DEVELOPMENT AND EFFECTIVENESS OF I-PROMATHS MODULE ON ACHIEVEMENT, THINKING SKILLS, MOTIVATION AND ENGAGEMENT IN CALCULUS AMONG MATRICULATION STUDENTS

By

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Mathematical achievement is still seen as less than encouraging even though many investments have been made after comparisons at the global level have been made. At the matriculation level, it is not left behind when matriculation students' mastery in calculus is seen as less impressive. In addition, through the needs analysis phase, matriculation students are seen to lack mastery of higher order thinking skills including critical and creative thinking skills. Likewise, from the aspect of motivation and student engagement that still needs attention. Therefore, a module was developed using the flipped classroom and problem-based learning (PBL) to help improve understanding in calculus at the matriculation level. The module called i-ProMaths module was developed based on the ADDIE (analyse, develop, design, implement, evaluate) model. During the needs analysis phase, semi-structured interviews were conducted together with six experienced senior lecturers from various matriculation colleges. The i-ProMaths module received validation from seven expert panels. Besides, the i-ProMaths module has also received high validity and reliability values,

exceeding the coefficient value of 0.90. The effectiveness of the i-ProMaths module was tested using a quasi-experimental design with a pre-post test conducted at one of the matriculation colleges in Kelantan. A total of 98 respondents consisting of four tutorial groups were involved in this study and divided into four different groups consisting of three experimental groups using the i-ProMaths module (flipped classroom and PBL), the ProMaths module (PBL), the i-Maths module (flipped classroom) and a control group using the module ConventMaths (conventional). The findings of the study show that students who were exposed to the i-ProMaths module significantly had better achievement in the post-test and delayed post-test compared to the other groups followed by the ProMaths, i-Maths and lastly ConventMaths groups. In addition, students in the i-ProMaths group significantly showed a better level of critical and creative thinking skills compared to other groups. Meanwhile, the results of motivation scores and student engagement also show significant differences in the i-ProMaths group compared to other groups. This study gives the implication that learning calculus integrated by flipped classroom and PBL module can help students gain achievement, critical and creative thinking skills, better motivation, and student engagement. In other words, the use of flipped classroom and PBL is suitable to be used in the teaching and learning of calculus to introduce the concept of calculus more clearly.

Keywords: Matriculation; Flipped classroom; Problem-based learning; Thinking skills

SDG: GOAL 4: Quality Education

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

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Pencapaian matematik masih dilihat kurang memberangsangkan walaupun telah banyak pelaburan yang dibuat setelah perbandingan di peringkat global dilakukan. Di peringkat matrikulasi juga tidak ketinggalan apabila penguasaan pelajar matrikulasi dalam kalkulus dilihat kurang memberangsangkan. Selain itu, melalui fasa analisis keperluan, pelajar matrikulasi dilihat kurang menguasai kemahiran berfikir aras tinggi yang merangkumi kemahiran berfikir secara kritis dan kreatif. Begitu juga dalam aspek motivasi dan penglibatan pelajar yang masih perlu diberikan perhatian. Justeru, sebuah modul dibangunkan menggunakan pendekatan kelas berbalik dan pembelajaran berasaskan masalah (PBM) bagi membantu meningkatkan kefahaman dalam kalkulus di peringkat matrikulasi. Modul yang dinamakan i-ProMaths dibangunkan berdasarkan model ADDIE (*analyse, develop, design, implement, evaluate*). Pada fasa analisis keperluan, temu bual separa berstruktur telah dijalankan bersama-sama enam pensyarah kanan yang berpengalaman dari pelbagai kolej matrikulasi. Modul i-ProMaths telah mendapat kesahan daripada tujuh panel pakar.

Selain itu, modul i-ProMaths juga telah memperoleh nilai kesahan dan kebolehpercayaan yang tinggi, melebihi nilai pekali 0.90. Keberkesanan modul i-ProMaths diuji menggunakan reka bentuk kuasi eksperimen dengan ujian pra-pasca yang dilaksanakan di salah sebuah kolej matrikulasi di Kelantan. Seramai 98 responden yang terdiri daripada empat kumpulan tutorial telah terlibat dalam kajian ini dan dibahagikan kepada empat kumpulan yang berbeza yang terdiri daripada tiga kumpulan eksperimen yang menggunakan modul i-ProMaths (kelas berbalik dan PBM), modul ProMaths (PBM), modul i-Maths (kelas berbalik) dan kumpulan kawalan yang menggunakan modul ConventMaths (konvensional). Dapatan kajian menunjukkan pelajar yang didedahkan dengan modul i-ProMaths secara signifikannya memperoleh pencapaian lebih baik dalam ujian pasca dan pasca tertangguh berbanding dengan kumpulan-kumpulan lain diikuti oleh kumpulan ProMaths, i-Maths dan akhir sekali ConventMaths. Selain itu, pelajar dalam kumpulan i-ProMaths secara signifikannya menunjukkan tahap kemahiran berfikir kritis dan kreatif lebih baik berbanding kumpulan-kumpulan lain. Manakala, dapatan skor motivasi dan penglibatan pelajar juga menunjukkan perbezaan signifikan dalam kumpulan i-ProMaths berbanding kumpulan-kumpulan lain. Kajian ini memberi implikasi bahawa pembelajaran kalkulus melalui modul berintegrasikan kelas berbalik dan PBM dapat membantu pelajar memperoleh pencapaian, kemahiran berfikir kritis dan kreatif, motivasi dan penglibatan pelajar lebih baik. Dalam erti kata lain, penggunaan kelas berbalik dan PBM adalah sesuai untuk digunakan dalam pengajaran dan pembelajaran kalkulus bagi memperkenalkan konsep kalkulus dengan lebih jelas.

