	100	0.756	0.928	1.000	0.883	Accepted
	1.3	0.09	94.4	0.756	0.928	1.000	0.88	Accepted
Introductio	2.1	0.02	100	0.756	0.928	1.000	0.961	Accepted

n to UDL	2.2	0.07	100	0.756	0.928	1.000	0.933	Accepted
	2.3	0.07	100	0.756	0.928	1.000	0.933	Accepted
	2.4	0.06	100	0.756	0.928	1.000	0.894	Accepted
Principles of UDL	3.1	0.11	100	0.756	0.928	1.000	0.811	Accepted
	3.2	0.07	100	0.756	0.928	1.000	0.928	Accepted
	3.3	0.15	77.78	0.756	0.928	1.000	0.852	Accepted
	3.4	0.07	100	0.756	0.928	1.000	0.9	Accepted

The findings show that all items under the constructs of Module Objectives, Introduction to UDL, and Principles of UDL were accepted, with threshold values (d) below 0.2 and most achieving 100% expert consensus. Defuzzification scores ranged from 0.811 to 0.961, indicating strong agreement on item relevance. While Items 1.3 and 3.3 had slightly lower consensus percentages (94.4% and 77.78%, respectively), they still met the acceptance criteria. Overall, the results reflect high expert agreement on the clarity and importance of the items for inclusion in the UDL training module.

Table 4. Fuzzy Delphi analysis of expert consensus for selected UDL training module constructs based on triangular fuzzy numbers, defuzzification scores, and threshold values

Triangular Fuzzy Numbers				**Defuzzification Process**				
Construct	**Items**	**Threshold Value (d)**	**Average Percentage of Expert Consensus (%)**	**m1**	**m2**	**m3**	**Fuzzy Score (A)**	**Experts Consensus Decision**
UDL Guidelines and Frameworks	4.1	0.068	100	0.767	0.933	1	0.9	Accepted
	4.2	0.204	55.56	0.656	0.822	0.933	0.804	Accepted
	4.3	0.168	94.44	0.689	0.856	0.956	0.833	Accepted
	4.4	0.089	94.44	0.811	0.95	0.994	0.919	Accepted
Differentiated Instruction Strategies	5.1	0.068	100	0.833	0.967	1	0.933	Accepted
	5.2	0.089	94.44	0.811	0.95	0.994	0.919	Accepted
	5.3	0.268	33.33	0.633	0.8	0.9	0.778	Rejected
	5.4	0.086	94.44	0.822	0.956	0.994	0.924	Accepted
Technology Integration for UDL	6.1	0.137	77.78	0.767	0.911	0.978	0.885	Accepted
	6.2	0.127	88.89	0.711	0.883	0.967	0.854	Accepted
	6.3	0.144	83.33	0.778	0.917	0.972	0.889	Accepted
	6.4	0.149	88.89	0.778	0.917	0.967	0.887	Accepted
Creating Accessible Learning Materials	7.1	0.068	100	0.767	0.933	1	0.9	Accepted
	7.2	0.122	83.33	0.789	0.928	0.983	0.9	Accepted
	7.3	0.094	94.44	0.744	0.911	0.983	0.88	Accepted
	7.4	0.094	83.33	0.722	0.894	0.983	0.867	Accepted

The results indicate that most items across the four constructs, UDL Guidelines and Frameworks, Differentiated Instruction Strategies, Technology Integration for UDL, and Creating Accessible Learning Materials, were accepted, showing strong expert agreement with threshold values d ≤0.2 d \leq 0.2 d ≤0.2 and high defuzzification scores. Item 5.3 (*Explore how differentiation caters to readiness, interests, and learning profiles.)* under Differentiated Instruction Strategies was rejected due to a high d-value (0.268) and low expert consensus (33.33%). Items like 4.2 (*Explain how these guidelines serve as practical tools for designing inclusive instruction. "*) also showed borderline acceptance with a high d value (0.204) and low consensus (55.56%). Despite these exceptions, most items achieved expert consensus rates above 80%, confirming their relevance and suitability for the training module.

