Needs Analysis for the Development of a STEM Training Module for the Topic of Functions: A Survey of the Difficulty Level of Additional Mathematics Topics Among Form Four Students

Raja Lailatul Zuraida binti Raja Maamor Shah*, Raja Noor Farah Azura binti Raja Maamor Shah, Fainida binti Rahmat, Siti Anis binti Ab. Rahman

Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia

DOI: https://doi.org/10.47772/IJRISS.2026.100601184

Received: 25 June 2026; Accepted: 30 June 2026; Published: 14 July 2026

ABSTRACT

Needs analysis is a critical preliminary step in the development of teaching and learning modules. This study aims to identify the difficulty level of topics and subtopics in the Form Four Additional Mathematics subject as a basis for justifying the development of a STEM Training Module for the topic of Functions. This survey study involved 150 Form Four science-stream students from three ordinary daily secondary schools in the district of Kota Bharu, Kelantan. The instrument used was the "Difficult Topics in the Form Four Additional Mathematics Syllabus" questionnaire, which measured students' perceptions of difficulty through a five-point Likert scale (1 = Very Difficult to 5 = Very Easy). The data were analysed descriptively using mean values. At the topic level, the findings show that Indices and Logarithms (mean = 2.24) and Differentiation (mean = 2.33) were perceived as the most difficult, while the topic of Functions was at a moderate level (mean = 2.78). However, analysis at the subtopic level revealed that Inverse Functions (mean = 1.97) was the most difficult subtopic in the entire syllabus, followed by the subtopic of Composite Functions (mean = 2.23). These findings demonstrate that measuring difficulty in aggregate at the topic level can mask the actual difficulty at the subtopic level. Therefore, there is a clear need to develop a training module that gives specific focus to the subtopics of Inverse Functions, Composite Functions and Quadratic Functions with the support of technological visualisation. This study contributes empirical justification for the development of a STEM Training Module and supports the practice of subtopic-level needs analysis in curriculum design.

Keywords: needs analysis, STEM Training Module, topic of Functions, Additional Mathematics, difficulty level

INTRODUCTION

Science, Technology, Engineering and Mathematics (STEM) education requires students not only to master knowledge but also to apply it in real-world contexts and to solve problems creatively (Ziatdinov & Valles, 2022). In efforts to strengthen STEM education, the integration of technology is increasingly emphasised, including the use of dynamic mathematics software and emerging technologies such as Augmented Reality, which are seen as having great potential in STEM learning (Hidayat & Wardat, 2023). The subject of Additional Mathematics plays an important role in this landscape because it serves as preparation for science-stream students before they pursue studies in STEM-related fields.

One of the core topics in Form Four Additional Mathematics is Functions, which forms the foundation for mastering more advanced topics. However, the topic of Functions is often perceived as difficult because of its abstract nature, particularly when students need to understand concepts in graphical form (Shahrul, Nasir & Suryadi, 2024). The development of an effective teaching module must begin with a careful needs analysis to ensure that the module being developed genuinely targets the real needs of students (Abdul Rahim, 2021; Ramli & Mohd Tajudin, 2021). Accordingly, this paper reports the findings of a needs analysis conducted to identify the difficulty level of topics and subtopics in Form Four Additional Mathematics as empirical justification for the development of a STEM Training Module focusing on the topic of Functions.

LITERATURE REVIEW

STEM Education and The Need for Teaching Materials

The integration of the STEM approach into mathematics education is seen to be effective when supported by suitable teaching materials, including the use of technology to visualise abstract concepts (Ziatdinov & Valles, 2022). Nevertheless, one of the main obstacles to STEM implementation is the lack of quality teaching materials and modules. The study by Abdul Rahim (2021) found that teachers were still dissatisfied with existing teaching aids and mathematics software, and therefore required new modules that met their needs. This situation indicates the need to develop more STEM-based teaching materials that are built systematically.

The Importance and Challenges of Learning the Topic of Functions

The topic of Functions is the first topic in the Form Four Additional Mathematics syllabus and is directly related to the topic of Quadratic Functions. Although important, the concept of Functions is often perceived as difficult because of its abstract nature. A content analysis of textbooks by Shahrul, Nasir and Suryadi (2024) found that there were tasks in the topic of Function Graphs that were incomplete in terms of technique and theory, which could potentially impair students' comprehensive understanding. This difficulty stems largely from a lack of visual representation during the learning process.