Kata Kunci: Matrikulasi; Kelas berbalik; Pembelajaran berasaskan masalah; Kemahiran berfikir

SDG: MATLAMAT 4: Pendidikan Berkualiti

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In the Name of Allah, the Most Gracious and Most Merciful

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LIST OF ABBREVIATIONS

ADDIE	Analysis, Design, Develop, Implement, Evaluate
BMKPM	Bahagian Matrikulasi, Kementerian Pendidikan Malaysia
CCTS	Critical and creative thinking skills
CONVENT	Conventional
DDR	Design and Development Research
HOTS	Higher Order Thinking Skills
KMKt	Kolej Matrikulasi Kelantan
KPM	Kementerian Pendidikan Malaysia
KSSM	*Kurikulum Standard Sekolah Menengah*
KSSR	*Kurikulum Standard Sekolah Rendah*
LKC	*Laporan Kerja Calon*
LOTS	Lower Order Thinking Skills
MKO	More Knowledgeable Other
OECD	Organisation for Economic Co-operation and Development
PBL	Problem-Based Learning
PISA	Programme for International Student Assessment
PPPM	*Pelan Pembangunan Pendidikan Malaysia*
PT3	*Penilaian Tingkatan Tiga*
SPM	*Sijil Pelajaran Malaysia*
STEM	Science, Technology, Engineering and Mathematics
T&L	Teaching and Learning
TIMMS	Trends in International Mathematics and Science Study
TST	Test Specification Table
UPSR	*Ujian Penilaian Sekolah Rendah*
ZPD	Zone of Proximal Development

CHAPTER 1

INTRODUCTION

1.1 Research Background

As we are concerned nowadays, graduates are required to obtain transferring skills to apply the soft and hard skills they gained from school and higher institutions into the real world. This competition in the real-world causes graduates to develop their full potential before moving up into career life. These skills need to be further developed and honed while still in school. According to Syah Muhibbin (2017), each student can achieve a certain level per their respective capacities. However, the teacher is often said to be responsible for developing their pupils' entire potential, including cognitive, affective, and psychomotor (Nurmalia et al., 2021). Teachers should therefore contribute to create a good environment and use appropriate teaching and learning strategies to mold students' potential.

One of the potentials students must develop is thinking skills, mainly focusing on Higher Order Thinking Skills (HOTS). The transformation of Creative and Critical Thinking Skills (CCTS) and HOTS has become the main agenda in the *Pelan Pembangunan Pendidikan Malaysia* (PPPM), which aims to raise the standard of national education to the top third in international assessments (Ariffin & Yunus 2017). Therefore, critical and creative thinking skills are specific types of HOTS that contrast with the Lower Order Thinking Skills (LOTS) of memorizing and translating (Goodson et al., 2014). Thinking skills are also one of the primary aims of today's educational systems worldwide, and it is also outlined in the PPPM from 2013-2025 (Kementerian Pendidikan Malaysia, 2012). One of the six student goals in the PPPM

2013–2025 is the element of thinking skills, and it is crucial in producing a new generation that is intelligent, creative, and innovative to address the challenges of the 21st century (Chew & Masingan, 2021). Teaching thinking skills in school courses is crucial (Rajendran, 2018). In foreign countries, thinking skills are taught in the classroom, such as being offered as a subject at A-level. Swartz (2018) stated thinking skills can be taught by co-infusion in subjects using an incorporation approach in school. Thus, thinking skills can be applied in teaching through effective lesson planning to achieve instructional objectives and instil thinking skills in students. It is possible to see that employing parts of HOTS in teaching and learning favourably affects student achievement (Si-Rajab & Musa, 2018). However, Syaubari and Yunus (2017) reported that the application of HOTS in the classroom decreased as teachers more focused only on implementation at the initial learning stage, which caused the integration of HOTS to become limited. Thus, teachers should be fully prepared to integrate HOTS, especially critical and creative thinking skills, into the classroom.

