Journal of Educational Research and Indigenous Studies
Volume: 3 (1), 2021
Journal website: www.jerisjournal.com
e-ISSN 2682-759X

Development and Usability of B-Geo Module in Differentiation Topic Using ASSURE Model of Instructional Design

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Article Info

Received:
05 November 2020

Accepted:
27 November 2020

Published
01 April 2021

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e-ISSN 2682-759X

ABSTRACT

This study aims to develop a brain-based teaching approach module with the integration of Geogebra Software called Module B-Geo by using the instructional design of the ASSURE Model. It also aims to study the usability of the Module B-Geo that has been developed. This development research aims to create products in the form of modules for the use of Additional Mathematics teachers and students at the secondary school level. This study refers to the adaptation of the ASSURE model which involves 3 phases and 6 steps. The phases involved are the design and development phase, the implementation phase and the module evaluation phase. The 6 steps involved are based on the ASSURE model, namely Analyzing Learners, Stating Objectives, Selecting Methods, Media and Materials, Utilizing media and materials, Requiring Learner Participation, and Evaluating and Revising. The data collection instrument is a questionnaire. The questionnaire developed was to obtain the validity of B-Geo Module according to 13 experts, while the module usability questionnaire adapted from Che Soh (2012) aimed to test whether or not the usability of the module was in a good category. The sample used to test the usability of the B-Geo Module was made up 13 secondary school teachers and 70 Form 4 students. The collected data were analyzed using descriptive analysis. The results of data analysis show that this B-Geo Module has good learning outcomes, Module design, Teaching Strategies, Teaching and Learning Activities, Media and Learning Materials. It received an overall good Assessment and is therefore considered as suitable and usable. This module has been developed in the hope that Additional Mathematics students will be able to master the topic of Differentiation to a more robust level.

Keyword: Additional Mathematics, Differentiation, Geogebra, Brain-Based Learning, model ASSURE, Instructional Design.

Introduction

Additional Mathematics is an elective subject at secondary school level in Malaysia. It is also the most feared subject because it is said to be the most difficult compared to other subjects (Khalin, 2014; Yahya & Amir, 2018; Zainuddin & Osman, 2018). Additional Mathematics by nature promotes meaningful and challenging learning. Students are mostly not exposed to the importance of learning Additional Mathematics in school, so they often think that the subject is not important and that there is no necessity for it to be learned (Abu & Leong, 2014). Students who take Additional Mathematics will have a high chance of entering the field of Science, Technology, Engineering and Mathematics (STEM) at a higher level of education. A Program for International Student Assessment (PISA) 2015 report shows that only 13.2% of Malaysian students are interested in Science and Engineering careers (*Programme for International Student Assessment Report*, 2015). Teaching strategies and teaching aid materials that are not fully effective are among the reasons why students' optimum learning and development for Science and Mathematics subjects cannot be generated (Fazil & Salmiza, 2016; Jumiran, 2014).

Students have the tendency to think that learning mathematics is hard because there are topics that require abstract knowledge and this causes them to face difficulties in understanding the conceptual knowledge of certain topics (Saad, 2002; Yahya & Amir, 2018). The process of T&L of Mathematics also focuses more on memorizing formulas and doing exercises, skills to answer examination questions, and teacher-centered teaching practice, which cause students to feel afraid and face difficulty in following what is being taught in the classroom (Puteh & Khalin, 2016; Yahya & Amir, 2018; Zainal Abidin, 2008)

Based on the Examination Board report obtained by the researchers (Malaysian Board of Examination, 2018), the percentage of students who failed Additional Mathematics for three consecutive years from 2015 to 2017 in the Malaysian Certificate of Examination (SPM) increased from 22.2% to 22.7 % and then to 24.2%. The average grade of Additional Mathematics in the year 2017 is still low (5.81), compared to other subjects. Likewise, the percentage of students from rural school who failed the subject for the last three years had increased from 28.18% to 28.74% and then to 31.35% (Examination Board report, 2018). There is still a huge percentage gap of passing students between rural and urban students in 2017, id est 68.65% for the former and 78.27% for the latter. The wish to close the gap between rural and urban students as expressed by the government in Malaysia's National Education Blueprint 2013-2025 is still not met with this huge gap. Students' confidence to register Additional Mathematics as a subject for the Malaysian Certificate of Education (SPM) also decreases. In 2015, the number of SPM candidates for Additional Mathematics was 152 004, in 2016 the number of candidates was 126 880 and in 2017 the number of candidates was 125 636 (Examination Board, 2018). Students are less motivated to register Additional Mathematics for SPM because of how difficult it is to get good results for the subject.

One of the topics in Additional Mathematics subjects that students consider the most difficult is the topic of Differentiation. According to the interviews in previous study by (Nasir et al., 2013) Additional Mathematics teachers argue that the topic of Differentiation is the most difficult topic. Kailani & Ismail (2010) have shown in their study that students still do not master the concepts and methods to solve Differentiation questions (Arshad & Abdullah, 2014). Differentiation is an important topic for understanding the concept of calculus and it is a topic that is difficult for students to understand (Orton, 1983; Park, 2013; Thompson, 1994; Zandieh, 2000; Zengin, 2018). Analysis of information on students' difficulties in learning Differentiation shows that these difficulties are due to their weaknesses in problem solving (Metaxas, 2007; Rubio and Chacón, 2011; Pepper et al., 2012; Tall, 1993, 1997, 2011; Willcox and Bounova, 2004; Javadi, 2008; Tarmizi, 2010; Ghanbari, 2012).

In the 21st century, Additional Mathematics teachers and students need to continue to transform and evolve, following changes in the global arena. T&L using information and communication technology (ICT) is very important so that students and teachers can familiarize themselves with the use of the latest technology in the subject of Additional Mathematics. In fact, the Program for

International Student Assessment (PISA) 2015 was also implemented for the first time based on ICT (PISA Report, 2015). According to a preliminary report of the Malaysia Education Blueprint (PPPM) 2013-2025, the first wave, which is to bring about the government's desire for the seventh PPPM shift, has caused the Ministry of Education to allocate the largest capital for infrastructure and ICT in schools. However, based on the inspection report of the Inspectorate of Schools (JNJK) in the year 2012 and 2013, the percentage of teachers using technology across Malaysia was very low, at 1.20% in 2013 and 0.00% in 2012 (Khor & Ruzlan, 2016). Previous studies suggest that despite the many benefits of using technology in teaching Mathematics, overall technology utilization in the classroom is slow (Cuban, Kirkpatrick, & Peck, 2001). This is because teachers do not have enough support modules and teaching aid materials that involve the use of ICT for the topic of Differentiation. Based on the researchers' initial study as well, only 22.2% of teachers have used the Teaching module during the T&L process of Additional Mathematics in the classroom.

