ISSN 2462-2052
DOI: https://doi.org/10.37134/jsml.vol11.1.2.2023

Journal of Science and Mathematics Letters
Volume 11, Issue 1, 10-19, 2023

RESEARCH ARTICLE

Development and Effectiveness of I-Algebra Module Towards Malaysian Year Five Pupils' Achievement and Motivation

S.W. Sathiyan Mooruthy S/O Subramaniam, Norazman Arbin*, Mazlini Adnan

Department of Chemistry, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia
*Corresponding author: norazman@fsmt.upsi.edu.my

Received: 10 June 2022; **Accepted:** 30 August 2022; **Published:** 28 February 2023

ABSTRACT

This study aims to develop and evaluate the effectiveness of the I-Algebra module, which employed the Normative Algebra Strategy (NAS). The development of the module was based on the adaptation of the Sidek model. The study also analyses the effect of the module on year five pupils' achievement and motivation. Quantitative approaches with the quasi-experimental design used for this study. Module was developed based the two phases stated in Sidek model, first phase is the draft phase of the module and the second phase is the phase that tries and evaluates the module. The module was evaluated by a panel of three experts to determine the content validity of the module. To determine the reliability and effectiveness of I-Algebra module, a pilot study was conducted which involved 30 year five pupils. The respondents were chosen using cluster sampling methods where they were divided equally into the treatment and the control groups. Data were analysed using SPSS software version 25 for inferential analysis, which involved the independent sample t-test and paired sample t-test. The findings showed I-Algebra teaching module had the values of Cohen's Kappa 0.86 and Cronbach Alpha 0.95. The comparison of mean scores for the control group and treatment group showed a significant improvement in post-test but the mean scores for the treatment group were higher. All the treatment group pupils had a high level of intrinsic motivation after the post-experiment. In a conclusion, the validity content and reliability of the I-Algebra teaching module are satisfactory and high respectively, and this module can have a positive impact in terms of achievement and motivation. The use of the I-Algebra teaching module implies the improvement of pupils' learning on the selected topics. As an implication, this study provides new ideas, guidance and information to teachers, especially Mathematics teachers. I-Algebra teaching module can help the pupils to master the selected topics more effectively.

Keywords: I-Algebra, Normative Algebra Strategy, pre-test, post-test, intrinsic motivation.

1. INTRODUCTION

Algebra is one of the dominant topics in mathematics and has always been a gateway to higher mathematics, such as from primary school to the college level. However, many students do not use this gateway successfully. The struggle encountered by many students in middle and high school, mainly because of the blunt introduction of algebra (Piriya, 2018). As in the Malaysian curriculum, the algebraic operation is introduced in Form One and then bluntly shifts

from arithmetic to algebra without any smooth transition. When the students first encountered algebra, it led to many difficulties for students who were exposed to concrete reasoning only throughout primary school years (Susac et al., 2014).

Traditionally, algebra has been taught by memorization, without a basis for algebraic thinking. Kieran (2018) defined algebraic thinking without even involving letter-symbolic. More recently, researchers have also noted the need to incorporate algebraic concepts into mathematics instructions starting from primary school (Brizuela, 2016). The motive for introducing algebra at the primary school level is because pupils are only exposed to surface level subject understanding when they study algebra at the beginning of high school (Piriya, 2018). Therefore, preparing and developing a module of algebra for primary school pupils which contain the basic algebraic operation would be a great selling point.

Gan and Munirah (2014) have suggested a module that prepares for who are not exposed formally to algebra. However, the algebraic syllabus is not covered directly in the Malaysian primary school curriculum. Hence, no module exists, which is mainly focusing only on algebraic operation and theory. Most students had experienced difficulties in learning algebra due to the premature introduction of symbolic mathematical notation (Piriya, 2018). Meanwhile, a study by Chow (2011) claimed that many students did not understand the symbols, concepts and reasoning skills that are found in algebra. It seems that not much has been reworked about developing the module of algebra for primary school students in Malaysia.