1.1.1 Matriculation Program in Malaysia

The Matriculation Program in Malaysia is implemented in colleges nationwide under the auspices of Bahagian Matrikulasi, Kementerian Pendidikan Malaysia (BMKPM). The Matriculation Program was established in 1998 as a preparatory program for students to further their studies at the first-degree level in Science, Technology, and Social Science. This Matriculation Program is implemented to address the need for more excellent students and fill vacancies in science, professional and critical fields in Public Universities (Bahagian Matrikulasi, 2020c). Matriculation Program run by BMKPM continued to grow with the change of study period from 18 months to 12 months in 2002. In 2008, the Two Year Matriculation Program for Science Program

was specially offered to Bumiputera students. Subsequently, the Matriculation Program expanded the Science Program by offering Technical Program in 2009. This coincides with the goal of Thrust 2 of the Education Development Master Plan, which is to provide students with more choices and equal opportunities for all SPM graduates. Three matriculation colleges have been entrusted to handle this program, namely Kolej Matrikulasi Kejuruteraan Pahang, Kolej Matrikulasi Kejuruteraan Kedah, and Kolej Matrikulasi Kejuruteraan Johor (Bahagian Matrikulasi, 2020c).

The rise in the number of applications and the number of KPM matriculation colleges has resulted in more excellent SPM students being placed for this program. Until 2019, 30,000 places are provided for matriculation students as stated by Husain et al. (2021). There are three fields of study under one year program: Science, Engineering, and Accounting. The field of Science is divided into three modules: Life Science, Physical Science, and Computer Science, based on the combination of subjects taken. In conclusion, the matriculation program is a foundation program and prepares around 30,000 students to pursue undergraduate studies at public, private, and foreign universities in science, technology, and professional social science.

1.1.2 Mathematics in Schools and Matriculation

Following the establishment of the *Kurikulum Bersepadu Sekolah Rendah* (KBSR), the *Kurikulum Standard Sekolah Rendah* (KSSR) for mathematics is processed and reorganized. The reorganization takes consideration and long viability to the next stage. Since the improvement offers mathematical knowledge and skills, it is appropriate for pupils with various backgrounds and abilities. With the knowledge and skills taught, students can learn science and develop modifications, innovations, and

adaptations to face and deal with future changes and challenges (Ministry of Education, 2013). The KSSR for mathematics education aims to improve students' comprehension of number concepts, fundamental computing skills, easy understanding of mathematical ideas, and capacity to utilise mathematical knowledge and skills effectively and responsibly in regular life (Kementerian Pendidikan Malaysia, 2014).

Kurikulum Standard Sekolah Menengah (KSSM) was introduced in 2017 to replace the *Kurikulum Bersepadu Sekolah Menengah* (KBSM). The content covered in secondary-level mathematics essentially extends what students learn in elementary school. In accordance with the advancement of science and technology along with the 21st century's challenges, mathematics in KSSM intends to develop mathematically minded individuals and persons who are creative, innovative, and skilled in utilizing effective knowledge and skills in Mathematics and responsible in problem-solving and decision making (Bahagian Pembangunan Kurikulum, 2017). Restructuring the secondary school mathematics curriculum considers the continuity from the elementary school level to the secondary school level and subsequently to higher levels. Besides, specific skills that should be developed among students through mathematics at the secondary school level include mathematics Skills, 21st Century Skills, and HOTS (Bahagian Pembangunan Kurikulum, 2018b).

Since the implementation of KSSR and KSSM, specific subjects such as Bahasa Melayu, English, sciences, and mathematics are compulsory for Malaysian students from primary school to secondary school. However, in school, mathematics is described as an important subject since it will be included as a requirement for

admission to public universities for Science, Technology, Engineering, and Mathematics (STEM) courses. Secondary school graduates interested in applying for pre-university programs such as matriculation, form six, or university foundation in the field of STEM requires students to obtain at least credit for mathematics and Additional Mathematics. This shows that good achievement in mathematics is essential for students to apply for STEM courses at higher institutions. Similarly, the matriculation program offers science, engineering, and accounting programs, and all matriculation students must take mathematics.

Table 1.1 : The combination of subjects taken by matriculation students

Science			Engineering	Accounting
Life Science	Physical Science	Computer Science		
Mathematics	Mathematics	Mathematics	Mathematics	Mathematics
Chemistry	Chemistry	Chemistry	Chemistry	Accounting
Physics	Physics	Computer Science	Engineering Physics	Economy
Biology	Computer Science	Biology	Engineering Engineering Foundation	Business Studies

(Source: Bahagian Matrikulasi, 2020c)

At matriculation, the mathematics syllabus continues the additional mathematics syllabus. The knowledge and concepts learned at the secondary level are very much needed by students when pursuing mathematics subjects at the preparatory stage, such as the matriculation program (Hoban, 2019). This gives a great deal about the significance of mathematics courses that need to be mastered by students at matriculation to advance their studies to a higher level (Hoban, 2019). Students who are relatively weak in the mastery of basic in mathematics at the school level would make it difficult for them to learn mathematics at the matriculation level. Table 1.1 shows the combination of subjects that matriculation students must take. In

conclusion, matriculation students need a vital mastery of mathematics learned in secondary school because mastering this knowledge and concepts is important to learn mathematics at the matriculation level.