Based on the problems and discussions above, the researchers found out that a study needed to be done to help the teachers in terms of developing an ICT module for Additional Mathematics, especially for the topic of Differentiation. Based on previous studies, ICT modules have been successfully developed, as can be seen from modules developed by Hutkemri (2013), Ayu Erlina (2013) and Norazah Nordin (2010). These ICT modules have solved problems in terms of conceptual, procedural, and problem solving faced by students when learning mathematics.

Literature Review

Developing a multimedia module using ASSURE Model

According to Ngadirin (2003), a module is a teaching material that has been divided into several specific subtopics and the arrangement of each of these subtopics has a relationship or continuity with each other. It is in the form of course materials that are implemented individually to achieve a skill. According to Harun & Tasir (2000), multimedia is an interactive communication tool based on computer technology that combines the use of various elements of digital media such as text, audio, graphics, animation, and video to convey information. Multimedia Module is a module based on these elements of digital media. The literature review has shown various types of multimedia modules that have been developed to achieve a certain goal and have been found to be effective.

Assin (2013), Rini, Sefriani; Indra (2001) , Henny Zurika Lubis (2018) in their study have proven that the practice of using teaching modules based on interactive multimedia modules (MMI) in technical and vocational education (PTV) has been effective compared to traditional teaching practices. In fact, the results of their study also show that the development of the modules they build is effective, efficient, and interesting. The use of multimedia modules is proven to help in the teaching and learning process (Reyes & Oreste, 2017).

The development of the module built should be based on Instructional Design Models. There are various types of Instructional Design Models which can be used to develop a module. Instructional design models help designers to better understand the theoretical framework in order to adapt it to teaching needs (Akbulut, 2007). In other words, designers can create a guideline by applying instructional theory to create an effective teaching method (Morrison et al., 2001).

One Model ID is the Assure Model. The ASSURE model was developed by Heinich, Molenda, Russell, and Smaldino (1999) and is a teaching model for planning teaching and technology that will improve T&L outcomes. The ID process is a planning or strategy that educators can use to design and develop the most appropriate learning environment for their students. The ASSURE model contains six steps and the letters in ASSURE form an acronym, namely:

A = *Analyze Learner*
S = *State Objective*
S = *Select method, media and material*
U = *Use media and material*
R = *Require learner participation*
E = *Evaluation and revise*

In this study, the ASSURE Model is adapted by dividing it into three phases of construction as shown in Table 1.1. The rationale for dividing the construction process into three phases is to make it easier for researchers to carry out the construction process in a planned and focused manner. The division of construction process of the module into 3 phases based on the instructional model is proven effective as can be seen from the studies by (Abdul Rahman, 2015) and (Abdul, 2016) which have also divided the instructional model into 3 phases.

Table 1.1: ASSURE Model Steps Distribution According to the Three Phases

Module development phase	ASSURE MODEL	Summary
Phase 1 DESIGN AND DEVELOPMENT	*Analyze Learners*	Analyzing teachers Analyzing students
	State Objectives	Determining objective and course learning outcome
	Select methods, media and materials	Determining the components of the content Selection of teaching approaches and teaching strategies Selection of Learning Activities Selection of Media and Learning Materials Text structure / physical format
	Utilize media and materials	Preparation of prototype Preparing materials and environment
Phase 2 IMPLEMENTATION		Using Media and Materials.
	Require learner participation	Preparing students Students' involvement
Phase 3 MODULE EVALUATION	*Evaluate and revise*	Confirmation by experts and improvement Pilot study Purification and improvement Experimental execution

BRAIN-BASED LEARNING

The Brain-Based Teaching Approach is a strategy implemented based on the 12 Principles of Brain-Based Learning developed by (Caine & Caine, 2003, 1991) through three teaching techniques. The 12 Principles of Brain-Based Learning developed by Caine & Caine (2003) are:

1. The brain is a parallel processor.
2. Learning engages the entire physiology.
3. The search for meaning is innate.
4. The search for meaning occurs through "patterning".
5. Emotions are critical to patterning.
6. Every brain simultaneously perceives and creates parts and wholes.
7. Learning involves both focused attention and peripheral perceptions.
8. Learning always involves conscious and unconscious processes.
9. Humans have at least two types of memory: a spatial memory system and a set of systems for rote learning.
10. Humans understand and remember best when facts and skills are embedded in natural spatial memory.
11. Learning is enhanced with challenge and inhibited by threat.
12. Each brain is unique

Twelve principles of Brain-Based Learning developed by Caine & Caine (1991, 2003) are discussed in Table 1.2.

Table 1.2: Principles of Brain-Based Learning by Caine & Caine (1991, 2003)

No. of Principle	Description of principle	
P1	The brain is a parallel processor.	Teaching should begin by delivering experiences to students as exposure to the realities of life. The brain can divide the experience as an overview or into small parts. Finally, students can relate the experience to the activities in their own life.
P2	Learning engages the entire physiology.	Brain-based learning should take into account students' needs in terms of the amount of sleep, nutrition, environment, and emotions, as all of these will affect the brain. A person's physiological state will affect his or her memory. Sensory and physical movements are very important for learning. When the uses of all the senses and body are combined, learning will be more effective because the mind and body are interconnected with each other (Hertzog, Kramer, Wilson, & Lindenberger, 2015)
P3	The search for meaning is innate.	The creative methods used to teach intelligent students should be practiced on all students. Apart from a stable environment to meet the needs of new discoveries and knowledge, learning also needs to attract students' attention. The innate tendency of the brain is to receive stimuli as well as to respond and find meaning. Understanding is easier to achieve when students have priorities, interests, and ideas from their own experiences.
P4	The search for meaning occurs	The brain tends to remember many things. The combination of all the desired information and experience will be embedded into the brain to create more patterns