It is this need for visual support that provides the rationale for integrating technology into module development. A systematic literature review shows that dynamic software such as GeoGebra has the potential to support the learning of mathematics and STEM topics by enabling students to explore concepts through multiple representations (Hamzah & Hidayat, 2022; Ziatdinov & Valles, 2022). Representations in two- and three-dimensional form can enhance students' ability to visualise and understand abstract mathematical problems.

Needs Analysis in Module Development

Needs analysis is a fundamental step in module development because it determines whether there is a genuine need to develop a module and helps establish the focus of its content. In the context of mathematics education in Malaysia, this approach has been widely applied. Ramli and Mohd Tajudin (2021) conducted a needs analysis as a preliminary step in developing a mathematics learning module for Form Four students based on the Sidek Module Development Model. Similarly, Abdul Rahim (2021) used needs analysis to identify the specifications of a teaching module for a topic in the Algebra domain. These studies indicate that a careful needs analysis is an important prerequisite before any module draft is developed.

Problem Statement

Topics related to Functions and the Algebra domain are often identified as among the most difficult for Form Four students to master (Abdul Rahim, 2021; Shahrul, Nasir & Suryadi, 2024). Given that Functions is a fundamental concept for higher-level topics, weakness in this topic will impair students' mastery at subsequent levels. However, much of the effort in developing mathematics modules is carried out without first identifying the subtopics that students genuinely find difficult to master. Most surveys of topic difficulty are reported at the topic level in aggregate. This approach risks masking the actual difficulty because the difficulty level of each subtopic varies. A topic perceived as moderate overall may contain subtopics that are very difficult. Without difficulty data at the subtopic level, module developers cannot accurately determine the content focus of a module. Therefore, there is a need to conduct a more detailed needs analysis that examines difficulty levels not only at the topic level but also at the subtopic level, to ensure that the module developed genuinely targets the real needs of students.

Research Objectives and Questions

This needs analysis study was conducted to achieve the following two objectives:

- To identify the difficulty level of Form Four Additional Mathematics topics among science-stream students.

- To identify the difficulty level of Form Four Additional Mathematics subtopics, particularly the subtopics of the topic of Functions, as a basis for determining the focus of the STEM Training Module development.

Based on these objectives, this study was guided by the following research questions: (i) What is the difficulty level of Form Four Additional Mathematics topics among students? and (ii) Which subtopics are the most difficult for students to master, and do the subtopics of the topic of Functions require specific attention in module development?

METHODOLOGY

Research Design

This study employed a survey design with a quantitative approach. The survey design was chosen because it is suitable for collecting information about the perceptions of a large group of respondents regarding the difficulty level of topics and subtopics within a specific period of time. This study constitutes the needs analysis phase of module development, that is, before any draft of the STEM Training Module is developed, in line with current practices in mathematics education module development (Abdul Rahim, 2021; Ramli & Mohd Tajudin, 2021).

Population and Sampling

The study respondents consisted of 150 Form Four science-stream students from three ordinary daily secondary schools in the district of Kota Bharu, Kelantan. Form Four students were chosen because they represent the group closest to the actual target of the module, that is, students who are currently studying the subject of Additional Mathematics.

Research Instrument

The instrument used was a questionnaire titled "Questionnaire on Difficult Topics in the Form Four Additional Mathematics Syllabus." This questionnaire was divided into two main sections, namely Section A (demographic data) and Section B (list of topics and subtopics). In Section B, students rated the difficulty level of each topic and subtopic using a five-point Likert scale, namely 1 (Very Difficult), 2 (Difficult), 3 (Neutral), 4 (Easy) and 5 (Very Easy). Based on this scale, a lower mean value indicates a higher level of difficulty. For interpretation purposes, the mean range was divided into three levels, as shown in Table 1.

Table 1. Interpretation of mean ranges for difficulty level

Mean range	Difficulty level	Interpretation
1.00 – 2.33	High	Difficult
2.34 – 3.66	Moderate	Moderate
3.67 – 5.00	Low	Easy

Note. A lower mean value indicates a higher perceived difficulty.

