International Journal of Modern Education IJMOE EISSN: 2637-0905
Volume 7 Issue 28 (December 2025) PP. 607-632
DOI: 10.35631/IJMOE.728044

INTERNATIONAL JOURNAL OF MODERN EDUCATION (IJMOE)
www.ijmoe.com

ASSESSING THE VALIDITY AND RELIABILITY OF THE NEEDS ANALYSIS INSTRUMENT FOR M-STEM MODULE'S DEVELOPMENT

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Article Info:

Article history:
Received date: 23.09.2025
Revised date: 20.10.2025
Accepted date: 17.11.2025
Published date: 10.12.2025

To cite this document:

Jahanadan, S., & Musa, M. (2025). Assessing The Validity and Reliability of the Needs Analysis Instrument For M-STEM Module's Development. *International Journal of Modern Education, 7* (28), 604-632.

DOI: 10.35631/IJMOE.728044

Abstract:

This study aims to assess the validity and reliability of the Needs Analysis Instruments for developing an M-STEM Module that focuses on problem-solving and learning motivation within the topic of measurement in primary mathematics education. The researcher developed separate need assessments for both pupils and teachers. The instruments were evaluated in terms of content validity, language validity, and reliability. A pilot study involving 36 teachers and 34 pupils was conducted to determine the reliability of the instrument, using SPSS Version 26.0 to calculate Cronbach's alpha. Results demonstrated a Cronbach's alpha of 0.947 for the teachers' questionnaire and 0.823 for the pupils' questionnaire, indicating that both instruments have acceptable reliability and content validity. These findings suggest that the instruments are suitable for use in the actual study to measure the targeted needs.

Keywords:

Need Analysis, Problem-Solving, Reliability, STEM Module, Validity

Introduction

The development of effective educational modules, particularly within specialized domains such as M-STEM, necessitates robust foundational research to accurately identify learner and instructional needs (Karpudewan et al., 2022). This foundational research often involves the

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meticulous design and validation of needs analysis instruments to ensure the collected data is both accurate and consistent (Shofiyah et al., 2021; V., 2018). The validity and reliability of these instruments are paramount, as they directly influence the quality and relevance of the subsequent module development (Villarino & Villarino, 2024). Therefore, this study aims to assess the validity and reliability of the needs analysis instrument specifically designed for the development of an M-STEM module, employing rigorous psychometric methods to ascertain its suitability for data collection.

This assessment will encompass content, construct, and criterion-related validity, alongside various reliability measures, to provide a comprehensive evaluation of the instrument's psychometric properties (Stefana et al., 2025). Such an evaluation is crucial to ensure that the instrument precisely captures the intended constructs, thereby providing a credible basis for addressing the identified educational requirement Furthermore, an instrument's reliability is essential to ensure (Butz & Branchaw, 2020; Greenwald et al., 2021) consistent measurements across repeated administrations or different evaluators, underpinning the dependability of the gathered insights (Lutfauziah et al., 2023). To achieve this, the research will utilize a multi-stage approach, incorporating expert validation during the planning phase to ensure content and construct alignment before proceeding with empirical testing (Mellyzar et al., 2024).

This comprehensive validation process is vital for ensuring the instrument accurately measures the intended constructs and consistently yields dependable data for informing M-STEM module development (Lia et al., 2020). The quality of the instrument used directly impacts the accuracy and reliability of the research, emphasizing the need for thorough testing and calibration to obtain valid data (Ni'mah et al., 2023; Subramaniam et al., 2022). One way to support such rigorous development is through the use of an instrument blueprint, which guides item creation and the collection of validity evidence (Menold et al., 2015). This systematic approach helps mitigate the risks associated with researcher bias or the uncritical adoption of items from existing instruments, particularly for emerging fields like engineering education where researchers may have limited experience with social science research best practice (Lin & Hess, 2022). For any study, the validity and reliability of data gathering instruments and methods are prerequisites, with acceptable levels generally set at a minimum of 0.5 (Dhlakama & Murairwa, 2024). This rigorous validation process ensures the instrument effectively measures the targeted constructs, providing a credible foundation for subsequent module development (Sondergeld & Johnson, 2019).

This emphasis on validity ensures that the data accurately represents the intended phenomena, while reliability guarantees that these measurements are consistent and reproducible under similar conditions (Ni'mah et al., 2023; Yulianti & Herpratiwi, 2024). Consequently, the present study will employ exploratory factor analysis and Cronbach's alpha to evaluate the instrument's item validity and reliability, respectively, after an initial pilot test . The pilot study, involving 30 students, allowed for initial refinement of the instrument by identifying and correcting issues in phrasing, arrangement, and comprehension of questions before the full-scale implementation (Akuba et al., 2021). This preliminary testing phase is critical for enhancing the instrument's clarity and ensuring that it effectively captures the nuanced needs of the target M-STEM audience (Halimoon et al., 2021). The subsequent analysis, drawing on data from a larger cohort, will then systematically evaluate the psychometric properties, including the instrument's factorial structure and internal consistency, using statistical software (Camacho-Tamayo & Bernal-Ballén, 2023). The findings from these analyses will critically

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EISSN: 2637-0905
Volume 7 Issue 28 (December 2025) PP. 607-632
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inform the refinement of the instrument, ensuring its fitness for purpose in accurately assessing needs for M-STEM module development (Chuan et al., 2025). This rigorous validation process ensures the instrument effectively measures the targeted constructs, providing a credible foundation for subsequent module development (Karim et al., 2025).