	through "patterning".	for meaningful learning. The unfilled brain capacity will create new patterns and connect them with the old patterns that have been understood.
P5	Emotions are critical to patterning.	Students' emotions need to be stable to improve long-term memory. The brain is very sensitive to changes that occur to emotions. Emotions will shape every experience and determine whether the brain will accept it positively or negatively. Effective learning can be enhanced with extensive emotional experience, and emotional and physical responses will result in good understanding (Caine, 2009).
P6	Every brain simultaneously perceives and creates parts and wholes. (brain is social)	The connection between the past experiences of educators and students, as well as others, can be adapted in the daily learning process to convince students that learning process does not necessarily take place formally. Good teaching is teaching that builds students' understanding and skills over time because learning takes place cumulatively. Informal learning with social interaction is very effective and helps to build trust, share information and solve problems collaboratively. Meaningful learning will result from social interactions and relationships with the environment and other people.
P7	Learning involves both focused attention and peripheral perceptions.	All aspects of the educational environment are important. The use of music is very important as a way to enhance and influence the natural acquisition of information. Educators need to prioritize students' needs by providing motivation and guidance to support learning and increase student interest. Individuals will absorb all the stimuli and information but they will always choose according to their personal priorities, beliefs, and differences.
P8	Learning always involves conscious and unconscious processes.	The connection between the past experiences of educators and students, as well as others, can be adapted in the daily learning process to convince students that learning process does not necessarily take place formally. Students will find out their own strengths and weaknesses and try to find ways to deal with them. Students need to be given enough time to reflect and experience for themselves an activity or experience in order to learn meaningful information.
P9	Humans have at least two types of memory: a spatial memory system and a set of systems for rote learning.	The types of memory include spatial memory system (long term) and semantic memory (rote learning memory). Contextual memory involves various systems for understanding experiences while semantic memory separates between facts, skills, and procedures. It is driven by curiosity, new things, and expectations. The rote learning approach sometimes has a good effect in certain situations. However, usually retention is not long in addition to interfering with the knowledge construction process. Long-term memory is usually the result of learning through a variety of approaches and daily routines.

P10	Humans understand and remember best when facts and skills are embedded in natural spatial memory.	Building relationships through exposure, repetition, and practice is important for students to add to and enrich their existing experiences, making the brain more compact with greater capacity for new and deeper understanding. Experience can stimulate brain development.
P11	Learning is enhanced with challenge and inhibited by threat.	The teaching strategies used should be enriched with challenges in order to improve the learning process but any threats such as punishment, caning, or things that can create a sense of unease among students should be avoided. A safe place to study is important for optimizing learning. Effective mental and emotional functioning can be impaired due to anxiety and will lead to failure (Deci & Ryan, 1985)
P12	Every brain is unique.	Everyone's brain is different and works better when facts and skills are embedded in real experience. All students should be empowered to make choices to understand the world using their own intelligence. The diversity of background, socio-economics, race, gender, and religion makes one's brain unique.

The Brain-Based Teaching Approach is believed to enhance learning because of its holistic approach to students. It is a learning approach that conforms to the best operating principles of the brain's natural processes, with the goal of achieving attention, understanding, meaning, and memory (Jensen, 1996). Students will learn better if learning is "authentic", in the sense that it relates to real-world problems and applications (Caine & Caine, 1991, 2003; Sousa, 1995, 1998; Jensen, 1998). Because the development and growth of the brain depends on one's experience, the challenge, in fact, is for teachers to vary teaching methods and shift the paradigm from "one with all" to "enriched environment" for each student (Caine & Caine, 1991, 2003; Jensen, 1998; Evan, 2007).

GEOGEBRA

The current learning method and teaching aid materials (ABM) need to be diversified and cannot be restricted to the traditional methods used in the classroom only. The assimilation of technology in the educational process happens all the time and as a result, many different types of tools, materials, and pedagogy methods are introduced in our education system. Technology can also be used for meaningful learning processes as well as for understanding a concept clearly (Altıparmak, 2014). By using computer software, students can interact with educational materials designed to develop required skills and solve everyday situations using their mathematical backgrounds. This learning technology needs to be useful and in keeping with our education system so it will not just be in vain. By using new technology in the classroom, there are evidences showing that there is a relationship between ICT-enabled activities, positive attitude towards mathematics, improvement of mathematical learning, and students' performance (Kenneth, 1996; Rosas et al., 2003). As noted by Jonanssen and Carr (2000), technology is used as a mindtool that can be utilized to support deep reflective thinking and is needed for meaningful learning. The existence of open source software has gained the attention of many educators in the world who use ICT in their teaching. This includes GeoGebra software which is a good example of software that can be used in the process of learning mathematics.

GeoGebra is a dynamic mathematics and open source software that can be found for free for the teaching and learning of mathematics. GeoGebra software offers geometric, algebraic, statistical and calculus features. The name GeoGebra itself comes from the words “geometry” and “algebra”. In line with the latest developments, GeoGebra has developed its software with the use of spreadsheets, graphics, calculus, and statistics in an easy-to-use package. GeoGebra has also become a worldwide provider of innovation in teaching and learning for dynamic mathematics, science, technology, engineering and mathematics (STEM) software. Maceková (2013) dan Antohe (2009) agree that GeoGebra can be an effective new platform for online learning on a regular basis (e-learning). Moreover, Blossier’s (2014) study has shown that students and teachers view the GeoGebra Software positively. Blossier's (2014) view is stated below:

Students love GeoGebra Software because:
a) It shows the mathematical connection between geometry and algebra at the same time. The same goes for visuals because students can finally see, touch, and experience mathematics.
b) It makes mathematics dynamic, interactive, and fun by teaching students interesting and new ways that transcend the mediums of blackboard, whiteboard, and even textbook.
c) It makes learning mathematics easily accessible because it allows students to learn anywhere, anytime.
d) It makes mathematics easier to learn by creating the interaction students need to absorb mathematical concepts and problem-solving abilities.

Meanwhile, teachers like GeoGebra Software because:
a) It allows them to continue teaching easily. GeoGebra does not replace teachers but it helps teachers to teach and provide good understanding in mathematics.
b) It allows teachers to plan and deliver more effective teaching as it gives students the freedom to create lessons that they want to explore according to their interest.
c) It allows teachers to communicate with other teachers: GeoGebra teachers are a part of the global mathematics community.

Methodology

RESEARCH DESIGN

Methodology is a group of equipment, techniques, procedures and methods used to collect, store, analyze and convey information. To develop a comprehensive research methodology, the ASSURE model has been adapted and combined with a usage-based design to achieve a goal, namely the usability of the product that has been developed. There are 3 phases and 6 steps to develop this B-Geo module. The phases are the design and development phase, implementation phase and module evaluation phase. The 6 steps involved are based on the ASSURE model, namely Analyzing Learners, Stating Objectives, Selecting Methods, Media and Materials, Utilizing Media and Materials, Requiring Learners’ Participation, and Evaluating and Revising. A summary of the phases and steps implemented by the researcher is shown in Figure 1.1 below.

