Development and Validation of a Teaching Module based on the Traditional Approach of the Japanese Bansho Plan Towards the Mastery of Quadratic Equations

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***Abstract*—This study is an effort to develop and evaluate the validity of the Bansho Plan-Based Teaching Module to improve students' Higher Order Thinking Skills (HOTS) mastery of the topic of Quadratic Equations. The interactive module comprises six lesson units to provide students with the opportunity to explore the application of the Quadratic Equations concept in real-life situations. The design, development, and validity evaluation of the module was based on the design and development research approach. The discussion focused on two phases, namely the requirements analysis and the development design. The Morrison, Ross, and Kemp (2007) model consisting of nine components was used to support the module development in the first stage of the current study. Meanwhile, the second stage involved an evaluation of the module's validity and the implementation of a pilot study. Responses from five Mathematics education experts were analyzed using the Percentage Calculation Method (PCM). The highest mean score for content validity coefficient was obtained by the knowledge level aspect with 0.96. This confirms that the module is in line with the national curriculum, as well as the complexity level of all problems presented in the module is not confusing and the module is capable of applying HOTS to the topic of Quadratic Equations. Furthermore, a reliability test was done on the learning objectives through a pilot study involving thirty students. The results showed that the module obtained a Cronbach's Alpha coefficient value of 0.915, indicating its good consistency. One major contribution of this study is that it highlights the uniqueness of combining multimedia modules with the traditional approach of the Bansho Plan. It creates an awareness that traditional teaching approaches, such as the Bansho Plan, should not be labelled as outdated, but instead its wisdom needs to be explored and adapted to the demands and needs of 21st century teaching.**

***Keywords*—Bansho Plan, design and development research, quadratic equations, development, validation**

I. Introduction

According to a report by the Programme for International Student Assessment (PISA) in 2018, Japanese education had shown a stable average mathematical literacy achievement from 2003 to 2018. The country has been recognised as among the top performers in mathematical literacy achievement along with Korea and Estonia [1]. However, it raises several questions, particularly on the speciality and prominence of the Japanese approach to teaching Mathematics in maintaining students' excellence. This can be answered by identifying the uniqueness of the teaching approach practised in Japan. According to Doig and Groves [2], the teaching situation in Japan differs from other countries where the local education process is a public activity. The establishment of a reflective learning situation and the cultivation of openness in giving and receiving suggestions for improvement among teachers serve as important ingredients in the Japanese teaching system. For this reason, we believe that investigating the nature of how to teach Mathematics shall be highly informative for Mathematics teaching in other countries [3].

The significance of exploring Teaching and Learning (T&L) methods for Higher Order Thinking Skills (HOTS) in Mathematics lies in the fact that it is a primary requirement for students to compete at the international level, in addition to mastering the subject [4]. According to Zulkifli *et al.* [5], students' ability to answer HOTS questions often depends on three main determinants: students themselves, learning materials, and teaching approaches. Therefore, it is crucial to enhance the pedagogy in secondary schools by developing modules based on interactive multimedia, with a focus on problem-solving while incorporating the concept of HOTS.

However, the limited availability of modules or other reference materials that encompass HOTS characteristics remains the primary constraint in the T&L of HOTS in the classroom [6]. The emergence of interactive multimedia software modules, created by multimedia designers who lack knowledge about the requirements of the national education curriculum, further poses significant challenges for teachers when applying these software modules in real learning [7].

In the 21st century, classrooms, especially in developed countries, are equipped with sophisticated teaching aids such as interactive whiteboards, Liquid Crystal Display (LCD) projectors, laptops, and public address systems. Although Japan is no stranger to technological advancement, the majority of local teachers or *sensei* still maintain the use of blackboards in teaching Mathematics [8]. They believe that blackboards are still relevant and have many advantages. Blackboards allow the students' strategies and solutions, expressed in the form of symbols, letters, algorithms, and labelled diagrams, to be recorded systematically on a large blackboard [9, 10]. As a result, blackboard use has been a practice for generations that it is integrated into the teaching system across Japanese schools [11].

In the current era of scientific and technological advancement, blackboards are perceived as an ancient teaching tool with no significant effect on learning [12]. However, its creative and innovative usage for teaching purposes is common in Japan, where a vast majority of the local classrooms have at least one large blackboard that

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stretches across the entire width of the classrooms (see Fig. 1 for an example). This is in contrast with how blackboards are typically used in Western classrooms where it tends to occupy a much smaller fraction of the front wall, and only a small amount of content is normally visible at one time [3]. According to Leong *et al*. [8], Japanese teachers emphasise the ability to use blackboards effectively with the view that it is a critical skill in teaching and learning Mathematics. They believe that learning Mathematics via blackboards can foster student-oriented learning through teaching strategies such as discovery and open exploration. As blackboard-based teaching is an important skill for teachers to develop, Japanese teachers use a unique term called '*bansho*' to discuss problem-solving questions that involve writing on the blackboards [13, 14].

Fig. 1. A large blackboard in a Japanese classroom [11].

A. Using Bansho to Support Structured Problem-Solving

Structured problem-solving questions are among the main components in the teaching and learning of Mathematics in Japanese classrooms, particularly through the Bansho plan [15]. Usually, problem-solving questions focus on the process to solve a problem but in Japan, structured problem-solving questions are incorporated into in-class lessons to cultivate problem-solving skills and strategies, as well as into the curriculum to develop mathematical concepts, skills, and procedures (see Fig. 2). While comparing solutions, students not only need to display their thinking, but also listen to ideas and solutions proposed by others, interpret these ideas, challenge different lines of reasoning if needed, and give feedback by solving the respective problem [16].

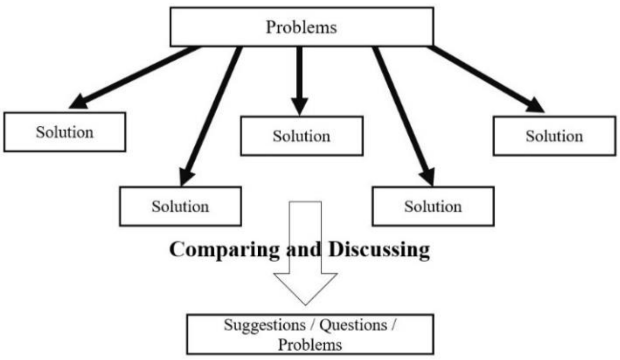


Fig. 2. Model of structured problem-solving.

The use of blackboards allows for students' solutions to be more organised, clear, and easy to understand by separating the blackboard into several segments or spaces. In each lesson, teachers will arrange every representation or idea on the blackboard carefully by providing a space to display the tasks for the whole class to view, a space for follow-up tasks, a space for response, a designated space to present the students' ideas, a comment space, and a space for reflection (see Fig. 3). Apart from displaying the tasks and solutions, Japanese teachers fully utilise the blackboard to allow for interpretations, judgments, predictions, summaries, descriptions, and relate each sequence of the learning process to further improve the students' intellectual performance.

Fig. 3. An example of blackboard usage by Japanese teachers [17].

Bansho-keikaku, also known as the Bansho Plan, is a technical term introduced by the Japanese education community that can be translated as a blackboard writing plan [18]. Kuehnert *et al*. [18] believe that the Japanese Bansho Plan is centred on a three step-by-step phase, namely (i) activating students' existing knowledge (*Hatsumon*), (ii) exploring problems (*Kikan-shido* and *Neriage*), and (iii) discussing and continuing ideas (*Matome*). In this approach, lesson contents are arranged from concrete (easy) to abstract (difficult) (see Table 1. Such arrangement facilitates students to view and understand how the teaching and learning process is conducted and ideas resulting from their thinking skills are discussed during and at the end of the teaching and learning process. Fig. 4 shows the proposed layout of the Japanese Bansho Plan Model.

