

The Need and Effectiveness of Form Two Algebraic Expression Training Module

Foo Jing Yao^{1*}, Mohd Faizal Nizam Lee Abdullah¹, Nur Hamiza Adenan¹ & Hoo Wai Yee²

¹Department of Mathematics, Universiti Pendidikan Sultan Idris, MALAYSIA,

²Faculty of Education, Tokyo Gakugei University, JAPAN

*Corresponding author: jyfoo1988@hotmail.com

Published: 03 Jun 2022

To cite this article (APA): Foo, J. Y., Abdullah, M. F. N. L., Adenan, N. H., & Hoo, W. Y. (2022). The Need and Effectiveness of Form Two Algebraic Expression Training Module. *EDUCATUM Journal of Science, Mathematics and Technology*, 9, 11-19. <https://doi.org/10.37134/ejsmt.vol9.sp.2.2022>

To link to this article: <https://doi.org/10.37134/ejsmt.vol9.sp.2.2022>

Abstract

The aims of the study are to determine the need and effectiveness of Algebraic Expression Training Module (Mi-T2) in improving Form Two students' higher order thinking skills. The level of thinking skill of Malaysian students is still low. A descriptive study and quasi-experimental study was conducted at a secondary school in Perak in order to determine the need and effectiveness of Mi-T2 module. Questionnaires about the need of Mi-T2 training module, pre-test and post-test were the instruments being used in the study. The school teacher provided responses by completing questionnaires to determine the need of module. A control group and experimental group were selected from the Form Two classes to be the sample study. They had to answer the instruments pre-test and post-test before and after the treatment. The findings showed that 80% mathematics teachers indicated that there is a need for the Mi-T2 training module. The comparison of the mean scores for the experimental group and control group showed that there was a significant improvement in the post-test result, but the increase of the mean score for the experimental group was higher which from 50.87% to 78.27%. In conclusion, the study shows that there is a need of Mi-T2 training module and the training module can help the students to master the topic of algebraic more effectively. It is in the hope that Mi-T2 training module can be used extensively to help more students in mastering the concept of algebra more effectively and improving their thinking skill.

Keywords module, algebra, need, effectiveness, thinking skill

INTRODUCTION

Mathematics is an interesting and inspiring subject. Continuous study of mathematics is very important for every individual. It can help to develop a person in terms of assertiveness, attention and ability to solve complex problems [1]. Therefore, Mathematic is a core subject in primary and secondary school curriculum. In year 2012, Ministry of Education Malaysia (MOE) introduced a blueprint named Malaysia Education Blueprint (PPPM) 2013 – 2025 to produce a young generation that have strong leadership skills, able to think critically and creatively, highly educated as well as able to communicate effectively at global level [2]. In the blueprint, Malaysia aspires to be the top third group in TIMSS and PISA international assessments within 15 years. In addition, MOE also aspires to maximize students' outcomes and the achievement gap between urban and rural areas [5]. Therefore, MOE reforms the curriculum and introduces Secondary School Standard Curriculum (KSSM) and Primary School Standard Curriculum – Review (KSSR Review) to provide a more comprehensive curriculum and help the students in mastering the mathematics knowledge more effectively. However, Malaysia's aspirations have not been achieved. Based on the international

assessments of Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS), the result showed that Malaysia's proficiency level in mathematics is still low. Malaysia scored 440 marks in PISA assessment year 2018 [3] and 461 marks in TIMSS assessment year 2019 [4]. According to the international assessment of PISA, the score between 421 and 482 is the second level of proficiency out of six levels. This level shows the students' ability in interpreting and recognizing situations in simple contexts that have direct conclusions but still unable to select and apply strategies in simple problem solving [5]. It showed that students' ability in solving mathematics is still weak and they are not able to use their understandings in solving complex mathematics questions. Students need more inputs and training to develop their thinking skills and knowledge in mathematics. It is the important step to realize the aspiration of PPPM 2013 – 2025.