A study by Blanton (2015) found out arithmetic and algebra are separated in most schools in the mathematics curriculum, where arithmetic is often focused in primary school while algebra is at the beginning of secondary school. This separation caused a cognitive gap between arithmetic and algebra (Kieran, 2018). In Malaysia, the syllabus at the end of arithmetic operations chapters, there is a small column that requires the pupils to think about "*anu*" which means unknown. This seems to be an introduction to the algebra world. These activities are indeed algebraic as they provoke students' understandings of number properties and arithmetic operations (Gan and Munirah, 2014). However, there is no evidence to show how much importance has been given to discuss this section in the classrooms. It is still questionable even the teachers are aware of the importance and the necessity of this section. Therefore, a strong foundation needed for algebra in primary level. Identification of the cognitive variables may assist in intensifying a strong early foundation in basic algebraic computation. The main objective of the research is to develop an effective module of I-Algebra for Malaysian year five pupils. Specifically, this research has three objectives, namely (a) To develop a valid and reliable I-Algebra module for Year 5 pupils. (b) To determine the effectiveness of the I-Algebra module on Year 5 pupils' achievement. (c) To determine the motivation level for the treatment group after intervention using the I-Algebra module.

2. MATERIALS AND METHODS

2.1. Research conceptual framework

The conceptual framework is defined as a diagram that provides a symbolic and abstract overview but can elaborate on the ideas related to the research elements (Ghazali and Sufean, 2016). This research is divided into two phases, namely the module development phase and module evaluating phase. The module development phase is a study to develop the module by using Sidek's Module Development Model (Mohd Noah, 2000). The next process is to analyze the instruments' validity and reliability to develop an effective module of algebra and achieve the research objectives. This research consists of two variables, namely the independent variable and the dependent variable. The independent variables were the teaching and learning methods, namely the I-Algebra method and the conventional teaching method. Two dependent variables

were the achievement andmotivation of year five pupils. The second phase was the research on evaluating the effectiveness of the I-Algebra module. The module evaluation was done through the pre-test and post-test with the design of a quasi-experiment.

The pupils were divided into two groups namely the control group and the treatmentgroup. The pre-test and post-test were the instruments used to identify pupils' achievementsbefore and after the implementation of the study. Both groups had pre-test before the intervention. The scores obtained from the pre-test were used to determine the early achievement of pupils. After that, the treatment group was followed the learning session based on the I-Algebra module, while the control group was remained in the conventional based learning session. This intervention process took four weeks. The duration of this intervention is in line with a study that was conducted by Foo Jing Yao (2017). After the intervention,both groups were given post-test to be completed. The scores obtained by the two groups were compared to determine the effectiveness of the I-Algebra teaching module withthe conventional teaching method. As the closing section, each pupil from the treatment group was provided with a set of questionnaires to scale their motivation level after their post-test. This whole process was structured in Figure 1.

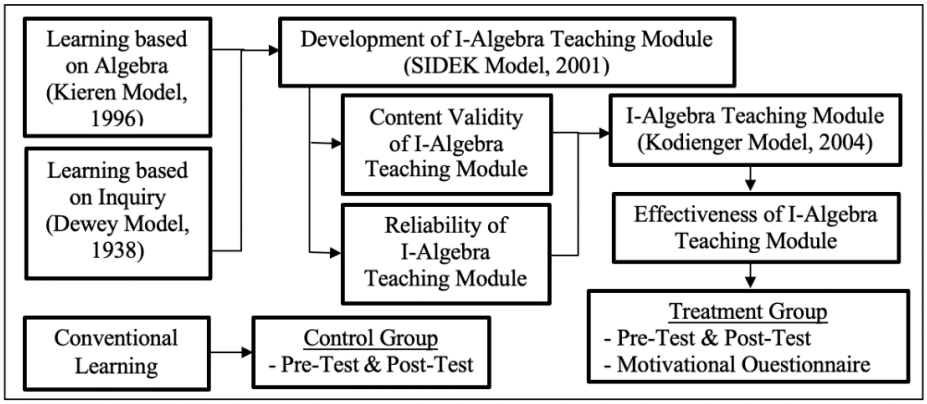

Figure 1. Research Conceptual Framework

2.2. Population and sample research

The targeted population of the research selected is comprised of year five pupils in Sekolah Kebangsaan (SK) Stowell, Bukit Mertajam. This school was randomly selected from a list of all the schools in Bukit Mertajam district. Another factor, size of the population is more than adequate seems the researcher aimed at 30 pupils only out of 77 students as the total number of Year Five pupils in Sekolah Kebangsaan (SK) Stowell, Bukit Mertajam. Chua (2014), also suggests the subgroup size is at least 15, then the group sample size is 30. Therefore, there 15 pupils were assigned for control group and another 15 pupils were assigned for treatment group.Year five pupils were chosen as the study participants for several reasons. Firstly, their maturity of thinking at the primary level and don't involve formative examination like PPSR. Secondly,the year five pupils can be expected to develop basic algebraic thinking (Cai, 2011).