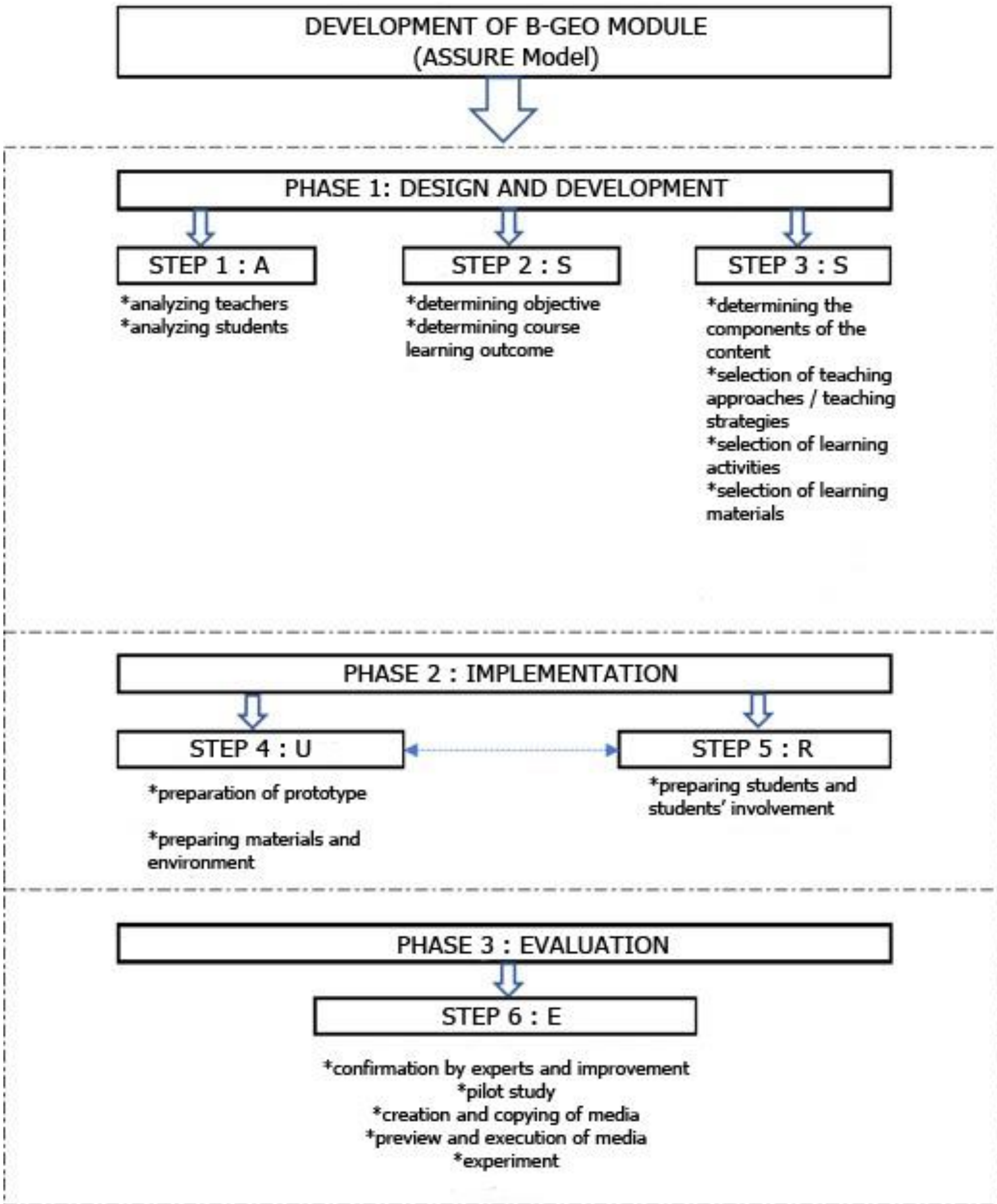

Figure 1.1: Development of B-Geo Module based on ASSURE Model.

SAMPLE

This study involves purposive sampling to test the usability of the B-Geo Module, and the samples are made up of 13 Mathematics teachers and 70 Form 4 students from rural secondary schools. To evaluate and validate the contents of the B-Geo Module, a total of 13 expert panels were selected and involved in the study.

INSTRUMENTATION

There are 3 instruments used in this study, namely, (1) questionnaire instrument for expert verification to confirm the B-Geo Module that has been built, (2) B-Geo Module usability instrument for teachers and (3) material and media usability instrument for students. The expert confirmation questionnaire instrument was adapted from (Abdul Rahman, 2015)'s and (Yaakob, 2015)'s questionnaires. The reliability of this instrument uses the Alpha Cronbach index. The results show that this instrument has a Cronbach alpha index exceeding 0.7. B-Geo Module usability instruments for teachers and materials and media usability instruments for students have been adapted from Che Soh's (2015) study. The reliability of this instrument uses the Alpha Cronbach index. The results show that this instrument also has an Apha value exceeding 0.7. Based on validity and reliability values, it is concluded that the instrument can be used in getting good information about module validity and reliability.

DATA ANALYSIS METHOD

Quantitative data from expert verification questionnaires and usability questionnaire of B-Geo module had used descriptive statistics with the help of IBM SPSS version 23. The suitability of the module built is based on the percentage of Rating of Module Suitability for Teachers by Shaharom (1994). In addition, the total marks obtained from the panel of evaluators which was made up of the appointed experts were also measured using mean and standard deviation.

Table 1.3 :*Rating of Module Suitability for Teachers* (Shaharom, 1994)

No.	Gradation	Percentage	Status
1.	Very Unsuitable	1 – 20%	Strongly Disagree
2.	Unsuitable	21 – 40%	Disagree
3.	No Difference	41 – 60%	No Difference
4.	Suitable	61 – 80%	Agree
5.	Very Suitable	81 – 100%	Strongly Agree

Meanwhile, quantitative data from the B-Geo module usability questionnaire and material, and media usability questionnaire had used descriptive statistics with the help of IBM SPSS version 23. Analysis was done using mean and standard deviation to see the usability of the module, which was interpreted according to Pallant (2010): mean values of 1 to 2.332 are considered as low level, 2.34 to 3.66 are considered as moderate level, and 3.67 to 5 are considered as high level.

Results and Discussion

PHASE 1: DESIGN AND DEVELOPMENT

There are 3 steps of the ASSURE Model in the design and development phase namely Analyzing Learners, Stating Objectives, and Selecting methods, media and materials.

STEP 1: Analyzing Learners

The researchers interviewed 4 teachers to obtain information on the needs of Additional Mathematics teachers. Next, they interviewed 6 Additional Mathematics students to find out the students' needs. From the data of teachers' needs analysis, four themes that can be identified are: the most difficult topics, the main problems of T&L, the lack of teaching aids, and the need to build teaching modules.