Procedure and Data Analysis

The questionnaire was distributed to students at the three participating schools. Students were informed that there were no right or wrong answers and that all information would be kept confidential. The data collected were analysed using descriptive statistics by calculating the mean value for each topic and subtopic. The topics and subtopics were then arranged according to difficulty level to identify the content most in need of additional learning support.

FINDINGS

Difficulty level by topic

Table 2 shows the difficulty level of the 10 Form Four Additional Mathematics topics arranged from the most difficult to the easiest. The findings show that the topics of Indices and Logarithms (mean = 2.24) and Differentiation (mean = 2.33) were at the difficult level, while the rest were at the moderate level, except for Simultaneous Equations (mean = 3.67), which was perceived as the easiest. The topic of Functions recorded a mean of 2.78, placing it at the moderate level and ranking it the fourth most difficult at the topic level.

Table 2. Difficulty level by topic (arranged by difficulty)

No.	Topic	Mean	Level
1	Indices and Logarithms	2.24	Difficult
2	Differentiation	2.33	Difficult
3	Circular Measure	2.43	Moderate
4	**Functions**	**2.78**	**Moderate**
5	Quadratic Functions	2.92	Moderate
6	Statistics	3.08	Moderate
7	Quadratic Equations	3.22	Moderate
8	Coordinate Geometry	3.31	Moderate
9	Solution of Triangles	3.36	Moderate
10	Simultaneous Equations	3.67	Easy

Note. Lower mean = more difficult. The topic of Functions (in bold) is at the moderate level at the topic level.

Difficulty level by subtopic for the topics of Functions and Quadratic Functions

Table 3 presents the difficulty level of the subtopics for the topics of Functions and Quadratic Functions. The findings reveal a pattern that is very different from the topic-level analysis. Although the topic of Functions was perceived as moderate overall, the subtopic of Inverse Functions recorded a mean of 1.97 and the subtopic of Composite Functions recorded a mean of 2.23, both of which were at the difficult level. By contrast, the subtopics of Relations (mean = 3.75) and Functions (mean = 3.28) were perceived as much easier, thereby raising the overall mean of the topic of Functions.

Table 3. Difficulty level of subtopics for the topics of Functions and Quadratic Functions

Topic	Subtopic	Mean
Functions	Relations	3.75

	Functions	3.28
	Composite Functions	**2.23**
	Inverse Functions	**1.97**
Quadratic Functions	Quadratic functions and their graphs	2.99
	Maximum and minimum values of quadratic functions	2.97
	Sketching graphs of quadratic functions	2.87
	Quadratic inequalities	2.84

Note. The subtopics of Inverse Functions and Composite Functions (in bold) are at the difficult level even though the topic of Functions overall is moderate.

The ten most difficult subtopics in the entire syllabus

To examine the relative position of the Functions subtopics within the entire syllabus, Table 4 lists the 10 most difficult subtopics. The findings confirm that Inverse Functions (mean = 1.97) is the most difficult subtopic in the entire Form Four Additional Mathematics syllabus, surpassing subtopics from the topics of Indices and Logarithms and Differentiation, which were considered the most difficult at the topic level. The subtopic of Composite Functions is also listed in this group.

Table 4. The ten most difficult subtopics in the Form Four Additional Mathematics syllabus

No.	**Subtopic**	**Parent topic**	**Mean**
1	**Inverse Functions**	**Functions**	**1.97**
2	Equations involving Indices and Logarithms	Indices and Logarithms	2.07
3	Change of base of Logarithms	Indices and Logarithms	2.11
4	Small increments and approximations	Differentiation	2.19
5	Second-order differentiation	Differentiation	2.19
6	Logarithms and the laws of Logarithms	Indices and Logarithms	2.21
7	**Composite Functions**	**Functions**	**2.23**
8	First derivative of polynomial functions	Differentiation	2.25
9	Related rates of change	Differentiation	2.40
10	The idea of a tangent to a curve	Differentiation	2.41

Note. The subtopics of the topic of Functions (in bold) rank first and seventh most difficult in the entire syllabus.