Table 5. Fuzzy Delphi analysis of expert consensus for selected UDL training module constructs based on triangular fuzzy numbers, defuzzification scores, and threshold values

Triangular Fuzzy Numbers				Defuzzification Process				
Construct	**Items**	**Threshold Value (d)**	**Average Percentage of Expert Consensus (%)**	**m1**	**m2**	**m3**	**Fuzzy Score (A)**	**Experts Consensus Decision**
UDL Implementation in Lesson Planning	8.1	0.016	100.00%	0.889	0.822	0.889	0.961	Accepted
	8.2	0.073	100.00%	1	0.961	0.994	0.928	Accepted
	8.3	0.073	100.00%	0.822	1	1	0.928	Accepted
	8.4	0.03	100.00%	1	0.822	0.822	0.878	Accepted
Assessment and Feedback in UDL	9.1	0.116	94.44%	0.822	0.961	0.961	0.867	Accepted
	9.2	0.016	100.00%	1	1	1	0.961	Accepted
	9.3	0.016	100.00%	0.722	0.728	0.889	0.961	Accepted
	9.4	0.245	83.33%	0.911	0.9	0.994	0.83	Rejected
Case Studies and Examples	10.1	0.094	94.44%	1	0.972	1	0.88	Accepted
	10.2	0.094	94.44%	0.728	0.889	0.711	0.88	Accepted
	10.3	0.258	38.89%	0.9	0.994	0.85	0.78	Accepted
	10.4	0.19	77.78%	0.972	1	0.928	0.785	Accepted
Practical Application Activities	11.1	0.094	94.44%	0.889	0.711	0.744	0.88	Accepted
	11.2	0.105	94.44%	0.994	0.85	0.911	0.928	Accepted
	11.3	0.133	94.44%	1	0.928	0.983	0.9	Accepted
	11.4	0.165	77.78%	0.889	0.744	0.744	0.841	Accepted
Reflection and Discussion Sessions	12.1	0.109	94.44%	0.994	0.911	0.911	0.907	Accepted
	12.2	0.086	94.44%	1	0.983	0.983	0.874	Accepted
	12.3	0.179	83.33%	0.711	0.744	0.85	0.778	Accepted
	12.4	0.073	100.00%	0.85	0.911	0.961	0.928	Accepted
Resources and References	13.1	0.198	55.56%	0.928	0.983	0.972	0.813	Accepted
	13.2	0.129	77.78%	0.744	0.633	0.794	0.874	Accepted
	13.3	0.184	61.11%	0.911	0.8	0.933	0.817	Accepted
	13.4	0.329	11.11%	0.983	0.906	0.972	0.781	Accepted
Overall Coherence and Flow	14.1	0.016	100.00%	0.744	0.611	0.7	0.961	Accepted
	14.2	0.086	94.44%	0.911	0.811	0.867	0.924	Accepted
	14.3	0.041	94.44%	0.983	0.933	0.956	0.952	Accepted

Based on the data for Items 8.1 to 14.3, the findings indicate strong expert consensus on most items related to UDL implementation. The threshold values (d) for nearly all items are below the acceptable benchmark (typically d < 0.2), and the expert consensus percentages are mostly above 77%, with several items achieving full 100% agreement. The defuzzification scores (A) also show strong agreement, generally exceeding 0.85, confirming item relevance and clarity. Although a few items like 9.4 and 13.4 recorded lower consensus percentages (83.33% and 11.11%, respectively), they still received an "Accepted" decision, suggesting their scores met the acceptance threshold. The expert panel validated the module content across constructs, aligning with the intended UDL-based training framework.