Table 1. Phases to implement the Japanese Bansho Plan in teaching and learning

Phase 1	Phase 2	Phase 3
Activating students' existing knowledge	Exploring problems	Discussion and continuation of ideas
• Induction sets in the form of media or mathematical keywords. • Situational-based problem statement.	• Individual problem-solving. • Group discussion. • Students' responses (Presentation of ideas)	• Application of new knowledge. • Arranging students' responses (Restructuring idea-schema and summaries). • Reflection (exercises and making continuation for the next lesson).
Concrete →	Semi-concrete →	Abstract

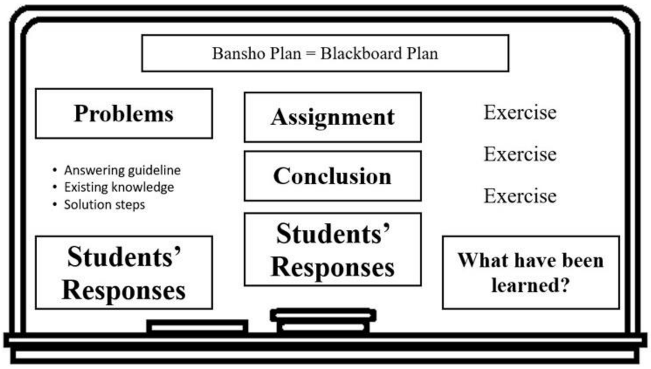


Fig. 4. Arrangement of the Bansho Plan.

Researchers have contributed prominent ideas as well as teaching and learning methods to improve students' HOTS for them to be able to solve problems within the job market and work industry in the future [19]. Many educators have also introduced various approaches to the teaching and learning of Mathematics. Nevertheless, the efficacy of combining a multimedia module and the traditional approach of the *Bansho* Plan in cultivating HOTS to solve everyday life problems in Mathematics remains a debatable notion. Such a teaching approach has long been introduced and utilised within the Japanese educational system, particularly in the teaching of Mathematics, and its prominence is now expanding across other countries including Malaysia. However, exposure to new methods or approaches may not necessarily have a positive impact on all students with different backgrounds and geographical factors [20]. Following this issue, this study aims to develop a multimedia module that integrates the Japanese traditional teaching method, namely the Bansho Plan, as an alternative pedagogical practice to improve HOTS for the topic of quadratic equations.

B. Conceptual Framework

The conceptual framework of this study is a combination of three theories and one model, namely the APOS theory (i.e., Action, Process, Object, Scheme theory), social constructivism theory, the Cognitive Theory of Multimedia Learning, and the Bloom Taxonomy Model. Discussions on the conceptual framework began with the APOS theory and social constructivism theory as the main pillars of the content and appropriate learning activities in developing the module. It was followed by Anderson's Taxonomy Model (2001) [21] as a guide to the cross-checking of the HOTS cognitive levels of learning for the Quadratic Equations topic. The Cognitive Theory of Multimedia Learning was then employed to design a teaching software in the form of a multimedia interaction teaching approach before the Morrison, Ross, and Kemp Model [22] was used to determine the module's development design.

The APOS theory helped the researchers systematically formulate the learning criteria for the Quadratic Equations content for the content to be in line with the students' cognitive development. The social constructivism theory was also utilised in the construction of this module to help teachers nurture students to be actively involved in learning mathematics [23]. The theory posits that students do not just receive knowledge passively but rather build their Quadratic Equations knowledge through active learning via the Bansho Plan approach. As the Bansho Plan teaching module is based on multimedia elements, the development of the module was also based on the Cognitive Theory of Multimedia Learning, which suggests that any image applied must be of high quality and that the narrative text must be relevant to the learning objectives. This is because the use of irrelevant multimedia elements can cause distraction and increase the cognitive load in students' memory [24].

Furthermore, Anderson's Taxonomy Model (2001) [21] was also used to develop teaching content that is in line with the HOTS domains (applying, analysing, and evaluating). As the module designed in this study is a teaching software, there is a need for a specific instructional design model to serve as the main pillar for the needs analysis and teaching module development phases. For this purpose, the Morrison, Ross, and Kemp [22] model was chosen as the basis for module development. It comprises nine interrelated components and is widely used to develop various mathematical instructional modules [25, 26]. Fig. 5 illustrates all theories and models used in this study.

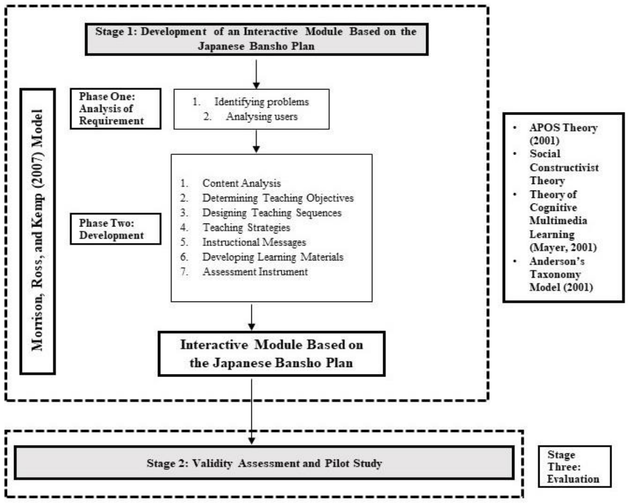


Fig. 5. Conceptual framework.

C. Research Questions

The research questions of this study can be divided into two levels:

Level 1: Developing a teaching module based on the Japanese Bansho Plan approach.

1) What is the HOTS mastery level for the topic of Quadratic Equations among form four students?
2) How is the teaching module based on the Japanese Bansho Plan approach developed for the form four Quadratic Equations topic?

Level 2: Assessing the validity of the teaching module based on the Japanese Bansho Plan approach.

1) To what extent does the content validity of the Bansho Plan-Based Teaching module achieved among experts?
2) How reliable is the Bansho Plan-Based Teaching Module among students?

II. MATERIALS AND METHODS

A. Research Design

In this study, the design of the development and validity evaluation of the Bansho Plan-Based Teaching Module was based on the Design and Development Research (DDR) approach [27]. The DDR approach comprises three phases, namely the requirement analysis phase, development design phase, and evaluation phase [28]. Nevertheless, the discussion of the current research focused on two phases, namely requirement analysis and development design phases. The Morrison, Ross, and Kemp model [22], which consisted of nine components, was used as the underpinning theory for the development of the module in the first stage of the current study.

The second phase was the evaluation of the module's validity and the implementation of the pilot study. During this stage, the module was revised and improved twice. The first revision was done based on the validity review from the content experts, followed by a reliability analysis during the pilot study. In short, the DDR approach was deemed advantageous as it systematically guided the researcher to develop research with the condition that every methodology used complied with the procedures that had been set [28].

The data analysis was conducted based on the respective research questions. In Research Question 1, descriptive statistical analysis was employed to determine the mean percentage value of the needs analysis diagnostic test score. Meanwhile, the second and third research questions involved calculating the confirmation levels of expert validity using the Percentage Calculation Method (PCM). Additionally, the last research question aimed to determine the module's reliability using Cronbach's Alpha coefficient. A detailed explanation of the data analysis procedures is available in the Module Development Procedure section.

B. Research Sample

1) Stage 1: Analysis of module development requirements

The research sample was selected via purposive sampling. It began with the needs analysis phase which involved the diagnostic test of form four students. In line with the Morrison, Ross, and Kemp model [22], the needs analysis phase involved identifying teaching problems and analyzing users. The participants of the HOTS Diagnostic Test consisted of 45 form four Malaysian students taking the Mathematics subject across three national secondary schools in the districts of Kunak, Lahad Datu, and Tawau. These participants were recruited based on several selection criteria including various racial backgrounds, genders, and academically good performance in Mathematics [29].

2) Stage 2: Validity evaluation of the module and implementation of the pilot study

A teaching module is a complete module that can be implemented in a real research context, once it passes the expert validation and reliability check processes [30]. The selection criteria for module content validity experts were based on Yazdanmehur and Akbari's [31] recommendations where the experts must have a minimum of five years of working experience and possess specific experience, such as a senior lecturer in mathematics education. In addition, experts must also be Subject-Matter Experts (SMEs) who are directly involved in related studies such as the drafters of HOTS in Mathematics and coordinators of the National Mathematics curriculum. Table 2 shows the panel of experts involved in the module evaluation of the current study.