2.3. Research instrument

A questionnaire is an instrument that used to collect data in this research. The instrument's reliability and validity must be evaluated at an early stage (Chua, 2006). The research comprised of two phases, namely the module development phase and the module effectiveness evaluating phase. The research uses only an instrument for the module development phase, namely the contents validity questionnaire. Meanwhile, two instruments were used for the module

effectiveness evaluating phase, namely I-Algebra achievement test sets and questionnaires for pupils' motivation. This is concluded in Figure 2. The researcher adapted the questionnaire of Dahaman (2014) to collect the teachers' opinions about the requirement of the I-Algebra teaching module. To obtain the validity of the module content, the researcher adapted the assessment form which was developed by Jamaludin Ahmad (2002). The researcher adapted a questionnaire based on a questionnaire assessing the reliability of the module Jamaludin Ahmad (2002) to evaluate the reliability of the module. The year five pupils' post-experimental intrinsic motivation questionnaire was adopted from the Intrinsic Motivation Inventory (IMI) by McAuley, Duncan, and Tammen (1987). These questionnaires were validated by two experts from Institute of Teachers' Education Tuanku Bainun, Bukit Mertajam (BM).

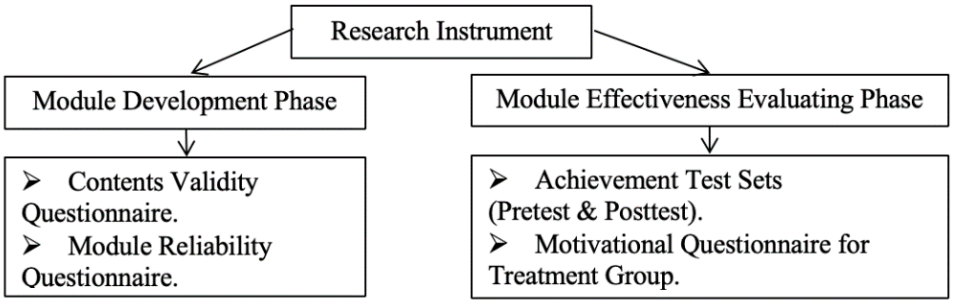

Figure 2. Research Instrument

A total of ten problem solving questions were provided in the pre-test and post-test which consists of sections A and B specifically in numbers and operations. Pupils were given one hour to answer all the ten questions. This was in line with research was conducted by Foo (2014) shows that the pupils were only given 30 minutes to answer all the five questions in the test paper. Pre-test and post-test questions and their answer scheme were adopted from the year five mathematical textbook (Chan et al., 2017) and some external year five exercise books. All the questions were in the pre-test and post-test were followed the test specification table (TST).

2.4. Research procedure

The researcher started to develop the module and research instruments that were adapted from the previous study. The instruments involved were questionnaires and test sets. Before a pilot test was conducted, the validity of the two instruments were evaluated. After obtaining the results, the pilot test was conducted in a primary school that involved 30 year five pupils. Then, the actual research was conducted at the location of the sample selection. The session started with a pre-test for I-Algebra. The duration of the intervention has been four weeks for us to implement the module teaching. The module learning session was held for 20 hours. This method was implemented by Li (2013). The post-test was given to pupils after the intervention process was done. As the closing section, each pupil from the treatment group was provided with a set of questionnaires to scale their motivation level after their post-test.

2.5. Data analysis

Data analysis is a process of evaluating the collected data and representing the information by using analytical and statistical tools. According to Konting (2004), data processing is a technique for data collection, processing, analysing, storage, and removal. The analysis of the research will be initiated by analysing the pupils' profiles and results of tests.

All the data will be analysed using the Statistical Package for Social Science (SPSS) software version 25.