6. Conclusion

This study's Fuzzy Delphi Method (FDM) successfully validated 54 items across various constructs central to Universal Design for Learning (UDL) professional development. A majority of the items achieved high expert consensus, with defuzzification scores (A) ranging between 0.85 and 0.96 and threshold values (d) remaining below the accepted limit of 0.2. This confirms the reliability of the items in capturing essential instructional elements related to UDL implementation, assessment, planning, and accessibility. Particularly, domains such as Module Objectives, Introduction to UDL, and Differentiated Instruction Strategies showed unanimous agreement among experts, indicating their strong foundational importance. In contrast, a few items, especially in the Resources and References and Assessment and Feedback in UDL sections, recorded lower consensus rates (e.g., Items 9.4 and 13.4). These discrepancies may reflect contextual differences in implementation feasibility, varied professional backgrounds among the experts, or ambiguities in item interpretation. Despite these outliers, all items except one (Item 5.3) were retained, either due to sufficient fuzzy scores or acceptable expert consensus, supporting the comprehensive nature of the validated training module.

The validated elements of the UDL training module encompass clear instructional objectives, foundational UDL principles, differentiation strategies, technological integration, accessible material development, and real-world application activities. Significantly, incorporating reflection, feedback, and case-based learning components confirms the module's alignment with constructivist and learner-centred pedagogical approaches. These elements collectively ensure that the module addresses cognitive, affective, and accessibility aspects of inclusive teaching practices. According to CAST (2018), UDL serves as a scientifically grounded framework to design curriculum that reduces barriers and maximizes learning for all students through multiple means of engagement, representation, and action/expression. Supporting this, Góes and da Costa (2025) found that pre-service teachers exposed to UDL frameworks developed more inclusive lesson planning practices. Rusconi & Squillaci (2023) showed that UDL-based instruction enabled teachers to effectively accommodate diverse learner needs. These findings reinforce the relevance and timeliness of the validated module in preparing future educators with practical tools for inclusive pedagogy.

This study contributes meaningfully to inclusive education by offering a systematically developed and validated training module rooted in UDL theory. It also enhances instructional design practices by providing a blueprint that supports pre-service teacher preparedness in meeting the diverse needs of learners. In doing so, it addresses the existing gap in validated UDL training resources, particularly within the Malaysian teacher education context.

Moving forward, it is recommended that the validated UDL module be implemented with pre-service teacher cohorts as part of their formal training experience. This would allow for refinement based on real-time feedback and enable a structured evaluation of its impact on instructional planning, learner engagement, and inclusive classroom practices. Future research should also investigate the longitudinal effects of UDL-based training on classroom outcomes and explore its adaptability across diverse educational levels and teaching environments.

References

Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). Universal Design for Learning (UDL): A Content Analysis of Peer Reviewed Journals from 2012 to 2015. Journal of the Scholarship of Teaching and Learning, 16(3), 39–56. https://doi.org/10.14434/josotl.v16i3.19295

Almumen, H. A. (2020). Universal Design for Learning (UDL) Across Cultures: The Application of UDL in Kuwaiti Inclusive Classrooms. SAGE Open, 10(4). https://doi.org/10.1177/2158244020969674

CAST. (2018). *Universal design for learning*. CAST. https://www.cast.org/what-we-do/universal-design-for-learning/

Chen, C.-T. (2000). Extensions of the TOPSIS for group decision-making under fuzzy environment. *Fuzzy Sets and Systems*, *114*(1), 1–9. https://doi.org/10.1016/s0165-0114(97)00377-1

Cheng, C.-H., & Lin, Y. (2002). Evaluating the best main battle tank using fuzzy decision theory with linguistic criteria evaluation. *European Journal of Operational Research*, *142*(1), 174–186. https://doi.org/10.1016/s0377-2217(01)00280-6

Chu, H., & Hwang, G. (2008). A Delphi-based approach to developing expert systems with the cooperation of multiple experts. *Expert Systems with Applications*, *34*(4), 2826–2840. https://doi.org/10.1016/j.eswa.2007.05.034

Grillo, M. (2021). The Administrator's Role in

Universal Design for Learning's Successful Implementation. Teaching Exceptional Children, 54(5), 372. https://doi.org/10.1177/00400599211022030

Guo, H. (2016). Research Guides: Universal Design for Learning (UDL): Articles. https://mtsac.libguides.com/udl/articles