Table 2. Face validity evaluation of the module

Expert	Position	Area of Expertise	Institution	Years of Experience
P1	Senior Lecturer	Mathematics Education	Department of Science, Mathematics, and Creative Multimedia, UTM.	7 Years
P2	Senior Lecturer	Pure Mathematics	Department of Mathematics, Centre of Technological Foundation, UMS.	12 Years
P3	Senior Lecturer	Mathematics Education	Department of Science and Mathematics, IPG Ipoh.	24 Years
P4	Head of Mathematics Department	HOTS in Mathematics	Beluran Bestari High School	12 Years
P5	Deputy Director of Mathematics	National Mathematics Curriculum	Science and Mathematics Unit, State Education Department	12 Years

A pilot study of the module was conducted for three weeks from 10 January 2022 to 24 January 2022. It involved thirty students from a national secondary school within the district of Nilai, Negeri Sembilan. The prototype of the Bansho Plan-Based Teaching Module used in the pilot study underwent validation and improvement processes based on the comments and suggestions received from the experts.

C. Module Development Procedures

1) Needs analysis phase

Aligned with the Morrison, Ross, and Kemp model [22], the Needs Analysis Phase involved two components, namely identifying the teaching problems and analysing the users. For this purpose, the Diagnostic Test for the HOTS Mastery of Quadratic Equations was used to identify the students' existing level of mastery. The test consisted of nine problem-solving questions based on everyday situations and the delivery of these structured questions adhered to the national exam assessment format [32]. This phase aimed to identify and categorise the students' existing HOTS level into three levels (i.e., low, medium, and high) in mastering the topic of Quadratic Equations in the Mathematics subject [33]. Examples of the HOTS items assessed in the Diagnostic Test are available in Fig. 6.

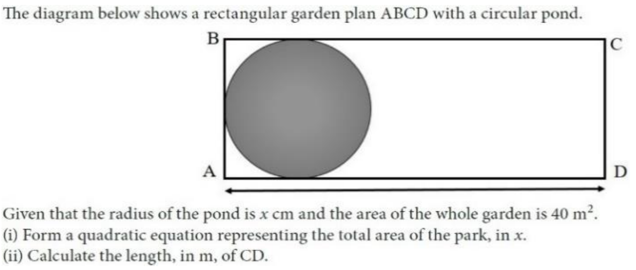


Fig. 6. HOTS items assessed in the diagnostic test.

2) Design and development phase

The development of this module was based on the components proposed in the Morrison, Ross, and Kemp Model [22]. As shown in Fig. 7 this model comprised nine small components that underpinned the first stage of this study. The first two components categorized in the needs analysis process were (1) identifying the teaching problems and (2) identifying the targets. Both components were implemented and will be discussed in the Needs Analysis Phase.

The subsequent components were (1) content analysis (selecting the topics and procedures), (2) determining teaching objectives, (3) designing teaching sequences (sequencing), (4) designing teaching strategies, (5) designing instructional messages, (6) developing learning materials and planning teaching delivery methods, and (7) developing teaching assessment instrument [22]. All seven sub-components were implemented in the design and development phase of the module.

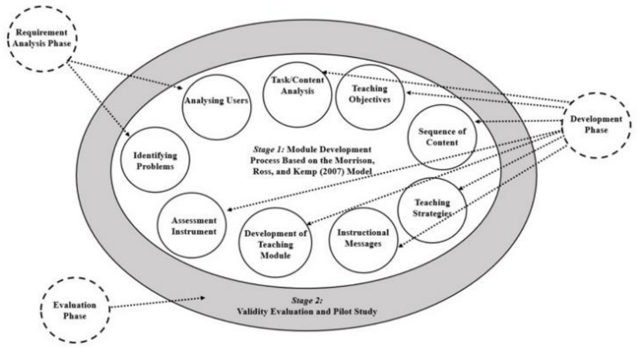


Fig. 7. Procedures for teaching module development based on the Morrison, Ross, and Kemp Model [22].

3) *Validity evaluation and pilot study phase*

The developed Teaching Module can be considered a high-quality and complete module once it undergoes the process of validity and reliability [30]. However, evaluating the validity of the module is not an easy task due to its abstract nature. This is because the aspect can only be determined indirectly and the most suitable approach is to obtain experts' opinions through an evaluation instrument such as a questionnaire developed based on the validity conditions of the module [34]. All experts were provided with a complete set of the module for it to be evaluated. They were then asked to complete a questionnaire provided either in digital or physical form. Validation from the panel of experts was critical to ensure that the module can be implemented perfectly and meet its intended objectives.

The level of experts' verification of validity was calculated using the Percentage Calculation Method (PCM) proposed by Tuckman and Waheed [35, 36]. The developed module was expected to obtain a minimum of 70% content verification for it to be considered as having good validity [37, 38]. This percentage was then converted into decimal form with 100% equalled to 1.00 and 0% as 0.00. The method allowed for the content validity coefficient to be determined [34].

Meanwhile, the pilot study involved a Mathematics teacher with 11 years of experience in teaching Mathematics at the upper secondary level. The sample comprised 30 form four students enrolled in the pure science major. The teacher conducted the pilot study for two hours outside the teaching and learning sessions, which was between 2.00 p.m. and 4.00 p.m. In this regard, Units 1 and 3 in the Interactive Module were implemented in the first week while Units 4 and 5 were taught in the second week. Fig. 8 contains a flow chart that summarises the procedures for the evaluation and pilot study of the Teaching Module based on the Japanese Bansho Plan.

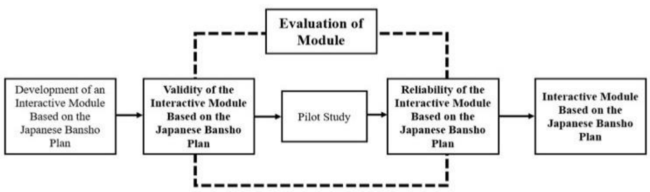


Fig. 8. Flow chart of the module evaluation.

III. Results

A. *Needs Analysis*

Following the selection of three schools within different districts in Sabah, the researcher analyzed the accuracy of students' answers to each subjective question in the HOTS Proficiency Diagnostic Test for the topic of Quadratic Equations. It was followed by identifying the mean percentage of the marks before categorising the students' mastery of HOTS into three levels (i.e., low, medium, and high) based on the interpretation of the level of students' ability to answer diagnostic tests adapted from Alias and Ibrahim [33] (see Table 3). In this regard, a high mean percentage of marks shows that the students have a good mastery of HOTS in Quadratic Equations, subsequently indicating that the topic is easy for students to learn.

Table 3. Intepretation of ability in diagnostic test

Level of Ability	High	Medium	Low
Range of score (%)	70–100	30–69	0–29

Table 4 shows a summary of the diagnostic test results on the level of HOTS mastery for the topic of Quadratic Equations among form four students.

Table 4. Summary data on HOTS level of mastery for quadratic equations (students)

District	School Category	Mean of Score Percentage (%)	Interpretation
Tawau	Urban	21.58	Low
Lahad Datu	Rural	26.14	Low
Kunak	Rural	15.44	Low
Overall Mean		21.05	Low

As shown in Table 4, the highest mean of diagnostic test score was recorded by rural school students from the Lahad Datu district with 26.14, followed by schools from the Tawau and Kunak districts with 21.58 and 15.44, respectively. The overall mean value of the diagnostic test is 21.05. The findings showed that the mastery of HOTS for the topic of Quadratic Equations across these schools is low as evidenced by the mean score range of below 29. Such a situation indicates that students from the three schools in different districts face difficulties in answering HOTS Quadratic Equations problems. The finding is in line with Teoh *et al*. [38] who reported that the majority of Malaysian students demonstrate an extremely low level of achievement in Quadratic Equations. Therefore, information from the Needs Analysis Phase served as a fundamental component in developing the teaching module.

