Validity, Reliability and Usability of a Geogebra-Integrated STEM Training Module for the Topic of Functions 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

***Corresponding Author**

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ABSTRACT

A teaching module must undergo rigorous evaluation before it can be widely used. This study aims to determine the validity, reliability and usability of a GeoGebra-integrated STEM Training Module for the topic of Functions among Form Four students. The evaluation was conducted through the second phase of the Sidek Module Development Model (SMDM). Content and construct validity were assessed by five experts using the STEM Courseware Evaluation Form (STEMCEF) through the expert percentage-agreement method. Usability was evaluated through a pilot study involving 10 students using a usability questionnaire, while reliability was determined using Cronbach's Alpha coefficient based on 15 valid student data sets. The findings show that the module has a high overall validity of 90.0%, with construct validity reaching 100%. For usability, all items in the Format and Content constructs recorded means above 3.00 with a high level of agreement. The Cronbach's Alpha coefficient obtained was .874, indicating good reliability as it exceeds 0.80. All reliability items recorded means above 3.00 and were accepted. These findings confirm that the developed STEM Training Module has good quality in terms of validity, reliability and usability, and is suitable as a supporting resource for the teaching and learning of the topic of Functions at the secondary school level.

Keywords: validity, reliability, usability, STEM Training Module, Cronbach's Alpha

INTRODUCTION

The development of quality teaching materials is incomplete without a systematic evaluation process. A module must have its validity and reliability determined so that it can help students master the intended learning objectives (Hamzah, Ramli & Khairani, 2022; Jahudin & Siew, 2023). Without such evaluation, a module's content accuracy and consistency for wide-scale use cannot be assured.

A STEM Training Module integrating GeoGebra and Augmented Reality for the topic of Functions was developed through the first phase of the Sidek Module Development Model (SMDM). Once the module draft was completed, it then needed to go through the second phase of the SMDM, namely trialling and evaluating the module. This paper reports the findings of the validity, reliability and usability evaluation of the module among experts and Form Four students.

LITERATURE REVIEW

Validity and reliability of modules

The validity of a module refers to the accuracy of the concepts and content of a module (Bahari & Saleh, 2023). Content validity and construct validity are commonly determined by a panel of experts through the expert percentage-agreement method, with the minimum level of agreement commonly accepted being

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between 75% and 80% (Bahari & Saleh, 2023). Reliability, in turn, refers to the internal consistency of an instrument, which is usually measured through the Cronbach's Alpha coefficient. Coefficient values above 0.70 are acceptable as consistent, while values above 0.80 are considered good (Hussey, Alsalti, Bosco, Elson & Arslan, 2025).

This evaluation approach has been widely used in the development of educational modules in Malaysia. Recent studies, for example, have combined expert validity and the Cronbach's Alpha coefficient to determine the quality of their respective modules (Hamzah, Ramli & Khairani, 2022; Yatim, Saleh, Zulnaidi, Yew & Yatim, 2022). Usability evaluation through a pilot study is also important for checking the suitability of the content, language, format and flow of a module before it is used in a real situation (Jahudin & Siew, 2023).

Research Objectives And Questions

This evaluation study aims to answer the following three research questions: (i) Does the STEM Training Module for the topic of Functions have usability? (ii) Does the module have high validity? and (iii) Does the module have high reliability?

METHODOLOGY

Research design

This study represents the second phase of the SMDM, namely trialling and evaluating the module. Three aspects were evaluated, namely usability through a pilot study, validity through expert evaluation, and reliability through a field test with students. Most of the evaluation was carried out online following the Conditional Movement Control Order (CMCO) during the COVID-19 pandemic.

Usability evaluation

The module draft and the usability questionnaire were given to 10 Form Four students at a secondary school in the district of Petaling. The students were provided access to GeoGebra and GeoGebra AR through a smart device and a laptop. The usability questionnaire measured two constructs, namely Format and Content, using a response scale in which an item mean above 3.00 indicates a high level of agreement.

Validity evaluation

Content validity and construct validity were assessed by five experts, consisting of three lecturers and two Additional Mathematics teachers with more than ten years of teaching experience. The list of experts is shown in Table 1. The experts made their assessments using the STEM Courseware Evaluation Form (STEMCEF) provided together with the printed module. The validity value was determined using the expert percentage-agreement method, namely the ratio of the number of items agreed upon by the experts to the total number of items, multiplied by 100.

Table 1. List of experts evaluating the validity of the module

Expert	Position & institution	Area of expertise	Teaching experience
E1	Associate Professor Dr., FSKIK UPSI	AR technology and software	16 years
E2	Associate Professor Dr., FSM UPSI	Mathematics	11 years
E3	Dr., UMT	Mathematics and STEM	12 years
E4	Teacher, Selangor State Education Department	Additional Mathematics	15 years
E5	Teacher, Selangor State Education Department	Additional Mathematics	12 years

Note. *E = expert.*

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Reliability evaluation

The module reliability questionnaire was distributed to 30 Form Four students at a secondary school in the district of Petaling through home-based teaching and learning (PdPR) sessions. Of this total, 15 complete and valid data sets were analysed, while 12 data sets were rejected because some students could not access the GeoGebra AR activity, which requires a particular device. A total of 15 respondents was considered sufficient for the purpose of a pilot study, consistent with the recommended minimum sample size for assessing reliability via Cronbach's Alpha (Bujang, Omar, Foo & Hon, 2024). Reliability was determined using the Cronbach's Alpha coefficient via SPSS software, with items accepted when the mean exceeded 3.00 on a four-point Likert scale.