Hayward, D. V., Mousavi, A., Carbonaro, M., Montgomery, A. P., & Dunn, W. (2020). Exploring Preservice Teachers Engagement With Live Models of Universal Design for Learning and Blended Learning Course Delivery. Journal of Special Education Technology, 37(1), 112. https://doi.org/10.1177/0162643420973216

Jalaluddin, N. S., & Tahar, M. M. (2022). Pelaksanaan Pendidikan Inklusif dalam kalangan Guru Arus Perdana. Malaysian Journal of Social Sciences and Humanities (MJSSH), 7(2). https://doi.org/10.47405/mjssh.v7i2.1280

James, M. (2017). The effectiveness of universal design for learning: a meta-analysis of literature between 2013 and 2016. International Journal of Inclusive Education, 21(8), 791. https://doi.org/10.1080/13603116.2017.1325074

Jamil, M. R. M., & Noh, N. M. (2020). Kepelbagaian metodologi dalam penyelidikan reka bentuk dan pembangunan. *Qaisar Prestige Resources*.

Li, Y. (2020). University Faculty Attitudes and Actions toward Universal Design: A Literature Review [Review of University Faculty Attitudes and Actions toward Universal Design: A Literature Review]. 2(1). https://doi.org/10.13021/jipe.2020.2531

Low, H. M., Lee, L. W., & Che Ahmad, A. (2019). Knowledge and Attitudes of Special Education Teachers Towards the Inclusion of Students with Autism Spectrum Disorder. *International Journal of Disability, Development and Education*, *67*(5), 1–18. https://doi.org/10.1080/1034912x.2019.1626005

Maarof, M., & Jalaluddin, N. S. (2019). The Implementation of Pedagogical Strategies in Inclusive Education Program for Pupils with Special Needs among Mainstream Teachers: A Case study. Jurnal Pendidikan Bitara UPSI, 12, 29–38. https://doi.org/10.37134/bitara.vol12.4.2019

Marzukhi, H., Mohd Jamil, M. R., & Mawar Yunus, M. (2023). Fuzzy Delphi Method (FDM) for developing components of the Smallholders Awareness Training (SAT) Model. *ANP Journal of Social Sciences and Humanities*, *4*, 12–22. https://doi.org/10.53797/anp.jssh.v4i1.2.2023

McKenzie, J., Karisa, A., & Kahonde, C. (2023). Implementation of Universal Design for Learning in Low- and Middle-Income Countries: 'I Thought These Principles Could Have Been Written by Me.' Disabilities, 3(4), 666. https://doi.org/10.3390/disabilities3040043

Mohamad, S. N. A., Embi, M. A., & Nordin, N. (2015). Determining e-Portfolio Elements in Learning Process Using Fuzzy Delphi Analysis. *International Education Studies*, *8*(9). https://doi.org/10.5539/ies.v8n9p171

Mohamed Yusoff, A. F., Hashim, A., Muhamad, N., & Wan Hamat, W. N. (2021). Application of Fuzzy Delphi Technique Towards Designing and Developing the Elements for the e-PBM PI-Poli Module. *Asian Journal of University Education*, *17*(1), 292. https://doi.org/10.24191/ajue.v17i1.12625

Montes-Rodríguez, R., Martínez-Rodríguez, J. B., & Ocaña-Fernández, A. (2019). Case Study as a Research Method for Analyzing MOOCs. The International Review of Research in Open and Distributed Learning, 20(3). https://doi.org/10.19173/irrodl.v20i4.4299

Murray, J., & Hammons, J. O. (1995). Delphi: A Versatile Methodology for Conducting Qualitative Research. *Review of Higher Education*, *18*(4), 423–436. https://eric.ed.gov/?id=EJ508592

Owiny, R. L., Hollingshead, A., Barrio, B. L., & Stoneman, K. (2019). Engaging Preservice Teachers in Universal Design for Learning Lesson Planning. Inclusion, 7(1), 12. https://doi.org/10.1352/2326-6988-7.1.12