Experts in survey design often review original items to establish face validity, ensuring the instrument effectively captures the intended content (Henderson, 2021). Therefore, the initial phase of this research involves an expert review to refine the instrument's content and ensure alignment with the M-STEM domain (Menold et al., 2015). Following this, a pilot study will be conducted with a small sample size to assess the instrument's initial correctness, utilizing Exploratory Factor Analysis to consolidate variables and Cronbach's alpha to evaluate the face and content validity of items (Lawal et al., 2022). This methodical approach allows for the identification of underlying factor structures and the assessment of internal consistency, which are crucial for confirming the instrument's robustness for broader application in M-STEM educational contexts (Chik & Abdullah, 2018).

This comprehensive psychometric evaluation will ensure that the needs analysis instrument is a robust and dependable tool for informing the design and implementation of M-STEM educational interventions (Maric et al., 2023). Furthermore, the use of a 7-point Likert scale, adapted and modified for this instrument, contributes to a more nuanced response capture, aligning with best practices for psychometric assessment in educational research (Hasim et al., 2024). This scale, validated by experts in e-learning, has demonstrated robust factor loadings exceeding the 0.5 threshold and an excellent Kaiser-Meyer-Olkin measure, indicating its suitability for factor analysis (Hasim et al., 2024). The rigorous validation process for the instrument included an Index of Content Consistency method, where a panel of five experts, comprising specialists in educational technology, curriculum design, and information technology, evaluated the content to ensure its completeness and relevance, achieving an IOC value range of 0.67 to 1.00 (Sriwisathiyakun, 2024). These experts confirmed the face and content validity of the instrument, with their feedback forming the basis for qualitative analysis and subsequent revisions (Mashhadi et al., 2023). The instrument's structure, originally comprising 70 items across various constructs, underwent refinement through expert review and empirical validation, resulting in a more focused and psychometrically sound tool (Halim et al., 2023).

The comprehensive validation undertaken in this study underscores the pivotal role of a psychometrically sound needs analysis instrument as the backbone for developing an effective M-STEM module. Through the systematic integration of expert judgement, pilot testing, and rigorous statistical analyses, this research ensures that the instrument possesses strong evidential support in terms of validity, reliability, and construct precision. Such methodological thoroughness is essential, as the accuracy of any educational innovation is inherently dependent on the strength of the diagnostic measures that inform its design. By establishing a credible and empirically supported tool, this study not only enhances the fidelity and relevance of the forthcoming M-STEM module but also contributes meaningfully to the broader discourse on quality assurance in STEM-related educational research. Ultimately, this validated instrument will serve as a robust foundation for informing evidence-based pedagogical decisions, ensuring that the M-STEM module developed is contextually responsive, theoretically grounded, and capable of addressing persistent challenges in mathematics problem-solving, motivation, and instructional effectiveness. In doing so, the study advances the development of transformative learning interventions that align with contemporary educational demands and the evolving competencies required of 21st-century learners.

Literature Review
Needs analysis is a crucial initial phase in the systematic development of educational modules, serving to identify gaps between current and desired states of knowledge, skills, or resources (Anwar et al., 2021). This process is fundamental for informing the design and content of effective learning materials, such as the M-STEM module, by ensuring they address specific learner requirements and educational objectives (Ahmad et al., 2019). The accuracy of this identification hinges significantly on the validity and reliability of the instruments employed for data collection during the needs analysis phase (Aung et al., 2021). Rigorous instrument validation and reliability testing are therefore indispensable to ensure that the gathered data accurately reflect the actual needs of the target population, thereby underpinning the credibility and efficacy of the subsequent module development (Gengatharan et al., 2021). Specifically, developing and validating instruments like the Student Needs Assessment Scale are critical steps in ensuring contextualized and accurate measurement of student needs within particular educational settings (Benson & Clark, 1982).

This comprehensive approach ensures that the insights gleaned from the needs analysis are robust and directly applicable to tailoring educational interventions, such as the HyFlex learning modality or a Learning Management System (Ahmad et al., 2024; Sapitan, 2024; Villanueva & Caalim, 2024). Moreover, the application of models like the Rasch Model can further enhance the empirical evidence for validity and reliability, providing a robust statistical framework for instrument evaluation (Mohamad et al., 2015). For instance, employing the Rasch model allows for unidimensional analysis through principal component analysis to evaluate validity, while reliability can be ascertained through summary statistics, variable maps, and item fit tables (Hamzah et al., 2022). (Hamzah et al., 2022) This comprehensive statistical approach allows researchers to evaluate the internal consistency of the instrument and the consistency of student responses, thereby ensuring the quality and appropriateness of the assessment tool (Azizah et al., 2021).

Furthermore, instructional design models like ADDIE often guide the systematic construction and validation of educational modules, emphasizing the iterative nature of development and evaluation processes (Baraquia, 2024; Fajrin et al., 2023). Subsequent phases often involve the rigorous assessment of content validity, construct validity, and inter-rater reliability to ensure that the developed instrument precisely measures the intended constructs and yields consistent results across different administrations and evaluators (Bakar & Ismail, 2020). This meticulous approach ensures that the needs assessment instrument accurately captures the target population's requirements, moving beyond mere descriptive statistics to provide actionable insights for module development (Choi & Park, 2023).