1.1.3 Mathematics Achievement in Malaysia

Studies on mathematics achievement cover primary, secondary, and pre-university levels. According to Mazalan and Kailani (2012), the study of mathematics achievement is a familiar matter in education. At the primary school level, achievement in mathematics for *Ujian Penilaian Sekolah Rendah* (UPSR) in 2019 has yet to reach a commendable level (Hamdan et al., 2021). At the secondary school level as well, based on the statistics of *Sijil Pelajaran Malaysia* (SPM) results in 2019, there has been a decrease in the percentage of mathematics achievement compared to 2018 (Wuong et al., 2021). In fact, students who obtain average or low results are likely to get a course that they are not interested in or are not offered a place at public university (Bukhori et al., 2015). This explains the importance of getting a good grade in mathematics to continue study at public university. However, a few complaints from various parties are often heard about the inadequate mastery in mathematics among the pupils in this country (Abu & Eu, 2017).

Mathematics achievements in Malaysia can also be measured by comparative international assessment scores, namely Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA). An economic survey report issued by the Organisation for Economic Co-operation and Development, Organisation for Economic Co-operation and Development [OECD] (2019) reported an increase in education spending in Malaysia from 16.7%

in 2006 to almost 20% in 2019. This spending is high compared to other countries and nearly doubles the average set by the OECD. Despite Malaysia's higher education expenditure from other OECD countries, Malaysia's achievements in the TIMSS and PISA are still poor (OECD, 2019). Based on the PISA score comparison in mathematics in 2019, Malaysia ranks 47th compared to 78 other countries. Similarly, international comparisons obtained by Malaysia in TIMMS for Mathematics also recorded poor scores. Malaysia recorded a significant drop in scores from 1999 to 2011, where the score plunged from 519 points to 440 points. Nevertheless, a slight decrease in 2019 recorded only 461 points. In conclusion, the achievement of mathematics by our country at the international level is still unsatisfactory despite the vast expenditure already spent on education.

Learning mathematics in matriculation colleges is implemented through lectures and tutorials. Student assessment is implemented formatively through continuous and summative assessments through the Matriculation Program Semester Examination. Students' achievement is based on the Semester Grade Point Average (SGPA) and the Cumulative Grade Point Average (CGPA) at each semester. The challenge of preparing students to learn mathematics at the college level has been the focus of this study on the transition period from high school to college. Nevertheless, studies on these mathematics subjects typically cover two years before and after entering university (Vandenbussche et al., 2018). Student achievement at the preparatory stage is seen differently by various stakeholders, including lecturers, administrators, and curriculum drafters, who often assume student achievement is measured from the perspective of their achievement in standardized tests (Bressoud et al., 2016).

Therefore, authorities such as teachers or lecturers should play a significant role in placing mathematics achievement at the school or college level in a better place.

1.1.4 Calculus in Mathematics

Many studies indicated that students struggle with calculus (Carnell et al., 2018; Çekmez, 2020). The most challenging topics in calculus reported are derivatives and integration (Tatar & Zengin, 2016). Meanwhile, Hoban (2019) stated that most students lack an understanding of basic calculus concepts at matriculation level. Carnell et al. (2018) explained poor prior knowledge as one of the factors calculus seems complicated among students. During the transition period, such as at the matriculation stage, the lecturer's role is very crucial in knowing and emphasizing the importance of basic concepts of mathematics, especially in calculus, to be grasped by students as a prerequisite for learning the subject at the next level (Kouvela et al., 2018). The findings of the previous needs analysis also show that matriculation students in Malaysia experience difficulties in calculus, especially the topic of integration (Husain et al., 2021). Therefore, prior knowledge, as well as the emphasis on the basic concepts of calculus, is essential for students in preparation to grasp the topic of calculus at the matriculation level.

1.1.5 Thinking Skills

Thinking skills have become one of the crucial components of education in Malaysia and become one of the six aspirations of Malaysian Education Blueprints (2013 - 2025) (Kementerian Pendidikan Malaysia, 2012). The essential skills that may be acquired during school are thinking skills and become the basis for high performance for most students (Nessel & Graham, 2006). There are two kinds of thinking skills

which are HOTS and LOTS (Krathwohl, 2002). The application of HOTS is the aspiration of national education to produce a generation that can compete globally (Nor et al., 2016). Rajendran (2018) describes HOTS as developing the utilization of the mind to face new challenges. HOTS also include creative and critical thinking skills (Ahmad et al., 2017). After implementing national curriculum changes, critical and creative thinking skills were introduced in 1989. Improving critical and creative thinking skills has been a top priority in mathematics education curricula worldwide (Butera et al., 2014).