From the results of this interview as well, the researchers learned that teachers found it difficult to explain the abstract concept of Differentiation because for students, the topic was difficult to understand using conventional methods. This makes it difficult for students to answer problem-solving questions. Although teachers know that the use of computers to show conceptual understanding to students is easier, teachers do not have enough time to build an assimilation to help students to understand the concept of Differentiation. The conclusion of the interviews that had been analyzed according to themes by the researchers is as in Table 1.4.

Table 1.4:Analysis of Teachers' Interview Results by Themes

No.	Theme	G1/A/B	G2/A/Ro	G3/A/Az	G4/A/Sa
1	Difficult Topic	Functions and Differentiation	Differentiation	Differentiation	Indices & Logarithms
2	The main problem of T&L	Students' conceptual understanding	Students' conceptual understanding	Students' conceptual understanding and problem-solving questions	Problem solving
3	Teaching Aid Materials	Insufficient	Insufficient	Insufficient	Insufficient
4	Need for Building Teaching Module	Yes	Yes	Yes	Yes

In order to analyze the students' needs, the researchers interviewed 6 Form 4 Additional Mathematics students to obtain the initial information on students' needs. The themes that had been produced from the semi-structured interviews are: the most difficult topics, learning problems, learning methods, and learning aid materials. From the results of the interviews, it was discovered that according to the students, the topic of Differentiation was the most difficult topic in Form 4 Additional Mathematics syllabus. The problems faced by students in this topic are in terms of conceptual understanding and problem-solving abilities. The results of the analysis of interviews on the 6 students is shown in Table 1.5

Table 1.5:Analysis of Results of Teachers' Interview by Themes

No	Theme	M1/A	M2/A	M3/A	M4/A	M5/A	M6/A	Conclusion
1	Most Difficult Topic	Differentiation	Differentiation	Differentiation	Differentiation	Differentiation	Differentiation	Differentiation
2	Problems of Learning	Concept	Concept	Problem solving	Concept and problem solving	Concept	Concept and problem solving	Concept and problem solving
3	Teaching Aid Materials (need of ICT)	Yes	Yes	Yes	Yes	Yes	Yes	ICT is needed
4	Learning Methods (need for diferent methods)	Yes	Yes	Yes	Yes	Yes	Yes	Another learning method

Therefore, the researchers decided that the construction of this module was very appropriate to help teachers in terms of facilitating the teaching of the topic of Differentiation topic in Additional Mathematics. In addition, building a teaching aid material can help in terms of teachers' time because it will improve students' conceptual understanding of the Differentiation Topic and they in turn can answer problem-solving questions well. To ensure that the applied approach has an optimal effect, a delivery aid material with a brain-based teaching approach (PPBO) was developed in the form of a Teaching Module called B-Geo Module.

STEP 2: Stating Objectives

Determining the objectives of the module

The objective of this B-Geo Module is to be able to present a new teaching approach for teachers to be implemented in the classroom during the T&L process. In addition, it can produce a delivery aid material for the Brain-Based Teaching approach with the integration of GeoGebra Software in Additional Mathematics T&L that is effective for students. This B-Geo Module can at least provide an alternative approach in teaching Differentiation Topic and fill in the lack of reference materials and teaching aid materials, especially in conveying specific approaches and strategies in the subject of Additional Mathematics.

Next, the objective for students is based on the purpose of the study, namely the results of T&L based on the use of B-Geo module is so that students can master the topic of Differentiation to a more robust level.

Course learning outcome

The learning outcomes of the module for teachers are that teachers can understand and are able to formulate learning strategies with brain-based teaching approaches. This matter is very important for teachers so they can focus on students' needs while determining the use of appropriate learning materials based on brain-based learning to ensure that students' learning outcomes can be achieved at the end of the learning session. Meanwhile, the learning outcomes for students are set by the MOE in the Assessment and Curriculum Standard Document (DSKP), Secondary School Standard Curriculum (KSSM) of Form 5 Additional Mathematics.

STEP 3: Selecting methods, media and materials

Determining the components of the content

The content in the B-Geo module is consistent and based on the Assessment and Curriculum Standard Document (DSKP), Secondary School Standard Curriculum (KSSM) of Form 5 Additional Mathematics. The selection of the topic of Differentiation was based on the researchers' initial survey in identifying the selection of topics to be developed. The content sequence starts from the background, module usage guide, module objectives, PPBO Principles, PPBO strategies, Teaching Sets from 1 to 10, Summary of T&L Process Activities Based on PPBO Phases, Self-Training as well as Resources and References.

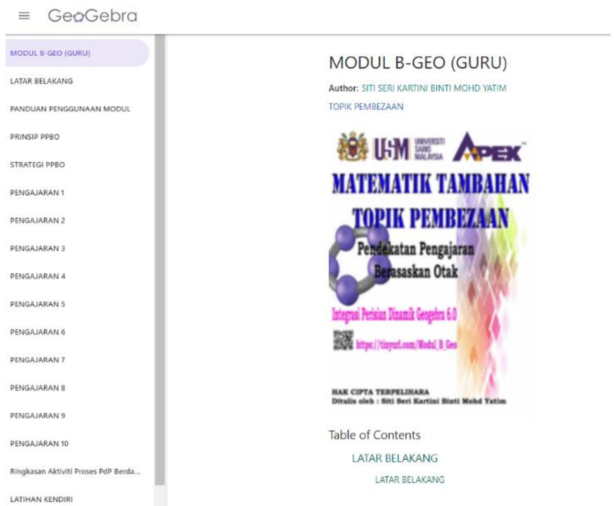

Figure 1.1. Main View of the Contents of B-Geo Module (Teacher).

In each set of lessons there are 4 parts, namely RPH based on brain-based teaching, GeoGebra Applet, Training Sheets, and Video Manuals on the Use of GeoGebra Applet. The content of each teaching set has been stated in the module usage guide to make it easier for teachers to use this B-Geo module.

Meanwhile, to determine the content of learning materials used by students, the B-Geo Module (Student), the researchers followed the Learning set 1 to 10 according to the teachers' B-Geo Teaching Module. Each Learning has a sequence of order with the presence of a GeoGebra applet, examples of questions and answers for solutions, as well as exercises for students to do during the learning process.

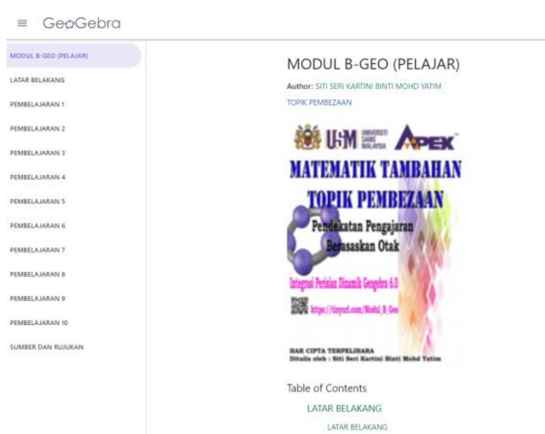

Figure 1.3. Main View of the Contents of B-Geo Module (Student).