In particular, developing culturally sensitive and locally validated psychometric tools, such as the Student Needs Assessment Scale in the Philippines, is essential for addressing the unique challenges associated with foreign-made psychological assessments (Benson & Clark, 1982; Sapitan, 2024). This often involves extensive statistical analyses, including exploratory and confirmatory factor analyses, to ensure the instrument's factorial structure aligns with theoretical constructs and effectively measures the intended attributes (Capinding, 2024; Gurjar & Bai, 2023). This rigorous psychometric validation process, encompassing both

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quantitative and qualitative methods, ensures that the evaluation scale is optimal for assessing curriculum implementation (Aquino, 2024). Such an approach ensures that the assessment tools are not only scientifically sound but also culturally appropriate and relevant to the specific educational context (Almazan et al., 2025).

The ADDIE model, encompassing Analysis, Design, Development, Implementation, and Evaluation, is frequently employed to guide the comprehensive development and validation of such instruments and modules, ensuring alignment with learner needs and instructional objectives (Alfan et al., 2025; Varga & Napoles, 2025). This systematic framework ensures that the resulting educational resources, such as the Matatag curriculum, are not only well-structured but also effectively implemented and evaluated for their impact on learning and development (Aquino, 2024; Varga & Napoles, 2025).

The integration of instructional design principles, usability considerations, and technology acceptance models within this framework can further optimize the development of self-directed modular learning systems, ensuring both pedagogical effectiveness and user engagement (Varga & Napoles, 2025). Specifically, instruments developed using the ADDIE model have demonstrated strong validity and reliability across various educational contexts, as evidenced by comprehensive testing involving large student cohorts and advanced statistical analyses such as those performed with IBM SPSS and LISREL (Astuti et al., 2023). These analyses typically involve rigorous examination of construct validity, content validity, and various reliability measures, including internal consistency and test-retest reliability, to ensure the instrument's robustness. This comprehensive methodological approach ensures the psychometric soundness of the assessment tools, which is paramount for generating dependable data that can effectively guide the development of educational interventions(Borsa et al., 2012; Mikkonen et al., 2022)Furthermore, advanced statistical techniques such as Confirmatory Factor Analysis are often utilized to validate the construct of the needs analysis instrument, ensuring it accurately measures the intended theoretical dimensions (Lamm et al., 2020; Suraiya et al., 2020).

In conclusion, the reviewed studies consistently highlight that rigorous needs analysis and validation processes are essential for the effective development of educational modules. Instruments that are psychometrically robust, contextually appropriate, and systematically validated ensure that the identified learner and instructional needs are accurate and actionable. The integration of advanced statistical techniques, instructional design frameworks such as ADDIE, and culturally sensitive approaches provides a strong foundation for designing and implementing educational interventions, including the M-STEM module. This approach not only enhances the credibility and reliability of the assessment tools but also ensures that subsequent educational resources are pedagogically effective, relevant to the target population, and capable of improving learning outcomes across diverse educational contexts.

Methodology

Design and Structure of the Need Analysis Questionnaire for Teachers

The questionnaire consists of four sections: demographic data, awareness of the STEM approach, the need for a STEM module, and elements within the module. To ensure language validity, three language experts from different fields reviewed the instrument, aiming to

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 7 Issue 28 (December 2025) PP. 607-632
DOI: 10.35631/IJMOE.728044
improve the language standards for both the teacher and pupil versions of the Need Analysis Questionnaire.

Three experts conducted language validation of the instrument. In this section, most questions use a five-point Likert scale, and one question requires respondents to tick the skills that they feel their pupils often struggle with, based on the Likert scale, which ranges from 1 (strongly disagree) to 5 (strongly agree). Subsequently, the fourth part consists of the content that should be included in the STEM Module.

The questionnaire for Dual Language Program (DLP) teachers, adapted from Foo, Abdullah, Adenan and Hoong (2021), Abdullah et al. (2017) and Puspitasari, Herlina and Suyatna (2020), comprises four sections and was developed using three distinct instruments. Note that the questionnaires were permitted to be used by the original authors, as written permission was acquired before adopting the questionnaires, as presented in Table 1.

Table 1: Dimensions of the Questionnaire

Dimension	Reference	Number of items
Demography	(Foo et al., 2021)	7
Awareness of the STEM Approach	(Abdullah et al., 2017)	6
Need for a STEM Module	(Foo et al., 2021)	8
Module Content	(Puspitasari et al., 2020)	13

The questionnaire consists of four parts: demographic data, awareness of the STEM Approach, the need for a STEM Module, and elements of a STEM Module. At the beginning of the questionnaire, the researcher collects general information, including email address, name, gender, age, school type, teaching experience, experience in teaching DLP, and grade level. On the other hand, the second part consists of questionnaires designed to gather information about teachers' awareness of the STEM Approach, and the third part consists of questions assessing the proposed module's needs. In this section, most questions use a five-point Likert scale, and one question requires respondents to tick the skills that they feel their pupils often struggle with, based on the Likert scale, which ranges from 1 (strongly disagree) to 5 (strongly agree). Subsequently, the fourth part comprises the content that should be included in the STEM Module.

Design and Structure of the Need Analysis Questionnaire for Pupils

The questionnaire is designed for Year 4 DLP pupils and consists of two parts, developed by adapting two instruments from Leong, Raja Maamor Shah and Mohd Idrus (2020) and Widiyanto, Herlina and Andra (2021). In this study, written permission has been obtained from the corresponding authors. Table 2 illustrates the dimensions of the questionnaire employed in the instrument for pupils. The questionnaire consists of two parts: demographic data and questions designed to identify the problems faced by the pupils. At the beginning of the questionnaire, the researcher collects general information, such as name, gender, and the type of school. Meanwhile, the second part consists of questions designed to gather information about the problems that pupils may face regarding the topic of measurement. In this section, all ten questions are five-point Likert scale questions, with a scale ranging from 1 (strongly disagree) to 5 (strongly agree).