Emphasis on thinking skills in all subjects in educational institutions allows for the cultivation of critical thinking and creativity, enabling students to think and make decisions more rationally, with consideration and objectivity (Peng & Nadaraja, 2016). Therefore, teaching rational thinking skills, especially critical and creative thinking, not only fulfils the desire of the National Educational Philosophy to produce balanced and harmonious individuals in terms of intellect, spirituality, emotions, and physicality but goes beyond that because developing critical and creative thinking skills among students is a humanitarian responsibility (Peng & Nadaraja, 2016). Critical and creative thinking skills can be integrated into teaching aimed at providing students with the ability to think critically and generate new ideas. Thinking skills are imparted to students through high-level questions, activities that encourage thinking and problem-solving, and teaching methods that can enhance thinking skills (Baharin et al., 2018).

Several experts say HOTS and student academic achievement are interrelated (Mursyid & Kurniawati, 2019). In this regard, students who learn using critical

thinking skills frequently perform well in school (Nguyễn & Nguyễn, 2017). Recognizing the significance of HOTS, including creative and critical thinking skills, many studies have been conducted. Dinni (2018) describes that using HOTS in learning can enhance mathematics literacy skills. In addition, Sinnasamy and Mahmud (2021) explain through critical thinking, students can solve mathematical problems by understanding concepts, drawing logical conclusions; providing explanations using models and facts; calculating the solution process and answering; apply patterns and relationships to analyse effectively mathematical issues. Numerous studies have indicated that pupils' mathematics achievement can be developed by cultivating their creative and critical thinking skills (Chukwuyenum, 2013). While, Akpur (2020) reveals that creative and critical thinking skills significantly influence positive correlations with each other, and these characteristics all predict academic achievement significantly and positively. This is also supported by the finding of several studies on critical and creative thinking skills can enhance mathematical achievement (Adeneye & Osarenren, 2020; Siburian et al., 2019). Therefore, teachers must play an important role in instilling HOTS, including creative and critical thinking skills, in the classroom so that students can improve these skills and their achievement.

1.1.6 Motivation

The degree of student achievement is also influenced by motivation in particular topics. According to Makmun (2002), motivation is a complex state of preparedness in humans to work towards specific purposes, consciously or unconsciously. Meanwhile, Darwis (2014) defines motivation as a phenomenon that promotes behaviour persistence so that it is focused and lasts longer. For decades, motivation has been essential in mathematics education (Hannula et al., 2016). Mathematics still

indicates low motivation among school students (Aryani & Suarjana, 2021). Previous PISA reports found that students in low socioeconomic backgrounds did not perform in mathematics and had low motivation (OECD, 2014). Comparison of student motivation in Malaysia shows a low level of motivation compared to students from Vietnam and Singapore (OECD, 2014). This may be observed in the seriousness of students engaging in learning mathematics and the quantity of effort they put forward. Motivated students will strive to find ways to achieve goals without being easily influenced by those around them (Zainuddin & Perera, 2019). Students motivated about something will constantly put in extra effort and work tirelessly to improve themselves. Put another way; people will be satisfied only if they understand after performing mathematics revision.

Students must gain powerful learning motivation during studying since it may offer enthusiasm, purpose, and endurance in learning activities (Berlyana & Purwaningsih, 2019). Providing students with sufficient motivation may have a strong influence since motivated students have a massive amount of energy and passion to engage in learning activities (Andriani & Rasto, 2019). Besides, motivation also acts as a driving factor among students, allowing them to develop, sustain, and drive their learning activities. Then the learning goals are anticipated to be fulfilled (Melinda, 2018). In addition, motivation significantly correlates with students' mathematical achievement levels (Herges et al., 2017; Pitsia et al., 2017; Prast et al., 2018). This relationship shows that motivational factors greatly influence student achievement in mathematics. Therefore, motivational elements must be applied in teaching to stimulate students to understand specific subjects better.

Several recent studies have been conducted to look at teaching approaches that influence student motivation in mathematics at the school and post-school levels. Studies were conducted at the school level using a problem-based learning approach (Malmia et al., 2019; Priyonggo et al., 2021; Septian & Komala, 2019), using a game-based learning approach (Chizary & Farhangi, 2017; Hwa, 2018; Siong & Osman, 2018) and using a flipped classroom approach (Chien & Hsieh, 2018; Turra et al., 2019; Umam et al., 2019) can increase student motivation in learning mathematics. Meanwhile, studies on motivation at the tertiary education level using augmented reality (Kamal & Junaini, 2019; Sudirman et al., 2020) and using flipped classrooms (Chien & Hsieh, 2018; Turra et al., 2019; Umam et al., 2019) can also improve motivation in learning mathematics. Therefore, teachers should implement innovations in teaching using the latest approaches to attract students and, in turn, enhance students' motivation to learn mathematics.