PROBLEM STATEMENT

Higher Order Thinking Skills (HOTS) is an important and emphasized element in the Malaysia education system. The HOTS element has been applied to all the learning subjects from Standard One until Form Five. Although the learning resources of HOTS are sufficient, but students' thinking skills have not been fully developed. The students' ability to apply knowledge and critical thinking in problem solving is still weak [6]. In [7] study, the findings showed that Form Five students' thinking skill is low and unable to solve mathematical problem with HOTS element. This issue occurred because the mathematics teachers are too focused on examination questions and tied to the common solution methods only. In addition, the teachers also do not provide HOTS questions in daily teaching [7]. Therefore, the students are not able to relate the facts and concepts with the application of mathematics in daily life. This issue affects the students' achievement in national and international assessments. According to [8] report, there were only 2.2% of the students scored distinction for all subjects, 19% of the students passed all subjects and 41.1% of the students failed at least one subject in *Sijil Pelajaran Malaysia* (SPM) in year 2018. For Mathematics subject, there were 18% of the students failed this subject and the Grade Point Average (GPA) was 5.03. This implied that majority of the Form Five students did not master the HOTS and only a small group of the students was able to use their HOTS to solve the problems. Besides that, the percentage of HOTS questions in national assessment such as SPM has been increasing. The percentage of HOTS questions had been increased from 30% (year 2018) to 50% (year 2021). If the students' HOTS is not able to be developed, the students' achievement in national assessment will deteriorate and unable to compete in the global stage in future. Besides that, the students' interest in learning Mathematics will be affected too. They may give up in learning Mathematics. Therefore, Mathematics teacher should provide more opportunities to expose the students with the HOTS questions and develop their HOTS since early stage secondary school. When the students' HOTS is developed, the students' self-confidence and interest in learning Mathematics will be cultivated too.

In the PPPM 2013 – 2025, Malaysia aspires to be the top third group in the TIMSS and PISA international assessments. However, this aspiration has not been achieved and year 2025 is around the corner. The country that in the top third group has scored at least 500 marks in TIMSS and PISA assessments. However, Malaysia has never scored more than 500 marks in the last decade for TIMSS and PISA assessments. There are three cognitive domains to be tested in TIMSS assessment which are knowledge, application and evaluation. Base on [4] report, Malaysia scored 451 marks for the knowledge domain, 464 marks for application domain and 462 marks for evaluation domain in TIMSS assessment year 2019. This situation shows that Malaysia's students are not ready to accept the challenge. In order to be the top third group, Malaysia students need to work hard in developing their thinking skills. It is because 65% of the questions in TIMSS assessment [4] and 50% of the questions in PISA assessment [9] are HOTS questions. If the students do not have HOTS, they may not be able to understand and answer the questions in the coming TIMSS and PISA assessments. Besides that, students need to master the concept of Algebra well before facing the assessment. There are four content domains in TIMSS and PISA assessment which are Numbers, Algebra, Geometry and Data and Probabilities [4]. Geometry and Data and Probabilities cover the minority of questions in the assessment which are 20% respectively, while Numbers and Algebra cover the majority number of questions in the assessment which are 30% respectively. The score for Algebra domain in TIMSS assessment is the lowest among the four content domains for year 2007, 2011, 2015 and 2019 [4]. It shows that Algebra topic is the weakness for Malaysia's students. Students need to strengthen their understanding in Algebra topic. Therefore, there is a need to help the students in mastering the concept

of Algebra well before the next assessment.

Mi-T2 module is a training module developed to help the students to master the concept of Algebra and HOTS. All the questions in the module are Algebra's HOTS questions. This intends to provide a chance for the Form Two students by exposing themselves to the HOTS questions. In this study, the need of Mi-T2 training module will be determined among the secondary school's teachers. Besides that, the effectiveness of the module will be tested to determine whether the module can have positive impact on the students' learning.

Study Objectives:

The objectives of the study are as below:

1. Determine the need of Algebraic Expression Training Module for the secondary school teachers.
2. Determine the effectiveness of Algebraic Expression Training Module on students' learning.

Study Questions:

The study is conducted to answer the following questions:

1. Are the secondary school teachers demonstrating a need on Algebraic Expression Training Module?
2. Is the Algebraic Expression Training Module having a positive effect on the level of achievement of Form Two students?

Study Hypothesis:

The study is guided by the following Null Hypothesis:

- H₀₁: There is no significant difference between the mean scores of experimental and control group on pre-test.
- H₀₂: There is no significant difference between the mean scores of experimental and control group on post-test.
- H₀₃: There is no significant difference between the mean scores of control group on pre-test and post-test.
- H₀₄: There is no significant difference between the mean scores of experimental group on pre-test and post-test.