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Table 2: Dimensions of the Questionnaire

Dimension	Reference	Number of items
Demography	(Leong et al., 2020)	3
The Problems Faced by Pupils	(Leong et al., 2020; Widiyanto et al., 2021)	5

The questionnaire consists of two parts: demographic data and questions designed to identify the problems faced by the pupils. At the beginning of the questionnaire, the researcher collects general information, including name, gender, and the type of school. The second part comprises questions aimed at gathering information regarding the pupils' problems related to the measurement topic.

Expert Selection and Validation Process

The researcher has chosen to conduct both language and content validity, which are important elements in ensuring that the instrument accurately reflects the constructs it is intended to measure and is suitable for the target respondents (Leong & Shah, 2023). If one expert is impartial and possesses a superior understanding of the whole subject of interest, this expert should be able to offer all the required quantitative data. Nevertheless, it is unlikely that such an "ideal" expert exists, especially if the area of interest is multidisciplinary or broad (Van Der Fels-Klerx, Goossens, Saatkamp, & Horst, 2002). Additionally, expert selection can be either heterogeneous or homogeneous, with each approach having its advantages. Since a multidisciplinary field of study typically employs a heterogeneous expert panel, the researcher has selected a heterogeneous expert panel (Van Der Fels-Klerx et al., 2002). It is also vital to determine the subject matter professionals, as approximately 5 to 7 years are needed for teachers to develop the high skill levels needed to be regarded as experts (Berliner, 2004).

Consequently, prior to being employed in the actual data collection, all instruments were evaluated by six experts with a cumulative total of more than seven years of work experience, as illustrated in Table 3. Three experts will be employed for language validation, while three more will be used for content validation. The selection of experts follows recommendations by Lynn (1986), Polit and Beck (2006) and Polit, Beck and Owen (2007), who suggest that at least three experts are required to assess content validity. Furthermore, the scholar identified the relevant panel of experts for the instrument validation and obtained their consent to participate in the validation process (Rejeki, Adnan, Ahmad, & Murtiyasa, 2025). The panel of experts was selected based on the various aspects of the instrument and its intended use. To ensure that human subjects were treated fairly and ethically, the researcher obtained permission to conduct the study through the Educational Research Application System (ERAS) 2.0.

Moreover, an official letter accompanied the instruments to request expert evaluation. Following language validation, the scholar implements the required adjustment. The scholar consults experts to calculate the Content Validity Index (CVI). The validation process involved three Mathematics education experts who were selected. The experts who participated in the language validation process are profiled in Table 3 below.

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Table 3: Language and Content Validation Experts' Profile

	Expert	Role	Profile	Experience
Language validation experts	E1	IPG English Lecturer	Pensyarah Cemerlang	16 years
	E2	IPG English Lecturer	Lecturer	19 years
	E3	Primary School Teacher	Guru Cemerlang DG48	26 years
Content validation experts	E4	SISC+ Mathematics	Writer of the KSSR Mathematics Year 4 Textbook	16 years
	E5	Senior Assistant for Co-Curriculum, National Head Coach of Mathematics	Selangor State Teacher Icon, Former Excellent Mathematics Teacher DG32, DG34	10 years
	E6	Primary School Teacher	Jurulatih Utama Negeri KSSR Year 4	9 years

Experts performed the CVI calculation since validation was the subsequent step in the procedure (Lynn, 1986). Notably, there are two types of CVI: the Item-Level Content Validity Index (I-CVI) and the Scale- Level Content Validity Index (S-CVI). The CVI of an item is calculated by dividing the total number of experts by the number of experts who score the item a three or four. Provided that there are five or fewer experts, they should all agree that the content is valid. As a result, the recommended CVI value for three experts should be 1 (Lynn, 1986; Polit & Beck, 2006). However, a range of 0.80 to 1.00 is also acceptable (Rubio et al., 2003). To assess the content relevance of the items on an instrument, this computation is essential. To revalidate, items with a CVI value less than 1 will either be deleted or modified. According to Yusoff (2019), validation forms and calculation tables for I-CVI, as well as S-CVI, were developed.

An instrument's reliability is the degree to which an instrument continuously evaluates what it is supposed to. A pilot study was performed with 36 teachers and 34 pupils to establish the reliability of the instruments. Additionally, the sample was chosen following Creswell's (2014) suggestion that the study requires a minimum sample size of 30. The reliability of the instrument was demonstrated using Cronbach's alpha. Furthermore, according to Chua (2020), Cronbach's alpha values of 0.65 to 0.95 are adequate. When the coefficient is below 0.65, the instrument's capacity to measure the variable is poor. When it is greater than 0.95, it indicates that the questionnaire has items that are comparable or overlap. Conversely, Fraenkel, Wallen and Hyun (2012) stated that reliability must be at a minimum of 0.70 and preferably higher.

Results and Discussion

Language Validation

Language Validation for Teacher's Needs Analysis Questionnaire

Three experts conducted language validation of the instrument. Table 4 below summarizes their agreement. The instrument fulfilled all language validation requirements.