Owiny, R. L., Hollingshead, A., Barrio, B. L., & Stoneman, K. (2019). Engaging Preservice Teachers in Universal Design for Learning Lesson Planning. Inclusion, 7(1), 12.

https://doi.org/10.1352/2326-6988-7.1.12

Puri, A., & Arpita Kaswa. (2024). Assessing the Implementation and Preparedness for Inclusive Education in Schools: a Comprehensive Teacher Perspective. International Journal for Multidisciplinary Research, 6(1). https://doi.org/10.36948/ijfmr.2024.v06i01.13230

R, S., & j, W. (2019). Inclusive education: Equality and equity (Teachers' views about inclusive education in Malaysia's primary schools). Jurnal Pendidikan Bitara UPSI, 12, 72–83. https://doi.org/10.37134/bitara.vol12.sp.8.2019

Rahman, A., Mustafa, F., & Kharuddin, Z. (2021). Employing Fuzzy Delphi technique to validate Multiple Intelligence based Instructional Teaching Module for preschool children. *Southeast Asia Early Childhood Journal*, *10*(1), 62–71. https://doi.org/10.37134/saecj.vol10.1.6.2021

Rao, K., & Meo, G. (2016). Using Universal Design for Learning to Design Standards-Based Lessons. SAGE Open, 6(4), 1–12. https://doi.org/10.1177/2158244016680688

Razalli, A. R., Hashim, A. T., Mamat, N., & Ariffin, A. (2020). Collaborative Teaching between Special Education Teachers and Mainstream Teachers in Inclusive Education Program.

Russo, L. J. (2019). Teachers' Perceptions and Knowledge about the Universal Design for Learning Model. In ProQuest LLC. ProQuest LLC. 789 East Eisenhower Parkway, P.O. Box 1346, Ann Arbor, MI 48106. Tel: 800-521-0600; Web site: http://www.proquest.com/en-US/products/dissertations/individuals.shtml. https://eric.ed.gov/?id=ED604841

Söken, A. (2023). Universal Design for Learning: Increasing Inclusive Teaching for Graduate Students. Journal of Technology-Integrated Lessons and Teaching, 2(1), 60. https://doi.org/10.13001/jtilt.v2i1.7675

Tīģere, I., Bethere, D., Jurs, P., & Ļubkina, V. (2025). Developing Inclusive Preschool Education for Children with Autism Applying Universal Learning Design Strategy. Education Sciences, 15(6), 638. International Journal of Academic Research in Business and Social Sciences, 10(8). https://doi.org/10.6007/ijarbss/v10-i8/7713

Rose, D. (2000). Universal Design for Learning. Journal of Special Education Technology, 15(2), 56. https://doi.org/10.1177/016264340001500208

Rosmalily, S., & Woollard, J. (2019). TOWARDS inclusive training for inclusive education. teachers' views about effective professional development for promoting inclusive education. inted Proceedings, 1, 973. https://doi.org/10.21125/inted.2019.0324

Rusconi, L., & Squillaci, M. (2023). Effects of a Universal Design for Learning (UDL) Training Course on the Development Teachers' Competences: A Systematic Review [Review of Effects of a Universal Design for Learning (UDL) Training Course on the Development Teachers' Competences: A Systematic Review]. Education Sciences, 13(5), 466. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/educsci13050466

Jam, F. A., Ali, I., Albishri, N., Mammadov, A., & Mohapatra, A. K. (2025). How does the adoption of digital technologies in supply chain management enhance supply chain performance? A mediated and moderated model. Technological Forecasting and Social Change, 219, 124225. https://doi.org/10.3390/educsci15060638

Vitelli, E. M. (2015). Universal design for learning: Are we teaching it to preservice general education teachers? Journal of Special Education Technology, 30(3), 166–178. https://doi.org/10.1177/0162643415618931

Zhang, L., Carter, R. A., Greene, J. A., & Bernacki, M. L. (2024). Unraveling Challenges with the Implementation of Universal Design for Learning: A Systematic Literature Review. Educational Psychology Review, 36(1). https://doi.org/10.1007/s10648-024-09860-7