B. *Stage 1: Design and Development of Module*

1) *Content analysis*

The procedures of developing the Bansho Plan-Based Teaching Module through the Morrison, Ross, and Kemp model [22] began with the content analysis process. It was divided into two main categories, namely topic analysis and procedural analysis [39]. Topic analysis was done by analysing the students' achievements using an evaluation standard. In the current study, the normative requirements were identified through a report on the quality of national examination answers for the topic of Quadratic Equations from 2013 to 2020. Among the problems highlighted was students' inability to show correct solution steps due to the failure of selecting the x-coefficient value that accurately represented the height of the container [40]. They also experienced difficulties translating versed problems into Quadratic Equation representations [41].

Procedural analysis was also implemented to identify the steps required for users to complete all tasks in the module [39]. All interactive content in the module was developed and arranged in separate and complete six lesson units using a modular approach, to provide students the opportunities to explore the application of Quadratic Equations concepts in real-life situations. Each lesson unit was secluded and contained HOTS knowledge that was identified as important to be mastered by students. The module can, therefore, be delivered regardless of its sequence.

2) Determining teaching objectives

Because the module is intended as teaching material for the topic of Quadratic Equations in secondary schools, it was crucial for the researcher to align the learning objectives with the learning standards listed in the Secondary School Standard Curriculum [42]. In addition, the teaching objectives also considered Bloom's Taxonomy, which comprises the three levels of HOTS (apply, analyze, and evaluate), as shown in Table 5.

Table 5. Learning objectives of every unit in the module

Unit	No.	Objectives	Taxonomy Level	Skills
Unit 1: **HOTS:** Solving Quadratic Equations Problems Involving Projectile Throwing.	1.	Forming quadratic function based on projectile movement and relating it to the quadratic equation.	Analyzing	HOTS
	2.	Solving problems involving quadratic equations.	Applying	HOTS
	3.	Making a mathematical proof whether the student will represent his sports house.	Evaluating	HOTS
	4.	Determining the horizontal distance of the projectile from the student from the maximum height of the throw.	Evaluating	HOTS
Unit 2: **HOTS**: Solving Quadratic Equations Problems Involving Fenced Wall Areas.	1.	Forming a quadratic equation based on the fence length situation using the Pythagoras theorem.	Analyzing	HOTS
	2.	Determining the root of a quadratic equation.	Applying	HOTS
	3.	Making a mathematical proof whether the root value of a quadratic equation satisfies the condition.	Evaluating	HOTS
	4.	Solving the problem of the fenced area using the area formula of a triangle.	Applying	HOTS
Unit 3: **HOTS:** Solving Quadratic Equations Problems Involving Charity Sale Profits.	1.	Forming a quadratic equation using the sales revenue formula based on the situation of a charity sale for earthquake victims.	Analyzing	HOTS
	2.	Solving a problem involving an increase in the price of a shirt by relating it with the concept of quadratic equations.	Applying	HOTS
	3.	Determining the number of shirts sold using the root value of a quadratic equation.	Applying	HOTS
Unit 4: **HOTS:** Solving Quadratic Equations Problems Involving Parabolic Bridges.	1.	Determining the exact quadratic function to represent the shape of the bridge supports.	Evaluating	HOTS
	2	Make a mathematical proof of the quadratic function selected to represent the shape of the bridge supports.	Analysing	HOTS
	3.	Solving a quadratic equation problem involving the maximum height of the bridge pier closest to the cars.	Applying	HOTS
Unit 5: **HOTS**: Solving Quadratic Equations Problems Involving Dragon Boat Race.	1.	Forming a quadratic equation based on the time difference between two dragon boats using the average speed formula.	Analyzing	HOTS
	2.	Solve a quadratic equations problem by relating it with time.	Applying	HOTS
	3.	Justifying the reason for choosing the root value of a quadratic equation with a mathematical proof.	Evaluating	HOTS
Unit 6: **HOTS:** Solving Various Mathematical Problems by Applying Quadratic Equations (Module Formulation)	1.	Forming quadratic equations based on simultaneous equations; one linear equation and one nonlinear equation.	Analyzing	HOTS
	2.	Solving simultaneous equations involving one linear equation and one nonlinear equation using the root value of a quadratic equation.	Applying	HOTS
	3.	Formulating the interrelationship between the quadratic equations concept with other mathematical topics such as logarithmic law topics.	Applying	HOTS

3) Organising and arranging the learning sequence

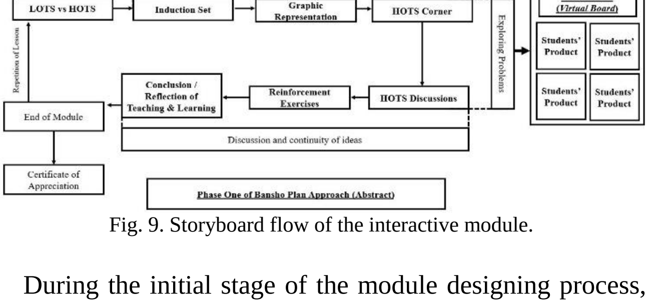


Fig. 9. Storyboard flow of the interactive module.

During the initial stage of the module designing process, each sequence of the interactive module content was illustrated in the form of a storyboard. This process is important to ensure that the design of the multimedia software presentations and the delivery of the teaching and learning content operates in an orderly manner. The sequence of content used in the multimedia applications was based on the three phases of the Bansho Plan (see Fig. 9).

4) Designing teaching strategies

The initial stage of module development is to identify appropriate teaching strategies that match the learning objectives. Hence, it is crucial for researchers to critically review, analyse, and synthesise the effective teaching strategies used in the previous studies of Mathematics learning. Table 6 presents a summary of the content analysis process of past research pertaining to Mathematics teaching strategies and activities.

Table 6. Past research on mathematics teaching strategies

Authors	Field	Teaching Strategy	Main Element	Appropriacy for Module Development
Birgin and Acar (2020) [43]	Exponents and Logarithms	Computer Supported Collaborative Learning	1. Creating a collaborative learning environment supported by the use of multimedia technology such as geometry software. 2. Students and teachers can communicate, add, and modify knowledge. 3. The activity is designed so that there is a reciprocal relationship between students' social interaction with the software to build knowledge.	The teaching strategy is suitable to be integrated into the Quadratic Equations module.
Niemi and Niu (2021) [44]	Self-Efficacy in Learning Mathematics	Storytelling	1. Students as scriptwriters, producers, and actors. 2. Students record, edit, and modify stories related to the learning topic with various types of images and effects.	The teaching strategy is inappropriate.
Lo and Hew (2020) [45]	Mathematical Cognitive Achievement	Game-Based Learning (Gamification)	1. In the game, a feedback icon is given immediately to indicate whether students' answer is right or wrong with a reward or penalty. 2. Students are motivated to re-evaluate the feedback given during the game, either from the clues in the game. 3. Rewards for completing all tasks.	The teaching strategy is suitable to be integrated into the Quadratic Equations module.
Holmes and Hwang (2016) [46]	Algebra and Geometry	Project-Based Learning	1. Students conduct research on an assigned topic to produce a product at the end of learning. 2. Students work autonomously over an extended period of time. 3. The product will be presented in front of real audiences.	The teaching strategy is inappropriate.
Panarach (2021) [47]	Mathematics	Mind Map	1. The knowledge content is written at the centre of the map while the subtopics grow outwards like branches of a tree. 2. Each subtopic is represented by an image or text written on a connecting line. 3. Students have an overview of the teaching quickly while detecting different aspects of the situation and its importance.	The teaching strategy is suitable to be integrated into the Quadratic Equations module.
Ryoo, Molfese, and Brown (2018) [48]	Early Childhood Education in Mathematics	Brainstorming	1. In groups, students present as many ideas as possible with the aim of solving a problem. 2. Open-minded, meaning that any ideas presented are accepted. 3. Ideas produced in groups or among friends can be developed in various real-world contexts.	The teaching strategy is suitable to be integrated into the Quadratic Equations module.
Ramadhan and Surya (2017) [49]	Multiplication	Demonstration	1. The teacher demonstrates how to implement a solution step in front of the whole class. 2. The teacher will repeat the explanation until all students understand.	The teaching strategy is inappropriate.
Tambunan (2019) [50]	HOTS Mathematics	Scientific Investigation	1. Students observe by reading, listening, and seeing. 2. Students ask questions. 3. Conducting an experimental investigation by collecting data. 4. Processing the data and presenting the final report.	The teaching strategy is inappropriate.
Novriani and Surya (2017) [51]	Space (Cubic Area)	Problem-Solving	1. Understanding the problems presented via linguistic (words) or non-linguistic (graphics). 2. Formulating appropriate solutions. 3. Implementing the strategy. 4. Scanning and rechecking the answer.	The teaching strategy is suitable to be integrated into the Quadratic Equations module.
Bahamonde, Aymemí and Urgellés (2017) [52]	Linear Algebra	Mathematics Modelling	1. Students have the opportunity to use their existing knowledge and further assimilate the information into new experiences. 2. When students encounter a problem of their situation of interest, they should be able to explore ways to represent the problem in mathematical terms. 3. Real-life experience is modelled in mathematical form.	The teaching strategy is suitable to be integrated into the Quadratic Equations module.
Ubuz and Duatepe-Paksu (2016) [53]	Geometry	Drama-Based Teaching	1. The learning environment allows students to imagine, formulate, and reflect on their experiences through body movements. 2. Spontaneous or planned acting, whether spoken or not, aims to explore the diversity of concepts.	The teaching strategy is inappropriate.