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Table 4: The Score by Language Experts

No	Criteria	Average Score	Criteria
1.	The given instructions are clear and precise.	100%	Very good
2.	The language used is easy to understand.	100%	Very good
3.	Proper grammar and spelling are utilized.	100%	Very good
4.	The terms are used consistently.	100%	Very good
5.	The words used are relevant and familiar to the respondent.	100%	Very good

The findings of the expert language validation indicate that the instrument developed is highly suitable for its intended use. As presented in Table 4, the average score per criterion, as evaluated by the language specialists, was 100%, with all items receiving a rating of "Very Good." The experts agreed that the instructions presented in the instrument are precise and clear, allowing respondents to accomplish them easily. They also ensured that the language employed is clear and easy to understand, with correct grammar and spelling consistently used in the instrument. Moreover, the terms are consistently used, and the words are appropriate and known to the target respondents, making it evident and reducing confusion.

These results confirm the linguistic soundness of the instrument, making it well-prepared for subsequent content validation. Precise and unambiguous language is crucial in survey tools targeting educators, as it ensures the proper interpretation of questions and credible responses (Widiyanto et al., 2021). When instructions are clear and the language is professional yet not overly complex, it reduces respondent error and enhances the likelihood of collecting valid data (Wang et al., 2022). The standard application of words and proper grammar throughout the survey adheres to the criteria outlined by Foo et al. (2021), which underscore the importance of linguistic consistency and term familiarity in enhancing comprehension and minimizing potential misinterpretation, particularly when using needs analysis tools for educational stakeholders. In addition, Zebua et al. (2022) argued that properly validated tools foster greater motivation and participation among respondents, as the use of precise language creates confidence and readiness to provide well-considered responses. Aligning with these observations, the validated language in the Teacher's Needs Analysis Questionnaire ensures that it captures accurate and relevant information effectively, providing a solid foundation for further reliability testing and future use in the formulation of targeted M-STEM education interventions.

Language Validation for Student's Needs Analysis Questionnaire

The expert validation results for the language quality of the Student's Needs Analysis Questionnaire indicate a perfect score of 100% across all evaluated criteria, which were rated as "Very Good." This assessment confirms that the questionnaire meets high linguistic standards, ensuring clarity, accuracy, and accessibility for respondents.

Table 5: Summary of Experts' Validation

No	Criteria	Average Score	Criteria
1.	The given instructions are clear and precise.	100%	Very good
2.	The language used is easy to understand.	100%	Very good
3.	Proper grammar and spelling are utilized.	100%	Very good
4.	The terms are used consistently.	100%	Very good
5.	The words used are relevant and familiar to the respondent.	100%	Very good

Firstly, the given instructions appeared to be clear and precise, meaning they effectively guide respondents without confusing them. Well-structured instructions are crucial for smooth navigation and accurate data collection, ensuring that students understand how to complete the questionnaire correctly. Additionally, the language used throughout the questionnaire was deemed easy to understand. This indicates that the wording and sentence structures are simple and accessible, allowing students to interpret the questions effortlessly, reducing the risk of misinterpretation.

The experts also confirmed that proper grammar and spelling were utilized, reflecting the questionnaire's linguistic accuracy and professionalism. The absence of grammatical or spelling errors ensures clarity and maintains the intended meaning of the questions. Moreover, the terms used within the questionnaire demonstrated consistency. This uniformity eliminates potential confusion by ensuring that key terms remain the same throughout, making it easier for respondents to recognize and understand them across different sections.

Finally, the experts agreed that the vocabulary used is relevant and familiar to the respondents. This means that the questionnaire avoids complex or technical jargon, making it accessible and engaging for students. The use of familiar words ensures that respondents can easily relate to the questions, enhancing their ability to provide accurate responses.

Overall, the validation results confirm that the questionnaire is well-designed from a linguistic perspective, guaranteeing clarity, coherence, and ease of comprehension. The perfect scores across all criteria suggest that the questionnaire is suitable for use without concerns about language-related barriers affecting response accuracy or reliability.

Proper grammar, spelling, and standardized terminology contribute to the overall validity and reliability of the instrument. As Widiyanto et al. (2021) emphasized, clear and well-structured language in educational materials, particularly those used in project-based learning modules, is essential for fostering problem-solving skills and improving learning outcomes. The questionnaire's adherence to these linguistic principles ensures that respondents can engage with the content effectively, minimizing ambiguity and enhancing comprehension. Furthermore, the 100% agreement among experts on the suitability of language affirms the instrument's alignment with best practices in research design. According to Foo et al. (2021), expert validation in needs analysis enhances the applicability of an instrument by ensuring it addresses the genuine needs of its target audience, thereby making it more impactful in practical educational settings.

Additionally, the use of consistent terminology and accessible vocabulary ensures uniform understanding among respondents, preventing potential misinterpretations that could compromise data accuracy. Zebua et al. (2022) demonstrated the importance of linguistic precision in instructional materials, particularly in STEM education, where conceptual clarity is crucial to prevent misconceptions that can hinder student learning. The questionnaire's perfect validation score thus confirms its readiness for deployment, ensuring high standards of readability, clarity, and applicability. This linguistic robustness enhances the instrument's effectiveness in capturing accurate insights from students while maintaining the integrity of the research process.

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Content Validation

Content Validation for Teacher's Needs Analysis Questionnaire

The researcher then proceeded to content validation, as the instrument had already met all language validation criteria.