1.1.7 Student Engagement

The concept of student engagement has long been discussed in literature highlights over the past 70 years (Kuh, 2009a). Student engagement in learning can influence teachers to develop students 'thinking and ability to participate in discussions (Bean & Peterson, 1998). Student engagement is described by Axelson and Flick (2010) as how active or enthusiastic students seem during school learning and how related they are to their classrooms, schools, and each other. Based on Fletcher (2007), student engagement is any continuous attachment a student has with any part of learning, institutions, or education. Student engagement has become more widely recognized as a sign of effective classroom instruction (Fletcher, 2007) and institutional quality (Axelson & Flick, 2010).

Student engagement is becoming more widely recognized as crucial to tackling low performance, boredom and detachment, and significant dropout percentages (Groccia, 2018). Besides, engagement is important in improving students' abilities, especially in academic achievement, emotions, and developing specific skills in mathematics. Student engagement can significantly predict student achievement (Handelsman et al., 2005). A study conducted among Partido State University students found a positive correlation between the three domains of student engagement (cognitive, behavioral, and emotional) with student academic achievement (Delfino, 2019). Furthermore, according to Kuh (2009), student engagement through various activities can increase retention in a specific course. Many past studies have examined the correlation between student engagement and academic achievement, particularly in mathematics. A positive correlation exists between student engagement and mathematical achievement (Fung et al., 2018; Gaylo & Dales, 2017; Jie et al., 2019). Thus, student engagement in classroom activities is essential to provide valuable and effective experiences for students to build lasting knowledge in mathematics.

1.1.8 Module Based Learning

A module is a unit of a series of independent learning activities designed to assist students in achieving a well-defined objective (Guido, 2014). Meanwhile, Zainudin (2017) defines a learning module as a module that contains the functions of various learning programs that are beneficial and flexible and use instructional intermediaries that can be used individually or in groups. In the meantime, Mohd Sarjan (2012) described that module -based learning method is a planned and guided teaching method. He added that planned teaching is a learning system that arranges the content of the subjects in order and breaks it down into several smaller steps. Students will

follow each step based on ability, and further learning is reinforced based on the assessment feedback given after each step. Meanwhile, Meyer (1998) states that the use of modules not only focuses on worksheets or units of work through chapters in a textbook reinforced by practice questions, but if a module is developed using apparent design features, it can significantly contribute to learning.

At the matriculation level, no textbooks or modules are provided by the ministry. Therefore, lecturers have developed modules and notes according to the curriculum guidelines given by BMKPM. The main objective is to ensure that lecturers understand the requirements and expectations in the mathematics curriculum specification and may use them as a guide while teaching and learning the subject. However, there is no standardized mathematics module in class delivery and its effectiveness is evaluated through experimental studies at the matriculation level. Husain et al. (2021) stated that the use of the calculus module in the topic of integration received a positive reaction among matriculation lecturers. Yuntawati and Aziz (2018) explained a positive increase in mathematics achievement in a group of students who used an inquiry-based calculus module. Improving student achievement in mathematics proves that using modules is successful strategy for teaching and learning in calculus. In addition, Siregar et al. (2022) reported on the need for module development at Riau University to enhance mathematical creative thinking skills among students in calculus. Therefore, it is clear that the development of learning modules is helpful to teachers and students. In the context of this study, the researcher develops a learning module focusing on calculus in the topic related to integration.

1.1.9 Flipped Classroom

Flipped classroom is one of the pedagogies that is gaining attention in the world of education (Suhari, 2015). Alsowat (2016) defines flipped classrooms as a learning technique that optimizes learning time for concept discussion sessions and questions classified as HOTS questions and achieving LOTS objectives via pre-class. Calculus is quite difficult and requires students to master the basic concepts before class begins. Therefore, pre-class is an important phase in the preparation of prior knowledge with a solid foundation in mathematics. At the same time, the flipped classroom is also defined as a growing 21st-century learning technique where students acquire knowledge outside the classroom and enrich it inside the classroom (Kutty, 2019). Generally, students will undergo three main stages in the flipped classroom, beginning before teaching, during and after teaching (Strayer, 2007). This matter is very important in calculus, especially in the phase before teaching to build basic concepts and after teaching to strengthen understanding. In fact, students will acquire their knowledge and experience outside the class and do activities inside the class to enrich their experience (Kutty, 2019). Subsequently, students will conduct post-learning activities through online activities provided after their interaction time.

Several studies report the advantages of flipped classrooms in teaching and learning (T&L). Masri and Mahamod (2020) stated flipped classroom can provide opportunities for students to manipulate a learning material before the actual learning session applies during the classroom. Therefore, the time-space for T&L activities in the classroom can focus on activities involving peers and teachers less emphasized in conventional learning. In addition, flipped classroom also becomes a form of support for student-centred learning, positively impacts learning activities, and encourages

student participation (Zainuddin et al., 2019). According to Karim (2016), flipped classroom can increase student engagement and assign self-responsibility. A recent study has also shown that the effect of flipped classroom on critical thinking skills is significantly practical on critical thinking skills in mathematics (Kaviza, 2019). Meanwhile, Tsai et al. (2020) reported that flipped classrooms could improve mathematical achievement and motivation, perhaps training creative thinking skills among engineering students. In conclusion, it is undeniable that the utilisation of flipped classrooms may benefit students while also assisting teachers in more effective T&L in the classroom.