3. RESULTS AND DISCUSSION

3.1. Validity of module

There are two methods of evaluation analysis made by the researchers to determine the validity of the content of a module. The methods were (Cohen, 1968) agreement scale and content validity index (CVI). The use of the percentage method was made based on the adaptation of the validity instrument content of (Noah & Ahmad, 2005). Polit and Beck (2006) recommended at least three to five experts for the validation. Based on the views of module experts, the value of 70 per cent is considered to have high content validity. This value is evaluated using the following formula. The data analysed using content validity instruments was described in Table 1:

$$\frac{\text{Total Scores of Experts}}{\text{Maximum Scores (25)}} \times 100 = \text{Mastery Level of Validity}$$

Table 1. Content validity scores of three experts for I-Algebra teaching module

	Expert's score (*x*/40)	**Validity %**	**Index**
Expert 1 (E1)	34	85	.85
Expert 2 (E2)	35	88	.88
Expert 3 (E3)	33	83	.83

The highest validity percentage of this module achieved is 88 per cent given by Expert 1. The lowest validity percentage was achieved given by Expert 3 is 83 per cent. The overall average validity of this module is 86 per cent. To determine the validity of module content based on Cohen's Kappa value scale, the percentage of content validity achievement should be converted to a decimal number to resemble the value of the correlation coefficient (Noah & Ahmad, 2005). Table 2 shows Cohen's Kappa agreement scale for the content validity of the I-Algebra teaching module.

Table 2. Cohen's Kappa agreement scale for content validity of I-Algebra teaching module

Experts	**Cohen's Kappa Value Scale**	**Agreement Scale**
Expert 1 (E1)	0.85	Almost perfect agreement
Expert 2 (E2)	0.88	Almost perfect agreement
Expert 3 (E3)	0.83	Almost perfect agreement

Based on Cohen (1968) agreement scale, the value scale is 0.81 to 1.00 indicates the instrument has excellent validity. Table 2 shows the Cohen's Kappa values for the I-Algebra teaching module is from 0.81 to 1.00 and the mean value of Cohen's Kappa for the I-Algebra teaching module is 0.85.

3.2. Reliability of module

There are main five topics in this module, namely addition, subtraction, multiplication, division and mixed operations. A total of seven statements for each topic were listed in the reliability questionnaire of the I-Algebra teaching module to determine the value of the reliability coefficient of the module. This reliability questionnaire was adapted and validated by

two experts. Likert scale five points were used in this questionnaire, namely Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5). Table 3 shows the Cronbach's Alpha values obtained questionnaire.

Table 3. Cronbach's Alpha values for selected topics of I-Algebra module

Topics	Cronbach's Alpha value
Addition	0.958
Subtraction	0.953
Multiplication	0.955
Division	0.952
Mixed Operations	0.950
Average	0.953

Based on Hair (2009), if the value of the Cronbach Alpha coefficient exceeds 0.6, the instrument is acceptable. If the value of the Cronbach Alpha coefficient exceeds 0.9, then the instrument has very high reliability. Based on Table 3, the I-Algebra teaching module has very high reliability of 0.953.

3.3. Normality test

The purpose of the data normality test conducted is to determine the data obtained were appropriate and any data were out of alignment. For this, the data obtained are normally distributed and correspond to the purpose of the research. Therefore, the data normality test was conducted on the pre-test and post-test for the control group and treatment group to remove the outlier. Table 4 shows the scores were obtained for the control group and the treatment groups in the pre-test and post-test were matched and there are no outliers in the data. Therefore, all appropriate data were used for the analysis t-test.

Table 4. Descriptive statistics for data normality test

	N	Mean	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Control Pre	15	34.80	.571	.580	-.579	1.121
Control Post	15	42.13	.402	.580	-.695	1.121
Treatment Pre	15	38.40	.890	.580	-.359	1.121
Treatment Post	15	63.33	-.386	.580	-.451	1.121
Valid N listwise	15					

For data to be normally distributed, the Skewness and Kurtosis value should be in the range from –1.96 to +1.96 (Chua, 2020). According to Table 4, the statistic values for both skewness and kurtosis lie between the ranges from –1.96 to +1.96. Therefore, the values shown are significant and were normally distributed. For the sample size of less than fifty, skewness and kurtosis are suggested to be used in research to determine the normality of data (Mishra, 2019). Thus, parametric techniques were used to determine the significant differences between the variables and to solve the research problems, frequency analysis and paired sample t-test were used.