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Table 6: The Relevance Ratings on the Item Scale by Three Experts

Construct	No.	Item	Expert A	Expert B	Expert C	Experts in Agreement	I- CVI	UA
Awareness of STEM Approach.	1.	I am aware of the introduction of the STEM Approach in Revised KSSR 2017.	1	1	1	3	1	1
	2.	I understand the teachers' role in implementing STEM Approach lessons in Mathematics.	1	1	1	3	1	1
	3.	STEM Approach is important in Mathematics Problem Solving.	1	1	1	3	1	1
	4.	I implement the STEM Approach in my T&L, which involves applying STEM practices to solve problems in the context of daily life.	1	1	1	3	1	1
	5.	I am aware that STEM Approach teaching is in line with PPPM 2013- 2025.	1	1	1	3	1	1
	6.	I am ready to use multiple strategies to encourage learning through the STEM Approach.	1	1	1	3	1	1
The need for a STEM Module for the topic of Measurement	7.	I often use the STEM Approach in my Mathematics classroom for Measurement topics.	1	1	1	3	1	1
	8.	I need a proper teaching module to improve my pupils' problem-solving skills on the topic of measurement.	1	1	1	3	1	1

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Construct	No.	Item	Expert A	Expert B	Expert C	Experts in Agreement	I-CVI	UA
	9.	I need a proper teaching module that could improve my pupils' learning motivation on the topic of measurement.	1	1	1	3	1	1
	10.	I am interested in carrying out STEM Approach teaching if proper guidance is provided.	1	1	1	3	1	1
	11.	Teachers should be provided with complete teaching materials to teach using STEM Approach, e.g., teaching aids, worksheets, and modules.	1	1	1	3	1	1
	12.	I think that there is a need to develop a STEM Module to improve Year 4 pupils' problem- solving skills and learning motivation in the topic of measurement.	1	1	1	3	1	1
	13.	If there is a STEM Approach Module for the topic of measurement, I will use it in my classroom.	1	1	1	3	1	1
	14.	Please select the Mathematics Skills that your pupils often struggle with. • Mathematics skills • Analyzing skills • Problem-solving skills • Research skills • Communication skills • Information Communication Technology skills	1	1	1	3	1	1
Module Content	15.	STEM Module should contain a step-by-step guide and instructions to utilize the module effectively.	1	1	1	3	1	1
	16.	STEM Module should include a brief introduction and history of the STEM Approach.	1	1	1	3	1	1
	17.	STEM Module should include video elements to ease pupils'understanding.	1	1	1	3	1	1

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Construct	No.	Item	Expert A	Expert B	Expert C	Experts in Agreement	I- CVI	UA
	18.	Resources from the internet should be used in the STEM Module.	1	1	1	3	1	1
	19.	STEM Module should use colorful graphic elements to capture pupils' interest.	1	1	1	3	1	1
	20.	The STEM Module should be available to access via soft copy and hard copy, e.g., Printed Module, Online Module via App or Web.	1	1	1	3	1	1
	21.	STEM Module activities should be interesting to grab pupils' attention.				3	1	1
	22.	STEM Module lessons should be based on problems from the real-world context and relevant to pupils.	1	1	1	3	1	1
	23.	STEM Module should consist of hands-on, minds-on activities to boost pupils' confidence and satisfaction.	1	1	1	3	1	1
	24.	Multiple teaching strategies should be incorporated into the STEM Module.	1	1	1	3	1	1
	25.	The printed STEM Module should be attractive.	1	1	1	3	1	1
	26.	Learning outcomes and objectives should be clearly stated in the STEM Module.	1	1	1	3	1	1
	27.	STEM Module should use clear, effective, and unambiguous language.	1	1	1	3	1	1
						S-CVI/Ave	1	
Proportion relevance			1	1	1	S-CVI/UA		1
			The items' average proportion was judged as relevant across the three experts		1			

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Content validation plays a crucial role in ensuring that an instrument accurately reflects the construct it is intended to measure. One of the widely accepted quantitative methods for evaluating content validity is the CVI, which assesses the relevance of each item within the instrument. The CVI is categorized into two primary levels: I-CVI and S-CVI. The I-CVI measures the proportion of experts who rate a specific item as relevant, with an acceptable threshold typically set at 0.78 or higher. On the other hand, the S-CVI provides an overall assessment of content validity for the entire instrument and can be computed in two ways. The first S-CVI/Universal Agreement (S-CVI/UA) indicates the proportion of items that all experts unanimously consider relevant, while S-CVI/Average (S-CVI/Ave) represents the average of the I-CVI values across all items. A well-validated instrument should achieve an S-CVI/UA of at least 0.80 and an S- CVI/Ave of 0.90 or higher to be deemed suitable for research and practical application. These benchmarks align with the recommendations provided by Polit et al. (2007), who emphasized the necessity of a rigorous validation process to ensure the reliability and accuracy of research instruments.

After the success of language validation, content validation was conducted to ascertain the relevance and suitability of items on the Teacher's Needs Analysis Questionnaire for the development of the M-STEM Module. Content validation plays a crucial role in developing educational tools, as it determines whether the items effectively measure the construct under scrutiny (Yusoff, 2019). In the present research, three STEM education experts were hired to review the items of the questionnaire for relevance. As evident from Table 6, each item was rated as perfectly relevant by each expert, and the I-CVI was 1.00 for all items, while the overall S-CVI/Ave was also 1.00. This unanimity confirms high content validity, implying that the items in the questionnaire are highly representative and applicable to the constructs they intend to assess. The outcomes of this validation exercise align with good practice in instrument development, as noted by Yusoff (2019), who emphasized the importance of seeking expert consensus to enhance the content validity of an instrument.