1.1.10 Problem-Based Learning

Problem-based learning (PBL) has not been a new learning method but was introduced in medicine five decades ago at McMaster University, Canada, in 1969 (Moallem et al., 2019). PBL is active learning that is increasingly applied because this method can improve conceptual knowledge, problem-solving skills, and student motivation in the learning process (Bakri et al., 2021; Butai et al., 2021). In addition, PBL is a teaching method that applies student-centred learning (Rajak et al., 2022). Student-centred teaching techniques can improve students' competence in reasoning ideas, developing analysis, and evaluating problems related to the topics discussed (Fakhruddin & Suhid, 2017). Student-centered learning is very important in learning difficult subjects such as calculus because it requires active student involvement. Generally, PBL is a learning approach in the classroom that is student-centred and uses problems as the focus of learning. Usually, students are given problems related to real-life problems or applications in daily life. Real-life problems or applications in daily life that are related in life are very important in calculus such as optimization, extremum problems

and finding areas and volumes so that students can relate concepts in calculus to the real world.

Several studies show PBL has a positive effect on learning. Rajak et al. (2022) studied the effects of STEM modules that use PBL strategy for secondary school students in rural areas. Their study positively impacts increasing interest in deepening STEM knowledge, motivation, and the formation of soft skills among high school students. In addition, a quasi-experimental study shows that PBL can improve the achievement of mechanical engineering students in calculus at PGRI University Semarang, Indonesia (Nizaruddin et al., 2019). Study also show that PBL can improve critical and creative thinking skills in visual arts education at higher institutes (Ulger, 2018). In conclusion, the implementation of PBL in-class activities can have a positive impact on either the cognitive, affective, and thinking skills domains of students.

1.2 Problem Statement

The results for TIMSS and PISA for Malaysia were not encouraging and showed that the students of Malaysia are still at a lace level of achievement in mathematics. This is also described in a study by Shin et al. (2019), reporting that student achievement in mathematics has significantly declined even though large sums of money have been invested to advance education in Malaysia. In contrast, these subjects are a way to higher success. Malaysia's international mathematics achievement indicates that, on average, Malaysian students still have not mastered the basic concepts of mathematics well. This reflects that the average level of achievement in mathematics of those tested in PISA and TIMSS at that time was unsatisfactory, and some of them pursued their studies at matriculation colleges and subsequently to university with low mastery in

mathematics. At the matriculation level, a study of the needs analysis on students showed that students still lack mastery of mathematics, especially involving calculus in the topic of integration (Husain, 2021). The same thing was also raised by Hoban (2019), who confirmed that most students lack mastery of the basic concepts of calculus among pre-university students. This requires the involvement of matriculation lecturers to improve students' basic concepts in mathematics, especially calculus, to become stronger. Therefore, matriculation lecturers need to be prepared to strengthen their understanding and basic concepts of mathematics by changing teaching and learning inside and outside the classroom.

Motivation and student engagement also affect achievement in mathematics. In their study, Gholami et al. (2019) encountered low motivation among pre-university students in learning mathematics. They also added low motivation and interest in mathematics cause students to face difficulty in learning concepts in mathematics. Perhaps, previous studies also reveal students with lower motivation will get lower achievement in mathematics (Mekarina & Ningsih, 2017; Wang et al., 2017). Besides, a study reveals low student engagement among higher institution students including pre-university students (Nahar et al., 2022). Perhaps, student engagement is also a factor in the mastery of mathematics at university (Ayub et al., 2021). Student engagement contributes to academic improvement, and teacher strategies should be emphasized to increase student engagement (Sa & Surat, 2021). The limitations of studying the effects of modules on student engagement and motivation at the matriculation level should also be taken into account. Hence, motivation and student engagement should not be ignored arbitrarily in the classroom because they influence mathematics achievement.

A research report by the Research Institute of National Higher Education stated many graduates obtain excellent results but fail to get employment equivalent to their qualifications (Heong et al., 2020). A few employers reported that several graduates lack knowledge, skills, and attitudes (Puad & Nawe, 2021). Among the skills that graduates fail to achieve are such as critical thinking skills (Mansour & Dean, 2016) and creative thinking skills (Yusof & Jamaluddin, 2017). A recent study indicates a significant gap between employability and thinking skills, especially in graduates' creative and critical thinking and leadership skills (Hanapi et al., 2017). They added the interview data also stated that employers were dissatisfied with the mastery of students' marketability skills, especially in communication, leadership, critical thinking, and problem-solving.