3.4. Achievement of pre-test and post-test

The purpose of the t-test analysis performed was to evaluate the constructed null hypothesis. If the value of $p < 0.05$, this means the null hypothesis is rejected. There were four null hypotheses tested to determine the effectiveness of the I-Algebra teaching module on

pupils' learning. To compare the mean scores of pupils for the control group and treatment group in the pre-test, independent sample t-test analysis was performed. The same analysis was also used to compare the mean scores of pupils for the control group and treatment group in the post-test. This analysis was used to test H_{01} and H_{02}. To compare the mean scores of pupils for the control group between pre-tests and post-test, paired sample t-test analysis was performed. The same analysis was also used to compare the mean scores of pupils for the treatment group between pre-test and post-test. This analysis was used to evaluate H_{03} and H_{04}. Table 5 represents the results of independent sample t-test analysis on comparison of mean scores of the pre-test between the control group and treatment group.

Table 5. Comparison of mean scores of the pre-test between the control group and treatment group

Group (Pre-test)	N	Mean Score	Standard deviation	t Value	Sig. (2-tailed)
Control	15	32.80	23.038	0.652	0.525
Treatment	15	38.40	22.106		

Based on Table 5, the mean score of pre-test for the control group was 32.80 and the standard deviation was 23.038, while the mean score of pre-test for the treatment group was 38.40 and the standard deviation was 22.106. The analysis result of independent sample t-test showed the value of t was 0.652 and the value of p was 0.525. The value of p has exceeded the value of 0.05 and H_{01} failed to be rejected. Therefore, there is no significant differences in mean scores of pre-test for the control group and treatment group. This indicates the early mastery level of the pupils for both control group and the treatment group are almost identical. To evaluate H_{02}, independent sample t-test analysis was performed on the mean scores of post-test between the control group and the treatment group. Table 6 represents the results of the independent sample t-test analysis.

Based on Table 6, the mean score of post-test for the control group was 40.13 and the standard deviation was 24.442, meanwhile the mean score of post-test for the treatment group was 62.27 and the standard deviation was 24.353. The analysis results of independent sample t-test showed the value of t was -2.434 and the value of p was 0.029. The value of p was less than the value of 0.05, thus H_{02} was rejected. Therefore, there is a significant difference between the mean scores of post-test for the control group and treatment group. This indicates I-Algebra teaching module can help pupils master the selected topics more effectively compared to common conventional teaching method. To evaluate H_{03}, paired sample t-test analysis was performed on the mean scores of pre-test and post-test for the control group. Table 7 represents the results of the paired sample t-test analysis.

Table 6. Comparison of mean scores of the post-test between the control group and treatment group

Group (Post-test)	N	Mean Score	Standard deviation	t Value	Sig. (2-tailed)
Control	15	40.13	24.442	-2.434	0.029
Treatment	15	62.27	24.353		

Table 7. Comparison of mean scores of the pre-test and post-test for the control group

Control Group	N	Score Mean	Standard deviation	t Value	Sig. (2-tailed)
Pre-test	15	32.80	23.038	-11.000	0.000
Post-test	15	40.13	24.442		

Based on Table 7, the mean score of pre-test for the control group was 32.80 and the standard deviation was 23.038, meanwhile the mean score of post-test for the control group was 40.13 and the standard deviation was 24.442. The analysis results of paired sample t-test showed the value of t was -11.000 and the value of p was 0.000. The value of p was less than the value

of 0.05, thus H_{03} was rejected. Therefore, there is a significant difference between the mean scores of pre-test and post-test for the control group. This indicates conventional teaching method slightly can improve pupils' mastery on the selected topics. To evaluate H_{04}, paired sample t-test analysis was performed on the mean scores of pre-test and post-test for the treatment group. Table 8 represents the results of the paired sample t-test analysis.

Table 8. Comparison of mean scores of the post-test between the control group and treatment group

Treatment Group	N	Mean Score	Standard deviation	t Value	Sig. (2-tailed)
Pre-test	15	38.40	22.106	-8.746	0.000
Post-test	15	62.27	24.353		

Based on Table 8, mean score of pre-test for the treatment group was 38.40 and the standard deviation was 22.106, meanwhile the mean score of post-test for the treatment group was 62.27 and the standard deviation was 24.353. The analysis result of paired sample t-test showed the value of t was -8.746 and the value of p was 0.000. The value of p was less than the value of 0.05, thus H_{04} was rejected. Therefore, there is a significant difference in the mean scores of pre-test and post-test for the treatment group. This indicates I-Algebra teaching module can help pupils master the selected topics more effectively compared to common conventional teaching method.. From the results of the above t-test analysis, H_{01} failed to be rejected and H_{02}, H_{03} and H_{04} were rejected. These results indicate the early mastery level of the pupils for both control group and the treatment group for the selected topics were almost identical. Common conventional teaching and learning process and I-Algebra teaching module can have a significant impact on pupils' learning on the selected topics.