A well-validated instrument ensures the relevance of the items' scale and enhances the reliability and validity of the data gathered, strengthening the credibility of the resulting research findings. As demonstrated by Varatharajoo and Setambah (2023), carefully designed and statistically validated instruments are crucial for producing credible and reliable findings in educational research. Moreover, the construction of this Needs Analysis Questionnaire aligns with the work of Guntur et al. (2023), who advocated for a stringent didactical design in STEM education to facilitate students' learning pathways in problem-solving. Their research emphasized the need to develop organized and relevant instructional materials that address the needs of both teachers and students. Here, the validated items of the questionnaire concern determining teachers' knowledge of the STEM approach, the need for STEM-based modules in teaching mathematics (particularly measurement subjects), and the essential elements required in a STEM module to enable effective teaching and learning strategies. Hasanah et al. (2019) demonstrated that the inclusion of Science, Environment, Technology, and Society (SETS) oriented learning approaches significantly enhances students' higher-order thinking abilities.

Likewise, the validated items here focus on the necessity for modules that blend STEM approaches, which can promote critical thinking, motivation, and student involvement. Lastly, Mulyani et al. (2020) presented the relationship between students' mathematics self-efficacy and motivation, validating the inclusion of module features that are intended to foster

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confidence through hands-on and minds-on experiences. The agreement among the experts validates that the items in the questionnaire thoroughly address these pedagogical requirements, further establishing the content validity of the instrument.

Content Validation for Students' Needs Analysis Questionnaire

Since the instrument met all the requirements for language validation, the researcher proceeded to content validation.

Table 7: The Relevance Ratings on the Item Scale by Three Experts

No.	Item	Expert A	Expert B	Expert C	Experts in Agreement	I-CVI	UA
1.	I like Mathematics lessons.	1	1	1	3	1	1
2.	I consider Mathematics lessons tough and boring.	1	1	1	3	1	1
3.	I have trouble when solving problems in questions involving Measurements.	1	1	1	3	1	1
4.	I have trouble using formulas in problem-solving questions involving Measurements.	1	1	1	3	1	1
5.	I have trouble analyzing graphics and pictures in questions involving Measurements.	1	1	1	3	1	1
6.	I have trouble implementing what I have learned in Measurement.	1	1	1	3	1	1
7.	I can relate the concepts I have learned to answer problem-solving questions involving Measurement.	1	1	1	3	1	1
8.	I can apply what I learned when answering problem-solving questions involving Measurement.	1	1	1	3	1	1
9.	I am confident when solving problems involving Measurement.	1	1	1	3	1	1
10.	I can recall the formulas and concepts when answering problem-solving questions involving Measurements.	1	1	1	3	1	1
					S-CVI/Ave	1	
	Proportion Relevance	1	1	1	**S-CVI/UA**		1
	The items' average proportion was judged as relevant across the three experts				**1**		

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After the language validation, the subsequent vital step taken by the researcher was content validation of the Student's Needs Analysis Questionnaire. Content validation is crucial to ensure that every item on the instrument accurately measures the intended constructs and is relevant to the research purpose (Yusoff, 2019). This procedure was conducted through a systematic review by three experts in the relevant fields of STEM education and elementary mathematics pedagogy. All ten questionnaire items were rated by three experts (Experts A, B, and C) as indicated by Table 7. They scored each item with its relevance to the students' needs analysis regarding learning topics in measurement mathematics. The experts scored each item on a dichotomous scale, with a value of "1" indicating relevance and "0" indicating irrelevance. The results were such that all items obtained total agreement among the three experts, as evidenced by an I-CVI score of 1.00 for all items, indicating that all experts rated all items as highly relevant. In addition, the S- CVI/Ave and the S-CVI/UA among Experts both recorded a perfect score of 1.00, demonstrating complete agreement that all questionnaire items were relevant.

The complete agreement among the experts indicates the questionnaire's high content validity. The result aligns with existing research on the development of educational instruments. For instance, Yusoff (2019) highlighted that high I-CVI and S-CVI/UA are the determinants of a well-validated measure, which contributes to more valid data collection. A validated questionnaire would ensure that the data gathered from students accurately captures their perceptions, challenges, and sentiments towards mathematics and measurements, which are central to crafting focused interventions such as the M-STEM Module. The findings underscore the importance of expert review for content validation. Guntur et al. (2023) emphasized the importance of expert and teacher input in designing instructional materials to make them suitable for students' needs and levels of cognition, in their didactical design study. Likewise, Hasanah et al. (2019) demonstrated that incorporating expert validation into the design of SETS-based learning tools resulted in notable enhancements in students' higher-order thinking abilities, underscoring the importance of validated instruments in maximizing learning outcomes.

Mulyani et al. (2020) revealed that motivation and self-efficacy play a crucial role in students' mathematics performance. Ensuring that items measuring confidence, recalling formulas, and applying concepts learned are included in the Student Needs Analysis Questionnaire guarantees that these are measured effectively. Validating these items ensures that the questionnaire can effectively measure students' motivational levels and confidence in problem-solving, providing critical information to help develop the M-STEM Module and address specific learning gaps. The high I-CVI and S-CVI ratings for the Student's Needs Analysis Questionnaire prove its excellent content validity. The use of expert reviews enhances the credibility of the instrument and ensures the relevance and clarity of the items. This validation process is crucial in ensuring that the analysis of needs accurately captures student learning problems, which will serve as the basis for creating effective learning modules based on STEM, intended to develop problem- solving capacities and motivation in the subject of measurement.