Selection of teaching approaches and teaching strategies

An approach, according to Edward M. Anthony (1963) is a set of assumptions that are interrelated with the teaching and learning process and has axiomatic elements. According to this, it can be concluded that the approach should be based on learning models, principles, or theories. Therefore, the approach used by teachers for learning this teaching module is through Mayer's (1997) Multimedia Learning Theory. Through this approach, teachers can make a survey using multimedia, namely the B-Geo module to understand the content and implementation of teaching using PPBO with the integration of GeoGebra software that will occur in the classroom.

Table 1.6: *B-Geo Module Learning Approach Based on Mayer's (1997) Multimedia Learning Principles*

Mayer's (1997) Multimedia Learning Principles	Approach in B-Geo Module
Multimedia Principles	There is a combination of pictures and words in the B-Geo module to enhance generative processing in Multimedia learning. In addition, multimedia in the form of video, namely Video Guide for Using B-Geo Module and Video Guide for Using GeoGebra Apparatus are also available in this module.
Personal Principles	The videos were recorded using non-formal language to attract teachers to learn PPBO strategies.
Voice Principles	Videos were recorded using polite narratives in human voices and not using the voice of a machine.

The teaching approach chosen during the T&L implementation process using the GeoGebra applet in this B-Geo module is the Brain-Based Teaching Approach (PPBO), using multimedia software. This approach meets the criteria set by the Ministry of Education, Malaysia where teachers must consider the cognitive and affective readiness of students. The strategy phase selected in this B-Geo module is also modified based on the PPBO phase written by Saleh (2018), that is before teaching, during teaching and after teaching. Teachers are also encouraged to consider persuasion strategies and reward during T&L in order to help with students' self-efficacy and learning anxiety in Differentiation topic.

Table 1.7: *Teaching Strategies Based on the Brain-Based Teaching Approach*

Before Teaching	**PPBO strategy**
Activation	Teachers should provide a good environment and atmosphere for students so that their brains are ready to receive new concepts. Teachers should attract students to engage in the teaching process and ask questions.
During Teaching	
Explaining the learning outcomes	Explanation of learning outcomes is important so that students are able to receive new concepts to be learned.
Carrying out learning activities	Learning activities are held in groups using B-Geo modules and assisted by teachers.
Demonstration of students' understanding	Students present their answers with group members. Teachers explain the important concepts.
Breaks	The brain needs to rest to make room for new concepts.
Making connections and building meaning	Students make connections to the concepts learned and solve the given questions.
Wrap up	Teachers provide explanation to maintain students' memory of the concepts learned.
After Teaching	
Previewing new/next concepts	Teacher give an explanation of the concepts to be learned next.

Selection of Learning Activities

Activity refers to an undertaking or something that is happening or being done. The selection of teachers' learning activities using this B-Geo Module is by exploring all the contents of the module including the 10 teaching sets. There are 5 teachers' learning activities in the B-Geo module, namely (1) the activity of watching the B-Geo Module Video Guide for Users. (2) Principles of Brain-Based Teaching Approach, (3) PPBO Strategies, (4) 10 Teaching Sets Using GeoGebra Applet (5) Self-Training.

Learning activities during the T&L process are selected based on the construction of GeoGebra Applet for each lesson. According to Caine & Caine (1991), to increase the potential of the brain during the teaching and learning process, the importance of the 12 principles need to be emphasized. Therefore, the researchers implemented the 12 principles of PPBO in the learning activities that had been discussed.

Then, these 12 principles were used in the teaching and learning activities of teachers and students, using the Brain-Based Teaching Approach (PPBO) phases. The PPBO phases have been summarized as in Table 1.8 according to the Daily Lesson Plan (RPH).

Table 1.8: *Table of teachers' and students' activities according to the PPBO phases*

PPBO phase		**Implementation in B-Geo Module**	
		Teachers' Activities	Students' Activities
Activation (5 mins)	Preparation before T&L by providing a comfortable environment so that the brain can be ready to learn new concepts and function optimally.	Dividing students into groups. Putting on appropriate music Providing refreshing scents. Motivating students to be interested in listening to the lesson that will take place	Students are in a state of readiness and highly motivated.
	Providing a global experience and sharing ideas	Attracting students to learn new topics by showing videos. Providing simple quiz questions for students to revise past subtopics.	Students are interested in the videos provided and listen to the teacher's explanation. Students answer quiz questions confidently and this interests students to learn new topics.
Explaining the learning outcomes (3 mins)	Explaining the learning outcomes will allow the brain to be better prepared and focused on new lesson.	Teachers explain the learning objectives that are to be achieved.	Students listen by paying attention to the teacher's explanation and focusing on the lesson that will take place.

Carrying out learning activities (20 mins)	This phase requires students to explore new knowledge through active learning experiences.	Teachers carry out the learning activities by using GeoGebra Applets according to the set of lessons.	Students in groups carry out activities provided by teachers using GeoGebra applets.
Demonstration of students' comprehension (15 mins)	Students apply and integrate new knowledge to stimulate long-term memory by demonstrating their understanding.	Teachers ask students to demonstrate the answers and the activities that have been implemented. Teachers are advised to give encouragement and praise or use persuasion during students' demonstrations so that students are more confident and strive to learn the topic of Differentiation.	Students demonstrate their understanding by answering questions in the activities provided in groups using the GeoGebra Applet. Students will be more confident and strive to solve the given questions.
Break (5 mins)	Rest is needed to control emotions, help refocus learning outcomes, and increase students' activities.	Teachers encourage students to do physical activities Example: Brain Gym	Students are encouraged to drink water
Making connections and building meaning (15 mins)	Students make connections between various inputs (learning outcomes and specific skills) based on various active learning activities to build their understanding.	Teachers use GeoGebra applets for activities that make connections and build meaning. Teachers ask students to complete the Exercise Sheet given according to the Teaching set. Problem-Solving Training Sheet Questions are solved using the Polya Model. Teachers are advised to give encouragement and	Students use GeoGebra applets to make connections and build meaning. Students complete the Exercise Sheet by following the given Teaching set. Students will be more confident and strive to solve the given questions.

		praise or use persuasion during students' demonstrations so that students are more confident and strive to learn the topic of Differentiation.	
Conclusion/Reflection (5 mins)	Learning involves both conscious and unconscious processes. Train the brain to formulate concepts that have been learned throughout T&L.	Teachers summarize the concepts that have been learned.	Students listen and summarize the concepts learned.
Previewing new/next concepts (2 min)	The brain needs to be prepared to learn new concepts.	Briefly show students new concepts that will be learned in the next class.	Students listen to new concepts that will be learned in the next class

Selection of learning media

Heinich, Molenda dan Russell (1993) defined media as means of communication channels such as films, television, diagrams, printed materials, computers, and instructors. According to Zaman and Eliyawati (2010) learning media is made up of 3 types, namely, visual media, audio media, and visual-audio media. The selection of learning media is based on this definition of visual-audio media. Learning media for teachers in this B-Geo Module are the B-Geo Module Video Guide for Users and Daily Teaching Plans, as well as DSKP KSSM Additional Mathematics for Differentiation Topic for the reference of teachers who use this module.