The Pearson Correlation coefficient (r), Table 9 represents the relationship between pre-test and post-test for treatment group which shows 0.924 or 92.4% and $p < 0.001$ considered very strong (Cohen, 1988). The measurement of both tests can be reliable. Therefore, these achievement test questions and scores can be used.

Table 9. Pearson Correlation of Treatment Group between Pre-Test and Post-Test

		Treatment Group Pre-Test	Treatment Group Post-Test
Treatment Group Pre-Test	Pearson Correlation	1	.924**
	Sig. (2-tailed)		.000
	N	15	15
Treatment Group Post-Test	Pearson Correlation	.924**	1
	Sig. (2-tailed)	.000	
	N	15	15

**Correlation is significant at the 0.01 level (2-tailed)

3.5. The post-experimental intrinsic motivation level

The Intrinsic Motivation Inventory (IMI) is a multidimensional measurement tool to assess participants subjective experiences related to target activity in laboratory experiments (Deci and Ryan, 1985). The year 5 pupils' post- experimental intrinsic motivation questionnaire was adopted from The Intrinsic Motivation Inventory (IMI) by MacAuley, Duncan and Tammen (1987). Abd Razak et al. (2010) has come out with an article based on students' motivation. The year five pupils' post-experimental intrinsic motivation level was measured based on three dimensions, namely interest/enjoyment, perceived competence and pressure/tension. The mean and standard deviation of each dimension of intrinsic motivation is shown in Table 10. Intrinsic motivation mean score is categorized into three levels, namely low,

medium and high to determine the post-experimental intrinsic motivation level of pupils. The guide from Ehrman and Oxford (1991) was the key to report the frequency level and calculate the mean scores for the motivation questionnaire. The mean score between 3.5 up to 5.0 on the motivation questionnaire responses was interpreted as a high level of motivation, a mean between 2.5 up to 3.49 is considered to be a medium level of motivation, and a mean between 1.0 up to 2.49 was interpreted as a low level of motivation. Overall, the mean and standard deviation of year 5 pupils' post-experimental intrinsic motivation is 4.63 and 0.62 respectively. All the treatment group pupils had a high level of motivation intrinsic after the post-experiment.

Table 10. Intrinsic motivation level of year five pupils

Dimension	Mean	Standard deviation	Level
Interest/Enjoyment	4.80	.39	High
Perceived Competence	4.52	.59	High
Pressure/Tension	4.57	.88	High
Average Score	4.63	.62	High

The I-Algebra teaching module have high content validity and reliability. The coefficient value of Cohen's Kappa was 0.86. Meanwhile, the coefficient value of Cronbach Alpha was 0.953. There is no significant difference in the mean scores of the pre-test between the control group and treatment group. Therefore, the null hypothesis for this research question was failed to be rejected. Meanwhile, there were significant differences in the mean scores of three other research questions. Therefore, the null hypotheses for these research questions were rejected. The mean and standard deviation of year five pupils' post-experimental intrinsic motivation is 4.63 and 0.62 respectively. This post-experimental intrinsic motivation level analysis shows a great positive impact in term of motivation. Results of analysis indicated that the early mastery level of the pupils for both control group and the treatment group for the selected topics are almost identical. After intervention, I-Algebra teaching module made a greater positive impact in pupils' learning on the selected topics compared to the conventional teaching and learning.

4. CONCLUSION

In a conclusion, this module can have a positive impact in terms of achievement and motivation. The use of the I-Algebra teaching module implies the improvement of pupils' learning and can be referenced and used to meet the learning standards and align with the topics. As an implication, this study provides new ideas, guidance and information to teachers, especially Mathematics teachers, to apply I-Algebra in the class.

Declaration of Interest
The authors declare that there is no conflict of interest.

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