FINDINGS

Usability of the module

To answer the first research question, the pilot study findings show that all items in both usability constructs recorded means above 3.00 with low standard deviations, indicating a high level of agreement. A summary of the findings is shown in Table 2. The students agreed that the module was easy to use in terms of format and content. Student comments also supported these findings, including that students understood the application of the topic of Functions in everyday life, were able to check their own answers, and enjoyed it because GeoGebra AR could represent various graphs of Functions.

Table 2. Summary of usability findings by construct

Construct	Number of items	Mean range	Level of agreement
Format	8	3.30 – 3.90	High
Content	16	3.20 – 3.90	High

Note. *An item is considered to have high agreement when the mean exceeds 3.00 and the standard deviation is less than 1.0.*

Validity of the module

To answer the second research question, the analysis of expert percentage agreement by construct is shown in Table 3. Construct validity reached full agreement of 100%, while the highest content validity was recorded by the Teaching Content construct (93.2%). The overall expert percentage agreement was 90.0%, far exceeding the accepted minimum level.

Table 3. Expert percentage agreement by construct

Construct	Number of items	Percentage agreement
Teaching content	11	93.2%
Instructional design	7	88.4%
User-friendliness	6	85.0%
Management	5	87.0%
Material learning aspects	5	88.0%
STEM Education Quality Framework	10	90.5%
Construct validity	6	100%
Overall	**50**	**90.0%**

Note. *The overall percentage agreement is calculated as the average across the seven constructs.*

The analysis of validity percentage by expert is shown in Table 4. Expert 3 recorded the highest percentage agreement (94.5%), while Expert 1 recorded the lowest (85.0%). The overall average agreement of all five experts was 90.6%. Given the high validity value and the absence of significant differences of opinion, no modifications were made to the module.

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Table 4. Validity percentage by expert

Expert	Content validity	Construct validity	Overall agreement
E1	83.5%	100%	85.0%
E2	89.8%	100%	90.1%
E3	94.3%	100%	94.5%
E4	91.5%	100%	91.8%
E5	91.5%	100%	91.8%
Average	**90.1%**	**100%**	**90.6%**

Note. *E = expert.*

Reliability of the module

To answer the third research question, the profile of the 15 students involved in the reliability test is shown in Table 5. The majority of respondents were female students (60.0%), and their Additional Mathematics achievement was satisfactory, with 53.3% obtaining Grades A and B and none failing.

Table 5. Profile of the reliability sample students (n = 15)

Item	Sub-item	Frequency	Percentage
Gender	Male	6	40.0%
	Female	9	60.0%
Grade	A	5	33.3%
	B	3	20.0%
	C	6	40.0%
	D	1	6.7%

Note. *No respondents obtained Grade E or failed.*

The Cronbach's Alpha coefficient obtained for the overall instrument was .874, indicating good reliability as it exceeds 0.80 (Hussey, Alsalti, Bosco, Elson & Arslan, 2025). The descriptive analysis of items by module section, as summarised in Table 6, shows that all items recorded means above 3.00 and were accepted. These findings indicate that the students were able to master the objectives of the STEM Training Module.

Table 6. Item mean ranges for reliability by module section

Module section	Item mean range	Interpretation
STEM Training Module manual	3.73 – 3.93	Accepted
GeoGebra and GeoGebra AR applet manual	3.67 – 3.87	Accepted
Unit 1 (Composite Functions)	3.13 – 3.87	Accepted
Unit 2 (Inverse Functions)	3.07 – 3.87	Accepted
Unit 3 (Quadratic Functions)	3.87	Accepted
Unit 4 (Quadratic Functions)	3.27 – 3.87	Accepted

Note. *An item is accepted when the mean exceeds 3.00 on a four-point Likert scale.*

DISCUSSION

Overall, the findings confirm that the developed STEM Training Module has good quality across all three evaluation aspects. The overall validity value of 90.0% indicates that the module content is accurate, complete and aligned with the Additional Mathematics syllabus. This finding is consistent with previous studies that reported high module validity through the expert percentage-agreement method (Bahari & Saleh, 2023; Hamzah, Ramli & Khairani, 2022).

The Cronbach's Alpha coefficient of .874 indicates good internal consistency and supports the finding that the students were able to master the module objectives. The high usability of the module, in turn, indicates that the students accepted the module in terms of format and content, while also appreciating the capacity of GeoGebra and AR to visualise graphs of Functions. Together, these three findings demonstrate that the systematic module-development process through the SMDM and the STEM Education Quality Framework produced a high-quality teaching resource (Jahudin & Siew, 2023; Rowley, Preiss, Pinnell & Franco, 2012).

Nevertheless, several limitations need to be noted. The evaluation was carried out online during the pandemic, which limited direct observation of students' interaction with the module. In addition, the requirement of a particular device to access GeoGebra AR limited the valid sample size. These limitations need to be taken into account in interpreting the findings and should be considered in future studies.

CONCLUSION AND RECOMMENDATIONS

This study concludes that the GeoGebra-integrated STEM Training Module for the topic of Functions has high overall validity (90.0%), good reliability (Cronbach's Alpha = .874) and high usability among Form Four students. These findings confirm that the module is suitable as a supporting resource for the teaching and learning of the topic of Functions at the secondary school level.

It is recommended that future studies evaluate the effectiveness of this module on students' achievement and motivation through a face-to-face quasi-experimental design. A larger sample size across various districts is also recommended to strengthen the generalisability of the findings, in addition to expanding access to AR technology so that more students can benefit from the visualisation component of the module.

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