MATERIALS AND METHODS

There are two types of study design involved in the study. The need of Mi-T2 training module among the secondary school teachers is determined through a survey study and the effectiveness of Mi-T2 training module is determined through a quasi-experimental study. This study is conducted in Perak state and a secondary school is chosen in the study. All the Mathematics teachers and two classes of the Form Two students involves in the study. The questionnaires about the need of Mi-T2 training module, Mi-T2 training module, pre-test and post-test are the instruments being used in the study. The questionnaires are answered by the secondary school Mathematics teachers and their responses will be recorded to determine the desire of teachers for the module. The validity and reliability of the questionnaire are valued at 1.000 and 0.912 respectively. For the instruments of pre-test and post-test, they are used to determine the effectiveness of the treatment. The validity and reliability of the tests are valued at 1.000 and 0.958 respectively. Pre-test will be provided before the treatment and post-test will be provided after the treatment. These instruments are answered by two groups of Form Two students which are control group and experimental group. The control group and experimental group follow different type of treatments. The control group follows the traditional way of learning process that teacher plays the major role in teaching and learning (T&L) process and Mathematics textbooks are the main resources for the students. For the experimental group, the teacher plays the role as facilitator to provide guidance to the students when they face problems and the students play the main role in the learning process. Students have to take their own initiatives in the learning process. The main resource for experimental group is Mi-T2 training module. The validity and reliability of the module are valued at 0.89 and 0.911 respectively. The students have to follow all activities and answer all

HOTS questions in the module. After the data collection process, teachers' responses and students' achievement in pre-test and post-test will be analysed. The Descriptive Analysis is conducted to analyse the teachers' response. The percentages of agreement and disagreement are calculated to determine the need of secondary school Mathematics teacher on Mi-T2 training module. For the pre-test and post-test, students' result will be analysed to find the mean scores. The mean scores of the students are compared to determine the effectiveness of the module. If there is an improvement on the mean score of experimental group after the treatment, it means that Mi-T2 training module is an effective module. Students can obtain a positive impact on their learning process during the treatment. Besides that, t-test analysis is conducted to reject the null hypothesis. Independent t-test is conducted to compare the mean scores between control group and experimental group in pre-test or post-test. Dependent t-test is conducted to compare the mean score of pre-test and post-post for control group or experimental group. If the p value is less than 0.05, the null hypothesis will be rejected. If the p value is more than 0.05, the null hypothesis will be failed to reject.

RESULTS AND DISCUSSION

The secondary school Mathematics teachers had answered the questionnaire about the need of Mi-T2 training module. All Mathematics teachers in the school are experienced teachers. 20% of the Mathematics teachers have at least 16 years of teaching experiences in Mathematics subject and 80% of the Mathematics teachers have at least five years of teaching experience in Mathematics subject. Therefore, they know the strengths and weaknesses of their students well. Besides that, 80% of the Mathematics teachers has Bachelor's degree and 20% of the Mathematics teachers has Master's degree. Table 1 shows the summary of secondary school Mathematics teachers' needs on Mi-T2 training module:

Table 1 The summary of secondary school Mathematics teachers' needs on Mi-T2 training module

No.	Statements	Agree	Not Agree
1.	Have you ever used i-think maps in daily teaching and learning process?	20%	80%
2.	Do you need an i-think module in daily teaching and learning process?	40%	60%
3.	Do you need a mathematics i-think module as a teaching aid in teaching and learning mathematics?	40%	60%
4.	Do you need a mathematics i-think module as a teaching aid in teaching Algebra topic?	80%	20%
5.	If there was an Algebraic Expression Training Module (i-think training module) as an additional teaching aid in teaching and learning topic Algebra, would you use it?	80%	20%

From Table 1, 20% of the teachers had ever used i-think maps in their daily T&L process whilst 80% of the teachers had never used i-think maps. It showed that majority of the Mathematics teachers in the school are not familiar with i-think maps. Besides that, 40% of the teachers indicated that there is a need on i-think module in daily T&L process and 60% of the teachers did not indicate the need on i-think module. The third statement had the same result as statement two whereby 40% of the teachers indicated that there is a need on Mathematics i-think module as a teaching aid in T&L Mathematics whilst 60% of the teachers did not indicate the need on Mathematics i-think module. From the first statement until third statement, majority of the Mathematics teachers in the school did not use i-think maps in their daily T&L process. I-think maps are not the famous thinking tool used by the secondary school teachers to develop students thinking skills. The teachers might use the traditional ways to deliver the knowledge to the students. The need of Mathematics i-thinks module in T&L process was low. However, the need of Mathematics i-think training module has increased when involving topic Algebra. 80% of the teachers indicated a need on Mathematics i-think training module as an additional teaching aid in teaching Algebra topic and only 20% of the teachers did not indicate a need on i-think module while teaching Algebra topic. According to the responses of the school teachers, these indicated that the students were weak in Algebra topic and they were not able to answer the Algebra questions effectively. Hence, the teachers need extra teaching aid to deliver