On the other hand, learning media to be used by students during T&L in this B-Geo Module consists of GeoGebra Applet, Training Sheets, and Applet Usage Video. DSKP, RPH and Training Sheet are learning medias for both teachers and students and are available in *pdf* format which can be downloaded and printed to make it easier for teachers and students to use. On the other hand, the GeoGebra Applet uses *ggb* format in the B-Geo Module which requires internet connection for browsing learning materials. This GeoGebra applet can also be downloaded and opened using the Software GeoGebra Classic and is available offline. However, there are GeoGebra applet animations that are limited to *online* version and cannot be downloaded. The researchers encourage teachers and students to completely use the GeoGebra applet*online*.

Text structure and physical format

The features of good authoring software are able to integrate multimedia elements consisting of text, graphics, animation, audio and video into an interactive presentation (Khairulhasni, 2017). According to Haris (2014) the use of colors, text and graphics can help in improving brain function. The element of interactivity in this B-Geo module allows users to freely access and select information in the module and it is also able to stimulate the brain optimally.

The use of text should be appropriate according to the type and size of font to make it easier for users to understand the information clearly. This study used text format according to the type that had been set in the software GeoGebra 6.0, with a choice of large and small fonts, italic, bold, and colored fonts to suit the user. Fonts for mathematical symbols have also been set in GeoGebra software. However, there are instructions that are already available in the GeoGebra software using English as the predetermined language of communication. Most of the text in B-Geo Module uses medium to large text to make it easier for users to read.

Graphics can take the form of sketches, writing, drawings, or graphics, 2D and 3D forms, and they play an important role in conveying information in software production (Goh, 2009). The selection of graphics should be able to attract and stimulate the users' interest. The use of graphics in this module is in the format *jpeg*. There are images sourced from the internet to make the learning situation more attractive to users and as well as can be understood consistently.

The use of animation in this B-Geo Module is included in each teaching activity called GeoGebra applet. GeoGebra applet format is in *ggb* format. Each GeoGebra App has a graph or image that can be moved to help users understand a concept in the topic of Differentiation. The purpose of this animation is to make the information presented more interesting and easier to understand because it allows stationary objects to move.

Audio is one of the important elements in multimedia that is an effective way to attract users to the information presented and can stimulate the brain to function optimally. The use of audio in this B-Geo module is from the sources Youtube and background sound. During teaching and learning, teachers are free to choose the appropriate background music source to help stimulate students' brains.

The most widely used multimedia element is video. Videos were inserted in every teaching and learning process to help teachers and students understand the GeoGebra applet that had been built by the researchers. The videos were uploaded to Youtube and then imported to the B-Geo module. In addition, there are videos taken from Youtube to help users understand the concept of Differentiation in daily life. The multimedia element of video serves to provide accurate information and can create a fun teaching and learning environment where students can relate the concepts that they learned to the real world.

PHASE 2: IMPLEMENTATION

STEP 4: Utilizing media and materials

In step 4, the researchers made sure that the media and learning materials in the draft modules were tested.

Preparation of prototype

The researchers prepared the prototype of the teaching module using GeoGebra after the prototype had been built for experts' verification and pilot study. The diagram below shows the main view of the B-Geo Module prototype that had been built. The built-in prototype was given to an expert panel who were allowed access to this B-Geo Module. The expert panel could view or access this Module using 2 ways, either via the computer or the smartphone.

Providing materials and environment

Providing materials and environment is necessary before conducting pilot study and module usability assessment. The researchers provided learning materials and media to teachers and collaborated with the school which provided rooms that were adequate in terms of infrastructure, namely the internet and computers according to the number of students. A total of 38 students and two teachers from two rural secondary schools were involved in this pilot study.

Usability of Media and Learning Materials

The researchers gave this B-Geo Module to 10 Additional Mathematics teachers to get usability feedback on this module. The usability instrument of this module was adapted from a coursework construction study by Che Soh (2012). The data obtained are as shown in Table 1.9

Table 1.9: *B-Geo Module Usability for Teachers*

No.	Item	Mean	S.D
1.	This B-Geo module is easy to use.	4.70	.483
2.	The use of icons is suitable.	4.70	.483
3.	The command button is clear.	4.70	.483
4.	Use of appropriate background colors.	4.70	.483
5.	The color combination is appropriate.	4.80	.483
6.	The writing used is easy to read.	4.80	.422
7.	The active button is clearly highlighted.	4.80	.422
8.	The exit button is clearly displayed.	4.80	.422
9.	The screen design is uniform.	4.8	.422
10.	The structure of this B-Geo Module does not cause users to get lost while exploring it.	4.6	. 516
11.	The trail of information presentation in this B-Geo Module is easy to follow.	4.7	.675
12.	Users easily access the information they need.	4.8	.422
13.	The B-Geo module can be explored without causing technical problems to computer systems.	4.7	.483
14.	This B-Geo module is free of program errors that may affect its functions.	4.7	.483
15.	The quality of graphic is good.	4.7	.483
16.	The B-Geo Module content presentation is organized.	4.8	.422

Based on table 1.9, it can be seen that the whole item exceeds the mean of 3.5. This means that teachers agreed on the usability of this B-Geo Module structure. Therefore, the researchers concluded that the usability of this B-Geo Module was acceptable and could be continued for an actual study.

The researchers also conducted a pilot study on the module and asked the 38 students to use the media and learning materials that had been built. Next, the researchers obtained the students' feedback on the usability of the media and material of this module. Table 1.10 shows the mean values and standard deviations of the measured items.