As illustrated in Table 6, several teaching strategies are inappropriate to be integrated into the interactive module due to the extensive time period needed for their implementations [44, 46]. Teaching strategies such as scientific investigation [50], demonstration or teaching [49], and drama-based teaching [53] are also not suitable because they require high costs, specific skills such as requiring students to master dialogue writing skills, and are teacher-centred.

Therefore, the module content of the developed model focused on integrating teaching strategies such as computer-assisted collaborative learning, problem-solving, mathematical modelling, discussion and brainstorming, mind maps, and game-based learning. All teaching strategies integrated into the module were in line with the social constructivism theory, which is the underpinning theory of this study. The theory posits that students actively build their knowledge through complex activities such as building relationships in mind maps, solving HOTS problems, and discussing with other students to solve problems [54].

This current module was developed based on the Bansho Plan, the Japanese national teaching approach. Therefore, every teaching strategy integrated into the teaching module intervention based on the Japanese Bansho Plan was implemented as an added value. For example, mind maps were integrated into the formulation of learning, game-based learning was applied in reinforcement exercises, while discussion and brainstorming were integrated during induction set activities.

5) Designing instructional messages

The procedures for designing instructional messages in the module comprised three aspects, namely (a) pre-instructional strategies, (b) integrating texts to convey the message, and (c) usage of images and graphics in the module [39].

a) Pre-instructional strategies

Prior to the teaching session, teachers administered a pre-test to assess students' ability to compare routine and non-routine questions of the topic to be learned. This was to ensure that they had mastered low cognitive items such as remembering and understanding constructs before using the teaching module that focused on HOTS items. An example of the activity was 'My Memory' as shown in Fig. 10.

Fig. 10. My Memory.

An overview of the lesson plan starting from the induction set activities to the learning summary was prepared in an orderly and detailed manner at the beginning of the module. Fig. 11 shows an example of the teaching overview for Unit 3.

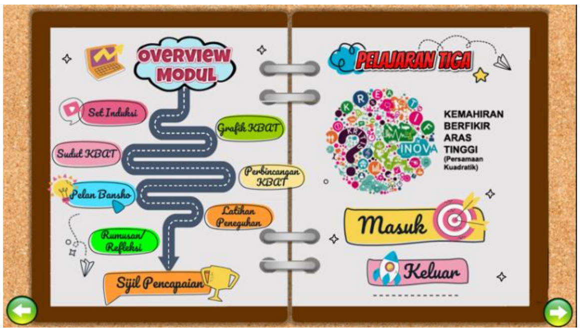


Fig. 11. Example of teaching overview for Unit 3.

b) Integrating texts to convey the message

It is crucial for researchers to consider typographical elements and the layout of the module's interface when conveying a message [55]. The current module's font size design was adjusted depending on the function of the texts during the teaching module presentation.

The function of the texts in the teaching module content was to comprehensively explain or convey facts such as problems, tips, learning summaries, and reinforcement exercises. Fig. 12 shows an example of the texts used in the 'HOTS Corner' of the module.

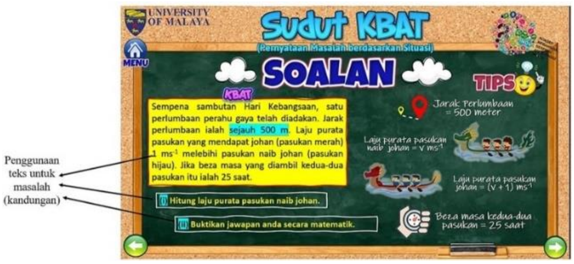


Fig. 12. Example of texts in presenting the module content.

Text navigation was also integrated into the teaching module. Users could click on one or more texts to be linked to other resources. Fig. 13 shows examples of text navigation used in the teaching module interface.

Fig. 13. Examples of text navigation.

The module development process also emphasised the continuity and cohesion of sentences, presented using accurate words and in structured paragraphs. An example is shown in Fig. 14 where the sentences explaining the problem-solving activity in Unit Four were in a linear form, with each paragraph containing topic and concluding sentences.

Fig. 14. Example of sentence organisation in problem-solving.

The use of mathematical texts (e.g., quadratic formula) in the form of symbols, alphabets, terms, characters, expressions, and notations impose a certain understanding to suit the learning objectives as well as the students' cognitive levels. Fig. 15 shows examples of texts used in the teaching module that were appropriate to the level of knowledge of the users. This aspect is important for students to be able to easily recognise and interpret every concept in the module.

Fig. 15. Examples of mathematical texts and symbols in the module.

c) Usage of digital graphics in the module

This module applied the Cognitive Multimedia Learning Theory [56] to edit graphics, which is an element in delivering the lesson contents. Modules should contain relevant multimedia elements to avoid distraction and increase the cognitive load of the students' memory. In addition, the designing principles according to [57] recommendations are summarized as follows:

i. Printed texts are arranged close to the position of the image or animation.

ii. Texts and images can be supported with audio.

iii. Using background audio of human voice.

iv. Images are displayed with text support.

In the developed module, digital graphics were integrated to interpret abstract HOTS problems. Such aspect is important to maximise the learning outcomes and reduce the burden on students' cognitive processing as they attempt to understand complex problems. Furthermore, it is believed that digital graphics in the form of static or animation present a HOTS problem in a realistic manner. Therefore, each unit in the module contains a 'HOTS Graphics' section as shown in Fig. 16.

Fig. 16. Examples of HOTS graphic section in the module.

In line with the social constructivism theory that serves as the foundation of the development of the current online module, learning is believed to occur when students interpret problems in new situations, such as by disaggregating information and representing it in a graphic form [58]. In the current module, information on non-routine questions on the topic of Quadratic Equations was simplified in a graphic form to be easily encoded in students' minds. Fig. 17 shows examples of problem representation graphics used in the module.

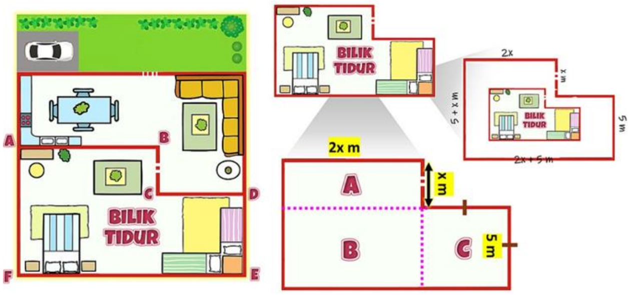


Fig. 17. Examples of problem representation graphics in the module.