the Algebra concept. Therefore, 80% of the teachers agreed to use Mi-T2 training module as an additional teaching aid in T&L Algebra topic and only 20% of the teachers did not agree to use it. The teachers hoped that the using of Algebraic Expression Training Module can help the students in mastering the concept of Algebra effectively. Based on the teachers' responses, the need of Mi-T2 training module was determined. The secondary school Mathematics teachers were demonstrating a need on Mi-T2 training module. The first objective was answered.

To test the effectiveness of Mi-T2 training module, experimental group and control group had answered the pre-test before the treatment and post-test after the treatment. The result of the pre-test and post-test were analysed to check the difference between the experimental group and control group. Table 2 shows the mean score of pre-test and post-test for control group and experimental group.

Table 2 Mean score of pre-test and post-test for control group and experimental group

Group	Mean Score of Pre-test	Mean Score of Post-test	Difference of Mean Scores
Control	48.8	54.6	+ 5.8
Experimental	50.87	78.27	+ 27.4

According to Table 2, the mean score for control group and experimental group in pre-test had no significant difference. The mean score for control group in pre-test was 48.8 marks and mean score for experimental group was 50.87 marks. The difference of mean score in pre-test was 2.07. The grade of the mean score for pre-test was D and E [14]. The students only achieved the minimum of the mastery level. However, the mean score for control group and experimental group in post-test had a significant difference. The mean score for control group in post test was 54.6 and mean score for experimental group was 78.27. The post test's mean score of experimental group was higher than control group at 23.67. For the difference between pre-test and post-test, the control group had a mean score increase of 5.8 and the grade of the mean score had improved from grade E to grade D [14]. For the experimental group, they had a mean score increase of 27.4 and the grade improved from grade D to grade B [14]. These results indicated that traditional teaching method and Mi-T2 training module can help the students to master the concept of Algebra better. Although both groups had an increase in mean scores, but the experimental group showed a higher improvement compared to the control group. These results indicated that Mi-T2 training module can have a positive significant impact on the student study in the topic of Algebra. This training module can help the experimental group students to master the concept of Algebra better compared to the traditional teaching method. The second objective was answered.

Table 3 T-test on the mean scores of pre-test for control group and experimental group

Group (Pre-test)	N	Mean Scores	Standard Deviation	t-Value	Sig. (2-tails) (p)
Control	30	48.80	20.407	- 0.540	0.594
Experimental	30	50.87	20.569		

(N = Number of respondent, Sig. = Significant)

According to Table 3, the control group's mean score in pre-test was 48.80 and the standard deviation was 20.407, where as the experimental group's mean score in pre-test was 50.87 and the standard deviation was 20.569. The results of t-test showed that the t-value was -0.540 and p-value was 0.594. Since the p-value had exceeded the value of 0.05, the hypothesis H_{01} failed to reject. It meant that there was no significant difference in the mean score of pre-test for control group and experimental group. The initial mastery level of students of experimental group and control group in the Algebra topic was almost the same. Besides that, the students' ability of experimental group and control group in solving Algebra's HOTS questions was almost the same.

Table 4 T-test on the mean scores of post-test for control group and experimental group

Group (Post-test)	N	Mean Scores	Standard Deviation	t-Value	Sig. (2-tails) (p)
Control	30	54.60	19.939	- 6.036	0.000
Experimental	30	78.27	12.191		

(N = Number of respondent, Sig. = Significant)

According to Table 4, the control group's mean score in post-test was 54.60 and the standard deviation was 19.939, where as the experimental group's mean score in post-test was 78.27 and the standard deviation was 12.191. The results of t-test showed that the t-value was -6.036 and p-value was 0.000. Since the p-value had not exceeded the value of 0.05, the hypothesis H_{02} was rejected. It meant that there was a significant difference in the mean score of post-test for control group and experimental group. Although both groups had improvement in post-test, but the experimental group students had a great improvement compared to control group. The experimental group students can score a high mark in post-test after completed the Mi-T2 training module. It proved that Mi-T2 training module can help the experimental group students to master the concept of Algebra more effectively compared to the traditional T&L methods.