Reliability

Teacher's Questionnaire Reliability

The most commonly utilized methodology to determine reliability when a questionnaire contains multiple Likert questions is Cronbach's alpha (Yahya, Md Said, & Mohd Yusof,

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2021). The value indicates that the instrument's level of reliability is satisfactory and exceeds 0.7. In order to achieve the purpose, the instrument must be able to measure what it is intended to measure. The reliability of the instrument was represented using Cronbach's alpha coefficient. According to Chua (2020), Cronbach's alpha values of 0.65 to 0.95 are satisfactory. A coefficient value of less than 0.65 indicates that the instrument's ability to measure the variable is low, while a coefficient above 0.95 suggests that there are overlapping or similar items on the questionnaire. The researcher ran the analysis in SPSS Version 26 and obtained a Cronbach's alpha coefficient value of 0.947. The value indicates that the instrument demonstrates a satisfactory level of reliability. The value also meets the criteria of Fraenkel et al. (2012), which require reliability to be at least 0.70 and preferably higher. Therefore, the instrument should be able to measure what it intends to measure to obtain the objective.

Table 8: Cronbach's alpha

Dimension	Cronbach's alpha	Number of items
Awareness of the STEM Approach	0.900	6
Need for a STEM Module	0.842	8
Module Content	0.959	13
Total	0.947	27

The scores are significantly higher, especially for the "Module Content" scale, indicating that the questions are well understood by the respondents and interpreted consistently. This is significant, as Widiyanto et al. (2021) suggested that educational needs analysis instruments must be both valid and reliable to ensure accurate reflection of educators' classroom requirements. An unreliable instrument compromises data integrity, making it difficult to draw valid conclusions for curriculum development and module design. Wang et al. (2022) also emphasized that valid assessment measures are crucial for developing effective STEM programs that effectively address the challenges and opportunities teachers encounter in practice. Additionally, the high reliability scores support the previous findings on language validation. Simultaneously, they demonstrate that the questionnaire is easy to read and understand, yielding consistent information regardless of who fills it out. As Foo et al. (2021) explained, consistency in the terminology and language of a questionnaire helps respondents stay on track and provides more reliable answers. This is especially applicable in the field of STEM education, where instructors should be assured that the questions represent their experience and reality (Zebua et al., 2022).

Pupil's Questionnaire Reliability

After establishing the content validity, the researcher then assesses the instrument's reliability. Consequently, the researcher ran the analysis in SPSS Version 26 and got a Cronbach's alpha coefficient value of 0.823.

Table 9: Cronbach's alpha

Dimension	Cronbach's alpha	Number of items
The Problems Faced by Pupils	0.823	10

The value indicates that the instrument is within a satisfactory level of reliability, which is greater than 0.70. Thus, the instrument should be able to measure what it intends to measure to obtain the objective. The reliability test of the Pupil's Needs Analysis Questionnaire, where Cronbach's alpha is 0.823, reflects a high internal consistency. Widiyanto et al. (2021) stated that a Cronbach's alpha of more than 0.70 is acceptable, indicating that the instrument consistently measures the intended construct in this instance, which is the problems faced by pupils. Accurate instruments are essential in determining students' needs, which in turn directly guide effective intervention measures. Note that high reliability also ensures that data is collected consistently, allowing teachers to craft STEM modules that address genuine challenges, which ultimately enhances pupils' learning and engagement (Zebua et al., 2022).

Conclusion

In the Malaysian context, the development of educational modules such as the M-STEM module similarly requires rigorous validation to ensure their relevance, reliability, and effectiveness in local classrooms. Malaysia's initiatives in STEM education, including MySTEM, Kurikulum Standard Sekolah Rendah (KSSR), and integrated STEM interventions, emphasize the importance of using validated instruments to inform module development. Validated tools not only enhance the quality of instructional materials but also ensure they meet the specific needs of Malaysian learners, foster higher-order thinking, problem-solving skills, and motivation, and align with national educational objectives. Consequently, the systematic validation of needs analysis instruments is not merely a procedural requirement; it is a critical determinant of the success and impact of educational innovations (Aquino, 2024; Prado & Asparin, 2025; Cruz & Bustoba, 2022; Shakeel et al., 2022; Ene et al., 2020; Hasim et al., 2024; Khojasteh et al., 2025; Gundín & Ramón, 2023). By ensuring the instruments are psychometrically robust and contextually appropriate, Malaysian educators and researchers can develop evidence-based M-STEM modules that are pedagogically sound, culturally relevant, and capable of significantly enhancing student learning outcomes in STEM disciplines.

Recommendations

This study has demonstrated a structured approach to validating and evaluating the reliability of needs analysis instruments for developing a STEM module focused on problem-solving in mathematics education. These instruments, which have been proven valid and reliable, can serve as a foundation for future educational research and practice. It is recommended that future studies explore the practical implementation of the M-STEM module in classrooms and assess its impact on pupils' problem-solving skills and learning motivation. Additionally, research can be extended to other mathematics topics or year levels to ensure broader applicability across the curriculum. In the Malaysian context, integrating these validated instruments into curriculum planning may support more data-driven and targeted interventions in STEM education.

Acknowledgement

I would like to express my sincere gratitude to **Dr. Muzirah Musa** for her invaluable guidance and support throughout the course of this study. Her insightful feedback and encouragement have greatly contributed to the development of this research. I am also thankful to the experts who assisted in validating the instruments, as well as the teachers and pupils who participated in the pilot study for their cooperation and commitment

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