Table 1.10: *Mean Values and Standard Deviation of Media Usability Items and Learning Materials for Students*

No.	Item	Mean	S.D
1.	The media and learning materials in this B-Geo Module are easy to use.	4.11	.649
2.	The use of icons is suitable.	3.92	.539
3.	The command button is clear.	3.95	.517
4.	Use of appropriate background colors.	4.00	.697
5.	The color combination is appropriate.	4.08	.673
6.	The writing used is easy to read.	4.13	.704
7.	The active button is clearly highlighted.	4.05	.517
8.	The exit button is clearly displayed.	3.95	.769
9.	The screen design is uniform.	4.13	.777
10.	The structure of this B-Geo Module does not cause users to get lost while exploring it.	3.95	.769
11.	The trail of information presentation in this B-Geo Module is easy to follow.	4.08	.632
12.	Users can easily access the information they need.	4.11	.559
13.	Media and learning materials in the B-Geo Module can be explored without causing technical problems to computer systems.	3.82	.766
14.	The media and learning materials in this B-Geo Module are free of program errors that may affect its functions.	3.92	.632
15.	The graphic quality is good.	4.05	.655
16.	The presentation of media content and learning materials in the B-Geo Module is organized.	4.13	.704

Referring to table 1.10, overall, the items are measured with mean values that are more than 3.5. This indicates that the media and learning materials measured are agreed upon by the students. Therefore, the researchers concluded that the Media and learning materials that had been built could be used for an actual study.

STEP 5: Requiring learner participation

Preparing students and students' involvement

The preparation of students and students' involvement had actually been performed by the researchers in step 4. A total of 38 students from a school were prepared to conduct this pilot study. Meanwhile, 2 teachers were also willing to work with the researchers to conduct this pilot study. Students and teachers should actively involve themselves in order to affect the T&L process.

PHASE 3: MODULE EVALUATION

STEP 6: Evaluation and revision
Confirmation from experts and improvement

Once the prototype module was built, the researchers submitted the B-Geo Module along with the experts' content validation questionnaire to a group of expert panels that had been identified for review and evaluation. This questionnaire had been adapted from (Abdul Rahman, 2015)'s and (Yaakob, 2015)'s questionnaires. A total of 13 expert panels were selected to evaluate the B-Geo Module. The list of experts involved included Mathematics experts, Module experts, Language Specialists, Brain-Based Teaching Approach Specialists and also GeoGebra Specialists. All views, suggestions and criticisms given by the panel of experts were used to correct the weaknesses and shortcomings found in the module.

Among the aspects that were evaluated by experts were the face validity (language and punctuation) and the content validity (the suitability of the content with the Malaysian curriculum). A panel of experts was given a questionnaire and asked to provide views or suggestions based on the items set by the researchers. The questionnaire is related to the aspects: (a) Learning Outcomes; (b) Module Design; (c) Teaching Strategies; (d) Teaching and Learning Activities; (e) Learning Materials and (f) Assessment. Table 1.11 shows the mean results, percentages and standard deviations for the approval of the expert panel in all six aspects.

Table 1.11: *Percentage, Mean and Standard Deviation for Experts' Evaluation*

No.	Aspect	Percentage of experts' agreement	Mean of experts' approval	Standard Deviation
1	Learning Outcome	93.8%	4.69	0.42
2	Module Design	91.0%	4.55	0.41
3	Teaching Strategies	89.8%	4.49	0.54
4	Teaching and Learning Activities	90.0%	4.50	0.64
5	Usability of Media and Learning Materials	89.6%	4.48	0.44
6	Evaluation	90.0%	4.50	0.50

Using Table 1.3 Rating of Module Suitability for Teachers (Shaharom, 1994), the percentage for all aspects is at a very appropriate level of 81-100%, and the overall percentage of the B-Geo module is at 90.7%. According to Sidek & Jamaludin (2005), a percentage of accomplishment and achievement above 70% is good and this module can be continued for study.

Pilot study

After undergoing experts' verification, the next step was to perform a pilot study of the module. A pilot study was conducted to see the extent to which this module could be implemented in the T&L of Additional Mathematics, as well as to see the strengths and weaknesses found in the B-Geo Module. A pilot study of the module was conducted in two SMK schools in Kedah with the involvement of 70 Form 4 students with 2 teachers. This pilot study was conducted for a week and each lesson took 70 minutes (2 hours). In addition, this intervention required infrastructure such as computer laboratory and the internet. The researchers conducted their own intervention in collaboration with Additional Mathematics teachers at a vocational school, which involved a total of 38 students. This was so that researchers could monitor any problems that arose during the intervention and take immediate action. The next study took place with the help of a teacher who was experienced at teaching Additional Mathematics as well as using GeoGebra, and this involved 32 Form 4 students. After the pilot study on the B-Geo Module was conducted, the researchers provided students with material and media usability questionnaires to assess the usability of the B-Geo Module's materials and media. This usability questionnaire was adapted from a coursework development study by Che Soh (2012). Next, the researchers interviewed two Additional Mathematics teachers who had used the B-Geo Module, in order to obtain their views and suggestions for this module. The results of observations, interviews, views, comments, and criticisms given by the teachers and students involved in this pilot study were used to improve and refine the B-Geo Module.

The Refinement and Improvement of the B-Geo Module
Based on the results of the pilot study that had been implemented, it was found that as a whole this B-Geo Module was suitable for use in the T&L of Additional Mathematics. The data findings obtained from the pilot study were used as a basis in refining and improving the B-Geo module. There were some weaknesses that had been identified, especially in terms of graphics and time allotted when creating activities using GeoGebra. Therefore, the researchers improved the front page graphics as well as the video manual to attract students' attention. In addition, the time allotted for the B-Geo module was increased from 60 minutes to 70 minutes so that more time was given to teachers and students in teaching and learning activities.

Conclusion

The validity of all aspects by the 13 experts on the development of this B-Geo Module shows a value exceeding 81%. According to the Rating of Module Suitability for Teachers (Shaharom, 1994), the percentage for all aspects is at a very appropriate level of 81-100%. Meanwhile, the overall percentage of the B-Geo module is 90.7%. According to Sidek & Jamaludin (2005), a percentage of accomplishment and achievement of above 70% is good and this module can be continued for study. Next, it can be seen that the development of this B-Geo module using the adaptation of the Assure Model is useful to teachers and students. All mean values for the usability of the Module to teachers and students exceed 0.80 which is above the good value (Sidek & Jamaludin, 2005). Therefore, this study has successfully shown that the ASSURE Model is a good model that can be used for Development studies.

After the researchers repairs and refines the prototype of the B-Geo Module and are satisfied with the corrections that have been implemented, the next process is the process of producing a complete B-Geo Module than can be used to guide teachers. Next, this B-Geo module can be implemented in the experimental group to see the effectiveness of the module.

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