Table 5 T-test on the mean scores of pre-test and post-test for control group

Test (Control Group)	N	Mean Scores	Standard Deviation	t-Value	Sig. (2-tails) (p)
Pre	30	48.80	20.407	- 6.435	0.000
Post	30	54.60	19.939		

(N = Number of respondent, Sig. = Significant)

Base on Table 5, the control group's mean score in pre-test was 48.80 and the standard deviation was 20.407. For post test, the control group's mean score was 54.60 and the standard deviation was 19.939. The result of t-test showed that the t-value was -6.435 and p-value was 0.000. Since the p-value was less than 0.05, the hypothesis H_{03} was rejected. It meant that there was a significant difference in the mean score of pre-test and post-test for control group. The control group's students had an improvement in mastering the concept of Algebra after the treatment. However, the improvement of the mean score for control group after the treatment was 5.8. This indicated that the traditional T&L method is not able to develop the students' HOTS skills well. The students' HOTS skills are still low and they are not able to solve the HOTS questions effectively.

Table 6 T-test on the mean scores of pre-test and post-test for experimental group

Test (Experimental Group)	N	Mean Scores	Standard Deviation	t-Value	Sig. (2-tails) (p)
Pre	30	50.87	20.569	- 8.307	0.000
Post	30	78.27	12.191		

(N = Number of respondent, Sig. = Significant)

Base on Table 6, the experimental group's mean score in pre-test was 50.87 and the standard deviation was 20.569. For post test, the experimental group's mean score was 78.27 and standard deviation was 12.191. The result of t-test showed that the t-value was -8.307 and p-value was 0.000. Since the p-value was less than 0.05, the hypothesis H_{04} was rejected. It meant that there was a significant difference in the mean score of pre-test and post-test for experimental group. There was an improvement for experimental group in mastering the concept of Algebra after followed the Mi-T2 training module. The mean score for experiment group had increased 27.4. This indicated that the students' ability in answering HOTS question had been improved. The students are able to use the HOTS skills to solve the HOTS questions after following the Mi-T2 training module.

From the analysis of the need of Mi-T2 training module, majority of the Mathematics teachers did not use i-think maps in their T&L process. The reason of the Mathematics teachers not familiar with i-think maps was because they are in view that by using the traditional ways to deliver the knowledge also can help

the students to master the concept of Mathematics successfully. Besides that, drawing an i-think map during the T&L process is a waste of time and the teacher might not be able to finish the content within the time allocated. Therefore, they were not accustomed to use i-think maps in their T&L process. However, the Mathematics teachers had different response when discussed the Algebra topic. They needed a module to help the students in mastering the concept of Algebra effectively. The teachers found that the students were weak in Algebra and they always confused with the Algebra's concept. Algebra is the most difficult topic between all the Mathematics topics [10], [12]. If the students are able to master the concept of Algebra well, they might be able to master other topics of Mathematics easily [11]. It is because some of the Mathematics topics like Geometry, Linear Equation and Linear Inequality need the concept of Algebra as basic in mastering the knowledge. Therefore, 80% of the Mathematics teachers agreed to use Mi-T2 module to help the students in mastering the concept of Algebra. They hope the Mi-T2 training module can help the students in mastering the concept of Algebra effectively. The need of Mi-T2 training module among the Mathematics teachers was determined.

From the analysis of pre-test, the difference of mean scores for experimental group and control group was not big. The mean scores for experimental group and control group in pre-test were not high, only 50.87 and 48.80 respectively. According to [14], the score range between 50 and 59 is at satisfactory level and the score range between 40 and 49 is at the minimum level. It meant that the students' understanding in Algebra topic only at medium level. Most of the Algebra's concepts are not mastered by the students. They are not able to apply the Algebra's concept in problem solving. Besides that, the p-value in t-test showed that there was no significant difference between experimental group and control group in pre-test. It meant that both groups had received similar input and the ability to solve the Algebra questions was also similar. However, the ability to solve the HOTS questions for both groups was still low. They were not able to apply the thinking skills such as applying, analysing, evaluating and creating in problem solving. The students' exposure to HOTS questions was not enough. As mentioned in [13] study, Algebra is a difficult topic to master and students' achievement in Algebra is still weak. Many Algebra questions in pre-test are in the form of long sentences and required students' analytical skills in problem solving. If the students learnt Algebra through the technique of memorizing, they might not able to understand and master the concept of Algebra well. It caused the students' failure in solving Algebra HOTS questions. If this situation continues, the students may lose their interest in studying Algebra and they may not put effort to master and understand the Algebra topic well. Without Algebra knowledge, the students will face the difficulty in studying other Mathematics topics too.