DISCUSSION

The findings of this study offer two main contributions. First, this study demonstrates that the measurement of difficulty level should not be carried out only at the aggregate topic level. The topic of Functions, which was perceived as moderate (mean = 2.78), in fact contains the most difficult subtopic in the entire syllabus, namely Inverse Functions (mean = 1.97). If the analysis were conducted only at the topic level, this critical subtopic would be overlooked and the module's focus could be misdirected. This finding reinforces the need for a detailed needs analysis before a module is developed (Abdul Rahim, 2021; Ramli & Mohd Tajudin, 2021).

Second, the difficulty of the subtopics of Inverse Functions and Composite Functions supports the finding that the concepts of function inversion and composition are abstract and difficult for students to visualise (Shahrul, Nasir & Suryadi, 2024). Students may be able to solve problems through algebraic procedures but fail to understand the concept when confronted with graphical representations. This reinforces the rationale that the module developed needs to emphasise the visualisation of concepts through the integration of technology such as dynamic software (Hamzah & Hidayat, 2022).

These findings are also consistent with recent research trends showing that the integration of technology such as GeoGebra improves the achievement and engagement of secondary school students (Hidayat, Kamarazan, Nasir & Ayub, 2023), as well as the increasingly growing use of Augmented Reality in STEM education (Hidayat & Wardat, 2023; Ziatdinov & Valles, 2022). Therefore, the proposed module should make use of visualisation technology to address the Functions subtopics identified as the most difficult.

CONCLUSION AND RECOMMENDATIONS

This needs analysis study concludes that there is a clear need to develop a STEM Training Module for the topic of Functions, particularly one that targets the subtopics of Inverse Functions, Composite Functions and Quadratic Functions. Although the topic of Functions was perceived as moderate at the topic level, subtopic-level analysis revealed that Inverse Functions is the most difficult subtopic in the entire Form Four Additional Mathematics syllabus. This finding underscores the importance of detailed needs analysis at the subtopic level as a basis for curriculum and module design.

Based on these findings, it is recommended that the development of the training module focus on delivering the concept of Functions visually through the integration of technology such as GeoGebra and Augmented Reality (Hamzah & Hidayat, 2022; Hidayat & Wardat, 2023). Further research is recommended to develop and test the validity, reliability and usability of such a module. Future studies could also expand the scope of respondents to other districts and states to strengthen the generalisability of the findings.

ACKNOWLEDGEMENT

This research was funded by Universiti Pendidikan Sultan Idris under the Education-Based University Research Grant (2019-0092-107-01).

REFERENCES

1. Abdul Rahim, S. S. (2021). Analisis keperluan terhadap pembinaan modul pengajaran kemahiran berfikir aras tinggi dan kemahiran literasi digital bagi tajuk Persamaan Kuadratik. JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik, 9(4), 15–31.
2. Hamzah, N. A. H., & Hidayat, R. (2022). The role of GeoGebra software in mathematics education: A systematic literature review. Jurnal Pendidikan Sains dan Matematik Malaysia, 12(1), 24–38.
3. Hidayat, R., Kamarazan, N. A., Nasir, N., & Ayub, A. F. M. (2023). The effect of GeoGebra software on achievement and engagement among secondary school students. Malaysian Journal of Mathematical Sciences, 17(4), 611–627. https://doi.org/10.47836/mjms.17.4.06
4. Hidayat, R., & Wardat, Y. (2023). A systematic review of augmented reality in science, technology, engineering and mathematics education. Education and Information Technologies. https://doi.org/10.1007/s10639-023-12157-x

5. Ramli, M. S., & Mohd Tajudin, N. (2021). Analisis keperluan untuk membangunkan Modul Pembelajaran Berasaskan Challenge dalam mempelajari Matematik bagi murid Tingkatan 4. Jurnal Pendidikan Sains dan Matematik Malaysia, 11(Isu Khas).
6. Shahrul, Q. D., Nasir, N., & Suryadi, D. (2024). Analysis of Form Two Mathematics Textbook content for Functional Graph topic using the praxeology method. Jurnal Pendidikan Sains dan Matematik Malaysia, 14(2), 99–122. https://doi.org/10.37134/jpsmm.vol14.2.9.2024
7. Ziatdinov, R., & Valles, J. R. (2022). Synthesis of modeling, visualization, and programming in GeoGebra as an effective approach for teaching and learning STEM topics. Mathematics, 10(3), 398. https://doi.org/10.3390/math10030398