6) Developing learning materials

a) Hardware and software development

This step refers to the process of translating the teaching material designs into a real interactive module. The development of a teaching module based on the Japanese Bansho Plan involved the use of several hardware requirements and software applications. The hardware requirements included a set of laptops with the minimum specifications of Windows XP operating system with Intel Pentium Dual Core processor, 1GB Random Access Memory (RAM), 1 MB VGA card, 10 GB of storage, image scanner, speakers, and microphones. Meanwhile, the software requirements for editing multimedia elements were Movavi Video Editor Plus 2020, Adobe Photoshop CS6, ClassPoint, FlamingText, Pixton Character, Easy Gif Animator Pro, Window Media Player, Bandicam, and Picasa 3. These software applications served as complements in developing the necessary multimedia support elements. For example, Movavi Video Editor Plus 2020 was used to edit videos and animations with high-definition quality, such as the introductory videos during the induction sets. On the other hand, the Adobe Photoshop CS6 software was used to modify and produce graphics such as menu buttons, HOTS graphics, and concept representation icons.

b) Japanese Bansho Plan screen

The Japanese Bansho Plan screen served as an interactive board in the module. It was a virtual wall display for students to share responses such as documents, notes, images, and videos of solution steps. As shown in Fig. 18, each 'Japanese Bansho Plan' screen is surrounded by a frame of reference. This is parallel to the traditional Bansho Plan, which records the teaching and learning process (e.g., problems, assignments, summaries, and exercises) happening on an actual day. Users will be directed to the respective section by pressing on the icon to explore sections within the reference frame.

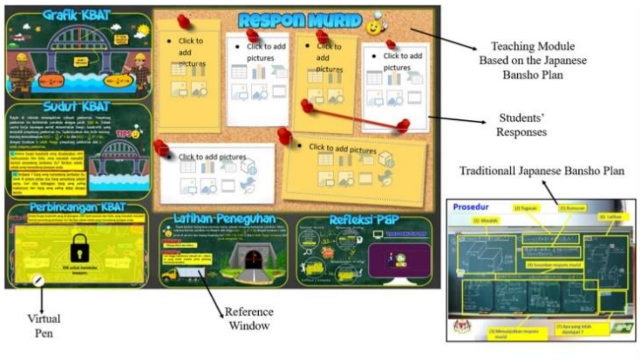


Fig. 18. Example of virtual Bansho Plan screen in the module.

Appropriate student responses were uploaded to the virtual blackboard platform provided in the module. The module differed from the traditional Bansho Plan in that students' responses were not limited to written documents, but also included solutions to the problems in the form of pictures, videos, audio, links, or coloured notes to be shared with friends. Users could also control what content to present, how it is presented, and when it is presented in a teaching and learning session. For example, teachers could zoom in or out or use a virtual pen to draw or check students' responses. This Bansho Plan-based module allowed students to be the producers and users of group assignment evidence.

c) Reinforcement exercises screen

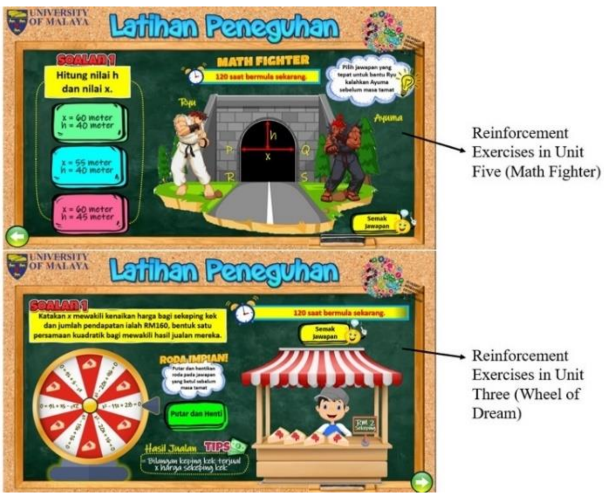
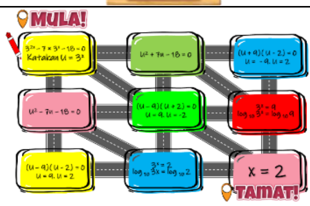


Fig. 19. Examples of reinforcement exercises screen in the module.

The "Reinforcement Exercises" screen served to reinforce students' understanding. These reinforcement exercises were in the form of interactive quizzes and games such as maze activities, correct arrangement, wheel of dream, fill-in-the-blanks, math fighter, and rapid challenges. Fig. 19 shows the interface that displays two types of reinforcement exercises, namely Math Fighter and Wheel of Dream. Upon answering the questions, students were provided with an immediate feedback icon that determined whether the answer was correct or incorrect, along with suggested solution steps (see Table 7).

Table 7. Feedback and gamification elements in the module

Feedback/Element	Icon
Reward	
Try Again	
Sustained Feedback	
Maze	
Wheel of Dream	
Math Fighter	
Medal as a reward for completing all tasks	

d) Teaching and learning reflection screen

The 'Teaching and Learning Reflection' screen consisted of two parts, namely learning summary and appreciation. The learning summary interface was developed by combining multimedia elements such as videos and mind maps. The latter served the purpose of reminding students about the main content of the module. The video element further strengthened the concepts that had been learned. However, learning assessment is not implemented in this section, but rather it only serves as reinforcement and closure. Students could also see the layout of their learning while the module was running. Fig. 20 shows one of the "Teaching and Learning Reflection" interfaces used in Unit 4.

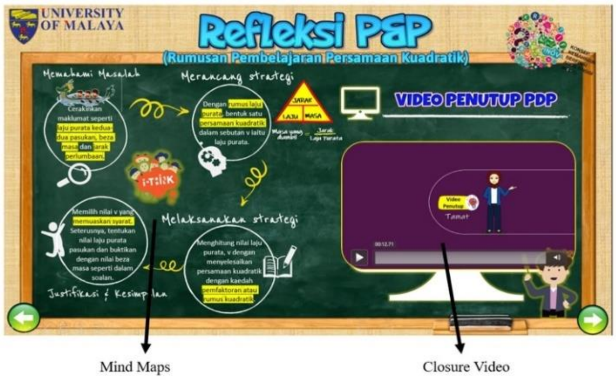


Fig. 20. Example of teaching and learning reflection interface in the module.

The Acknowledgment screen was the last part of the teaching module. It was displayed after users had successfully completed all teaching and learning modules based on the Bansho Plan. Upon checking the worksheets, teachers could provide students with a password for them to print the Certificate of Appreciation by scanning the QR code displayed on the Appreciation Screen. The certificate is given as a form of positive reinforcement or reward for having achieved the learning objectives. Fig. 21 explains how users can use this screen to print the Certificate of Appreciation including the icon to be clicked and the QR code to be scanned. In addition, this screen also provides users with the option of repeating or ending their exploration of the module.

Fig. 21. Procedure for obtaining the certificate of appreciation.

7) Developing teaching assessment instruments

For the purpose of assessing the achievement of the learning objectives, an assessment instrument was developed in the form of a worksheet based on the module content like HOTS problems and reinforcement exercises. The assessment process was conducted throughout the teaching and learning session. Students used the worksheet throughout the teaching and learning session. The worksheet contained the same set of questions as the module displayed and could be printed in black and white on an A4 paper. This could be done by clicking the worksheet button as shown in Fig. 22.

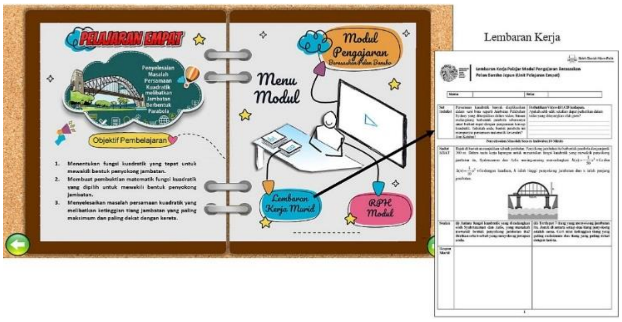
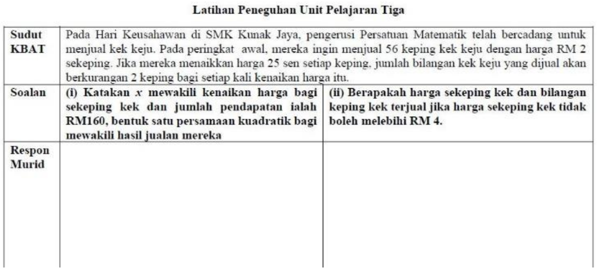


Fig. 22. Print worksheet icon.