From the post-test's analysis, the result showed that the mean scores for experimental group and control group had increased. The p-value in Table 5 and Table 6 also proved that there was a significant difference in the mean score of pre-test and post-test for experimental group and control group. It meant that there was a positive impact for experimental group and control group after received the treatment. The ability of the students in answering Algebra questions for experimental group and control group becomes well after the treatment. Traditional teaching method and Mi-T2 training module can help the students to understand the concept of Algebra better. However, the increase of mean score for experimental group in post-test was higher than control group. The experimental group increased by 27.4 marks and control group increased by 5.8 marks after received the treatment. Although there is an increment in mean score of control group, but the increment is very small and it is at satisfactory level only which is grade D. The students do not achieve the good or distinction level yet. The students at this level still do not have the ability to face the challenging assessment like TIMSS and PISA. For experimental group, the mean score improved from grade D to grade B which is credit level. Although the students do not achieve distinction level yet, but the ability in solving Algebra question has improved. The experimental group's students had a better problem solving ability in Algebra questions compared to the control group after the treatment. If the experimental group continues to receive training module treatment, they may achieve distinction level soon and able to answer the challenging assessment.

From the t-test analysis, the p-value in Table 4 showed that there was a significant difference in the mean score for experimental group and control group in post-test. It showed that Mi-T2 training module had a better effect on students' study if compared to traditional teaching method. The experimental group scored a better mean score in post-test compared to the control group. The experimental group was able to apply their understandings in solving the Algebra's HOTS questions more effectively compared to the control group. On the other hand, it also meant the experimental group's students had developed their HOTS skill after the treatment. They were able to apply the thinking skills such as applying, analysing, evaluating

and creating in solving the HOTS questions during the post-test. However, the HOTS skill for control group had not been developed. They were not able to apply HOTS skill in solving HOTS questions and scored a high mean score in post-test. Therefore, Mi-T2 training module can help the teachers to deliver the knowledge of Algebra more effectively and the HOTS of the students can also be developed. If all students have the opportunity to follow HOTS training module like Mi-T2 training module, the aspiration of PPPM 2013 – 2025 will be achieved on time to be the top third group in the TIMSS and PISA international assessments. The effectiveness of the Mi-T2 training module was determined.

CONCLUSION

HOTS is emphasized in the Malaysia education system since PPPM 2013 – 2025 introduced. A lot of studies were conducted by the educators and researchers to develop the students' thinking skills. Mi-T2 training module is built to develop students thinking skills in Algebra topic. From the analysis of the result, majority of the secondary school mathematics teachers indicated the need on Mi-T2 training module since the thinking skills of the students had yet to be fully developed. Besides that, the mastery level of the students in Algebra is still low. Students do not have the ability to solve the Algebra's HOTS question confidently. Therefore, the Mathematics teachers agree to use Mi-T2 training module as an additional teaching aid for them to develop students' thinking skills and understandings in Algebra topic. From the quasi-experimental, the result showed that Mi-T2 training module is able to help the students in developing their HOTS in topic of Algebra. The mean score of the students improved from Grade D to Grade B. It proved that Mi-T2 module is a useful module and able to enhance the students' problem solving ability. Besides that, the HOTS questions in Mi-T2 training module can stimulate HOTS of the students. The HOTS of the students are developed after receiving the treatment. The effectiveness of the module is reliable. It is hoped that Mi-T2 training module can be widely used in secondary school and the Mathematics teachers can use the module to help the students in improving their understanding and thinking skills in topic of Algebra. Besides that, the secondary school students also can use Mi-T2 training module to reinforce their understanding in Algebra topic and stimulate their thinking skills in solving HOTS questions.

ACKNOWLEDGEMENTS

The highest appreciation to the Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, Malaysia (FSM, UPSI) for funding the participation fee (RM300) to the 9th International Postgraduate Conference on Science and Mathematics (IPCSM) 2021.

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