Each exercise in the units could be reviewed by the teacher to assess whether students had achieved the targeted learning objectives. Fig. 23 shows an example of HOTS items in the assessment instrument for Unit 3.



Latihan Peneguhan Unit Pelajaran Tiga

Sudut KBAT	Pada Hari Keusahawan di SMK Kunak Jaya, pengerusi Persatuan Matematik telah bercadang untuk menjual kek keju. Pada peringkat awal, mereka ingin menjual 56 keping kek keju dengan harga RM 2 sekeping. Jika mereka menaikkan harga 25 sen setiap keping, jumlah bilangan kek keju yang dijual akan berkurangan 2 keping bagi setiap kali kenaikan harga itu.	
Soalan	**(i) Katakan *x* mewakili kenaikan harga bagi sekeping kek dan jumlah pendapatan ialah RM160, bentuk satu persamaan kuadratik bagi mewakili hasil jualan mereka**	**(ii) Berapakah harga sekeping kek dan bilangan keping kek terjual jika harga sekeping kek tidak boleh melebihi RM 4.**
Respon Murid		

Fig. 23. Examples of HOTS items in the assessment instrument.

C. Stage 2: Validity Assessment and Pilot Study

1) Content validity assessment

Table 8 shows the results of the content validity coefficient for the four aspects evaluated in the module, namely teacher's readiness, level of content knowledge, teaching strategies and physical support, and module learning evaluation. An expert evaluation was conducted using the Teaching Module Content Validity Questionnaire based on the Japanese Bansho Plan.

Table 8. Summary of experts' background for content validity of the module

	No	Content Validation of Items	Number of Expert	Coefficient of Validity
Teachers' Readiness	1.	The Bansho Plan-Based Teaching Module is suitable for form 4 and 5 students aged 16 to 18 years old.	5	1.00
	2.	The Bansho Plan-Based Teaching Module contains learning objectives that are clearly stated.	5	0.98
	3.	The Bansho Plan-Based Teaching Module can be implemented according to the designated time period.	5	0.90
	4.	The Bansho Plan-Based Teaching Module has a clear Daily Teaching Plan as a guide for the implementation of teaching and learning.	5	0.94
Level of Knowledge	5.	The Bansho Plan-Based Teaching Module is in line with the Form Four Mathematics and Additional Mathematics syllabus for Malaysian secondary schools.	5	1.00
	6.	The Bansho Plan-Based Teaching Module helps students to connect the knowledge that they have learned to solve mathematical problems.	5	1.00
	7.	The Bansho Plan-Based Teaching Module contains HOTS (Higher Order Thinking Skills) items for the topic of Quadratic Equations.	5	0.98
	8.	The Bansho Plan-Based Teaching Module contains difficulty level and complexity of problems that are not confusing.	5	1.00
	9.	The Bansho Plan-Based Teaching Module fosters digital literacy skills for the topic of Quadratic Equations.	5	0.98
	10.	The Bansho Plan-Based Teaching Module demonstrates the steps for solving mathematical questions in an orderly manner.	5	0.98
	11.	The Bansho Plan-Based Teaching Module uses the correct mathematical terms, characters, and symbols.	5	0.96
Teaching Strategies	12.	The Bansho Plan-Based Teaching Module offers equal opportunities in forming a conceptual understanding on the topic of Quadratic Equations.	5	0.96
	13.	The Bansho Plan-Based Teaching Module helps students in using quadratic equations concepts to explore new situations.	5	0.98
	14.	The Bansho Plan-Based Teaching Module encourages students to work independently and collaboratively to solve problems.	5	0.98
	15.	The Bansho Plan-Based Teaching Module provides teaching strategies (problem-solving, mathematical modelling, discussions, brainstorming, and games) for the topic of Quadratic Equations.	5	0.98
	16.	The Bansho Plan-Based Teaching Module encourages students to plan various strategies to solve problems for the topic of Quadratic Equations.	5	0.98
	17.	The Bansho Plan-Based Teaching Module uses thinking tools such as mind maps to encourage students to think.	5	0.98
Physical Support and Assessment	18.	The Bansho Plan-Based Teaching Module provides feedback to ensure students learn to correct mistakes.	5	0.98
	19.	The Bansho Plan-Based Teaching Module can be used by students for self-studying.	5	0.98
	20.	The Bansho Plan-Based Teaching Module cultivates the use of technological support, especially software and mobile applications in solving mathematical problems.	5	0.96
	21.	The Bansho Plan-Based Teaching Module provides appropriate reinforcement exercises to strengthen mathematical knowledge.	5	0.98
	22.	The Bansho Plan-Based Teaching Module has a suitable set of worksheets to support learning.	5	1.00
			Mean	0.90

Table 8 shows the feedback given by the five experts on all items in the evaluation form. The results indicate that teachers' readiness to use the module, including aspects of clear learning objectives and the ability of the module to be implemented within the designated time, recorded a content validity coefficient mean value of 0.90. Meanwhile, the level of knowledge obtained the highest mean value of 0.96 [59]. This includes aspects such as aligning the module with the national curriculum, ensuring that the complexity level of problems presented in the module is not confusing, and applying HOTS for the topic of Quadratic Equations. The findings agree with Polat *et al*. [60] who stated that the teaching strategy integrated in the module is in line with the Social Constructivism Theory, which emphasises that students actively build their own knowledge through the involvement of complex activities such as thought mind maps in enabling the visualisation of the interconnections among emerging ideas.

Furthermore, the module's teaching strategies have also reached a high content validity coefficient mean value of 0.96. Experts agree that the module provides various teaching strategies (problem-solving, mathematical modelling, discussions, brainstorming, and games) for the topic of Quadratic Equations, as well as applying thinking tools such as mind maps. In addition, physical support and evaluation also recorded a high mean value of 0.96. It assessed whether the module could provide learning feedback for self-correction and supporting learning through suitable sets of worksheets. Therefore, it is concluded that the coefficient validity values for all four aspects of the module content exceed the minimum value of 0.70, suggesting that the Bansho Plan-Based Teaching Module has good content validity [37, 60]. This means that the teaching module can effectively strengthen the HOTS content for the topic of Quadratic Equations.

2) Pilot study

Although the module comprises a total of six units, only four units were tested during the pilot study. This is because the school administrators only allowed the pilot study to be conducted outside the teaching and learning sessions for two weeks due to the COVID-19 pandemic situation. The pilot testing of the four units was sufficient to determine the reliability of the module because the steps for each activity were similar. For example, in HOTS activities, the discussion and brainstorming steps while conducting Bansho Plan activities were the same for each unit.

The reliability of the Bansho Plan-Based Teaching Module was determined by the students' assessment of the learning objectives outlined in the module. Such justification was made on the basis that the sample mastery of the module will be achieved when they are able to follow the activities in the module to achieve the intended objectives. This is in line with Mohd Noah and Ahmad [34] and Russell [61] who suggest that the use of a questionnaire to test the reliability coefficient of a module can be based on the objectives of the respective module.

Table 9 shows the results of the reliability test pertaining to the learning objectives of the Bansho Plan-Based Teaching Module.

Table 9. Reliability value of the module

Lesson Units in the Bansho Plan-Based Teaching Module	Cronbach Alpha Value	Strength of Relationship
Lesson Unit 1	0.632	Good
Lesson Unit 3	0.606	Good
Lesson Unit 4	0.651	Good
Lesson Unit 5	0.879	Very Good
Overall	0.915	

The results in Table 9 show that all reliability coefficient values were above 0.60, indicating that the overall reliability of the module is good. The highest Cronbach's Alpha coefficient values were 0.879 and 0.651, respectively, for Lesson Unit 5 and Lesson Unit 4. The results indicate that the Bansho Plan-Based Teaching Module Based had a good level of consistency with 0.915. This suggests that the module can be accepted and the activities in the module can be successfully followed by students to achieve the targeted learning objectives [36].

IV. Discussion

Results from the diagnostic test suggest that Quadratic Equations are a relevant concept to be integrated into the module. Although the topic is considered important in daily life applications, many students still make mistakes in finding the correct solutions [62]. Past studies reported that students produce various Quadratic Equations mistakes across all levels. Among the factors of such weakness is that students find it difficult to interpret or understand the terms used to represent the root of quadratic equations [63]. The priority needs of the topics identified in this phase thus provide valuable input for researchers to focus on certain parts of the topic and avoid excessive teaching, allowing for the planning of a more efficient and effective intervention. This is in line with the needs analysis goals in the Morrison *et al.* [22] model which aims to identify gaps in performance to decide whether those gaps can be improved through intervention. Furthermore, there is a scarcity of research that looks at the development of teaching and learning modules for the topic of Quadratic Equations [19]. Such an issue thus justifies the need for further research in the development of a teaching module based on the Bansho Plan.

Once obtaining a clear view of the problems faced by the target group as well as the need for module construction, the researcher proceeded to develop an interactive teaching software module that integrates the Bansho Plan with the aim of increasing HOTS elements in the topic of Quadratic Equations. The module is known as the Bansho Plan-Based Teaching Module. The development phase of this module was based on the seven components of the Effective Teaching Design Model, also known as the Morrison, Ross, and Kemp [22] model. The module development process was also supported by three theories (APOS Theory, social constructivism theory, and Theory of Cognitive Multimedia Learning) and a model (Bloom's Taxonomy Model). The Theory of Cognitive Multimedia Learning was applied following to integrate multimedia elements in the module. Moreover, the strategy and content of the module were planned through literature review analysis, and it was carefully arranged so that the learning objectives of each unit could be achieved. In total, the Bansho Plan-Based Teaching Module was developed for a duration of ten months.

The completed teaching module had undergone content verification by Mathematics education experts from various institutions. Content validity is based on the perception and theoretical constructs that are intended to be assessed [64]. The developed module records high content validity across the aspects of teachers' readiness, level of content knowledge, teaching strategies, as well as physical support and assessment. The PCM method was chosen because it is simple to administer, low-cost, time-saving, and simple to implement. Other studies such as the development of the Adventure-Based Learning Module [65] also used the same analysis method to measure content validity. The process of adapting educational assessments to expert recommendations is a necessary step to make the module more scientifically rigorous and effective for measuring HOTS amongst students.

A pilot study was also successfully conducted for two weeks at a national secondary school in Negeri Sembilan. The results show that the teaching module has good consistency, suggesting the stability of all items and the consistency of all activities when repeatedly tested among respondents with homogeneous characteristics [66].

Furthermore, the findings of this study align with the development of many multimedia-based mathematics learning modules, including the Kvisoft E-Module Mathematics [67] and the Triangle Geogebra Module [68]. However, the development of software modules contradicts the study by Goodwin and Highfield [69], who believe that technology usage often leans towards procedural learning through repeated interactions. This view is further supported by Barrot *et al.* [70], who reported several problems in the use of multimedia elements for teaching and learning, such as teachers' heavy reliance on multimedia modules and a lack of teaching communication that requires help-seeking between teachers and students. Therefore, the uniqueness of this Quadratic Equation Teaching Module, based on the Japanese Bansho Plan, successfully addresses the problems stated in past studies by combining modern and traditional teaching and learning approaches known as Bansho Keikaku or the Bansho Plan.

Unlike conventional learning modules, the combination of the Bansho Plan and the software module developed in the Teaching and Learning (T&L) environment is not entirely dependent on the integration of multimedia elements but rather focuses on one phase of the Bansho Plan, namely "neriage" or structured problem solving with the help of active verbal discussion. Another advantage of the developed module is that the design of each module's Bansho Plan screen revolves around an interactive frame of reference that follows the basic principles of the traditional "bansho keikaku" approach, thus serving as a record of the T&L process during the actual day. The findings of this study align with those reported by Hamzah *et al.* [71], where, although the Bansho approach involves the comparison of various types of solution steps, each module plays a role in improving teachers' knowledge, skills, and practices regarding metacognition-based HOTS teaching.

This study further proposes on the need for the traditional Japanese teaching approach (i.e., the Bansho Plan) to be studied and modified within the Malaysian context as it will provide valuable insights and understanding on its suitability and efficacy to be used in the T&L of Mathematics. Japan often stands as a benchmark for Malaysia across various aspects, including Science and Technology education [72]. In fact, the education systems of both Japan and Malaysia carry several similarities, including the use of an equivalent national curriculum structure and a centralised education system [73]. Therefore, the development of a module that emphasises on the application of the Bansho Plan strategy is supported by Tan *et al.* [13] as it provides equal rights and opportunities for every individual to contribute to the formation of the parts in the Bansho Plan without worrying about being evaluated.

Following the revision and improvement process, the teaching module is acceptable and can be used in the context of real studies. Although the assessment process was complicated and time-consuming, the obtained comments and suggestions for improvement were useful to further improve the quality of the module. The appropriacy of using the module in a real context also coincides with the results of previous studies which show that the use of modules in the teaching and learning of Mathematics is a revolution from traditional pedagogy towards a student-centred approach [20].

V. Conclusion

This study serves as an effort to develop and evaluate the validity of the Bansho Plan-Based Teaching Module in improving students' mastery of HOTS for the topic of Quadratic Equations. A module development must experience accurate and correct procedures from the aspects of (1) identifying teaching problems, (2) determining the target, (3) content analysis (selecting the topics and procedures), (4) determining teaching objectives, (5) designing teaching sequences (sequencing), (6) designing teaching strategies, (7) designing instructional messages, (8) developing learning materials and planning teaching delivery methods, dan (9) developing teaching assessment instruments. To answer the research questions, the researcher manifested his understanding and ideas through the relationship between the selected theories, models, and variables to produce a holistic conceptual framework. The validity analysis using the Percentage Calculation Method (PCM) and the reliability test using Cronbach's Alpha Coefficient shows that the Bansho Plan-Based Teaching Module is a valid and reliable tool to improve HOTS mastery for the topic of Quadratic Equations among secondary school students.

Traditional teaching approaches, such as the Bansho Plan, should never be labelled as outdated. Rather their wisdom must be explored and adapted to the demands of the 21st century teaching strategy. Although it is nearly impossible to implement this teaching approach in the local context, with close resemblance to the Japanese learning environment, the development of the Bansho Plan-Based Teaching Module is expected to open the minds of various parties to the numerous potential and benefits as a result of combining a traditional teaching approach, active learning, and multimedia elements. Finally, it is hoped that this study will serve as a guideline for affiliate parties to plan an effective HOTS teaching strategy. The study also addresses the research gaps related to mathematical technology as there is a scarcity of studies related to the use of technology, especially those based on the concept of Quadratic Equations.

Nevertheless, this study has its limitations. The Bansho

Plan-Based Teaching Module can only be implemented if students have mastered Low-level Thinking Skills (LOTS) such as the cognitive domain of remembering and knowing. Otherwise, the proliferation of cognitive ability cannot be developed if there are obstacles in the knowledge base before moving towards mastering the HOTS domain. Thus, it is recommended that the teaching module can be improved by integrating digital literacy skills with HOTS. For example, through the use of the Computer Algebra System (CAS) Graphical Calculator students can be shown how to determine the root of a quadratic equation on the graph of a quadratic function in the instrument using MATLAB software or the TI-Nspire CAS Calculator.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

RPTKH: conducted the research, prepared the literature review, and overlooked the writeup of the whole article; HZ: analyzed the data and wrote the research methodology; and SSAR: carried out the analysis and interpretation of the results. All authors approve final version of the article.

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