Moreover, Nirmala and Kumar (2018) emphasize the importance of graduates mastering thinking skills, including creative and critical thinking skills, as a factor in being recruited. This problem was inherited at the school and university levels, where students fail to master critical and creative thinking skills at school (Falah & Sistiana, 2018; Fatmawati et al., 2019; Jafar, 2018) and at university (Masrukan, 2018; Sari et al., 2017). Therefore, students need to equip themselves with critical and creative thinking skills to meet the needs of the current market. Learning and assessment in the classroom may help students develop students thinking skills (Widana et al., 2018). Hence, educators should play an essential role in improving students' critical and creative thinking skills in early school to produce students who can meet the needs of future employers.

The teacher is responsible for developing the students' potential in the school. At matriculation, thinking skills are one of the potentials that lecturers need to develop among their students, and Husain (2021) stated that the matriculation mathematics syllabus also emphasizes aspects of thinking skills provided by BMKPM. A few studies show a correlation between thinking skills and academic achievement. Siburian et al. (2019) report critical and creative thinking skills positively correlate with cognitive learning achievements among university students. Susanti (2019) confirms this argument with her findings, which reveal a positive correlation between critical and creative thinking skills and mathematical performance. However, Kassim and Zakaria (2015) stated a few teachers are less equipped to integrate thinking skills into their teaching and learning due to the teachers' lack of diversity in teaching strategies. Besides, the study showed teachers have the minimum knowledge about understanding and implementing thinking skills, especially HOTS, in the classroom (Rasyid et al., 2021). Furthermore, the shortage of modules to be employed as guidance during the teaching and learning process on integrating HOTS in teaching seems to be a significant issue at all level education including pre-university (Hassan et al., 2017). This contributes to the limits of diverse HOTS teaching techniques and practices in the classroom (Sharuji & Nordin, 2017). Therefore, the need for a module that can enhance students' thinking skills is necessary so that it can help teachers to instill thinking skills in the classroom.

The teaching method is vital in engaging students to understand mathematics (Acharya, 2017). The current teaching methods at all levels of education heavily rely on a conventional approach through lecture explanations on class material and home assignments, with just a few students participating in all classroom activities among

higher institutions' students (Afrasiabifar & Asadolah, 2019) including in Malaysia (Jopri, 2022). In this context, conventional lectures are executed with the lecturer in front of the classroom using teacher centred. The classroom seems to have the same regular activities where the lecturer demonstrates full supervision, and students simply sit and listen to the explanation (Hadibarata & Rubiyatno, 2019). It ignores students' cognitive development, especially in thinking skills. Hong et al. (2017) reported teaching mathematics still using the conventional approach with a higher emphasis on the classroom than encouraging students to think critically and apply their knowledge to real-world situations. Therefore, teachers need to change the approach by using a student-centred approach to develop students' full potential.

Recent studies show how modular-based learning among students can improve thinking skills such as HOTS, including critical and creative thinking skills in mathematics (Feriyanto & Putri, 2020; Ibrahim et al., 2020; Maskur et al., 2020). However, most studies among matriculation students population revolve around correlational studies (Bakar et al., 2021; Husain, 2020; Sabarudin et al., 2019) and survey studies (Abd Manaf, 2021; Daud et al., 2021; Isaac & Bakri, 2021; Shaari, 2021). The study reveals a lack of module development for pre-university students, including matriculation (Lim, 2016; Silk et al., 2017). Besides, much of the module development revolves around students in school. The study of the development of the mathematics module at matriculation was carried out by Husain (2021). Still, his study only focused on module development without testing the module's effects on matriculation students. In addition, the module is developed using the ADDIE model. Many modules have been developed using the ADDIE model and their effectiveness has been experimentally proven to be effective. The module development study at the

matriculation level has been done using Sidek model (Amirnudin & Saleh, 2020a; Husain et al., 2021; Sulong et al., 2019), ASSURE model (Mazlan, 2018) and DDR approach (Abdussyukur et al., 2021; Jaafar & Ishak, 2023). The ADDIE model is also used in the development of modules at the matriculation level but using surveys in the needs analysis phase (Abdullah et al., 2021; Abdullah et al., 2023; Arif et al., 2021). Therefore, it is a necessity to develop a module using the ADDIE model and interviews in the needs analysis phase at matriculation.

After all, BMKPM does not provide textbooks or modules for matriculation level studies. In fact, several matriculation lecturers develop their own modules. However, most of the modules produced are more focused on the concept of drills or rote learning. Due to the existing exam-oriented education system, pre-university learning still relies on rote learning (Amirnudin & Saleh, 2020b; Darby & Rashid, 2017; Kandaiah, 2017). This obviously ignores development of the student's potential such as soft skills, thinking skills and also students will have difficulty answering questions that are different from the usual exercises given. The limitations of the module's effects on matriculation students in mathematics and focusing more to meaningful learning without relying on rote learning and thinking skills development prompted this module development to be implemented at the matriculation level.

The development of this module uses flipped classroom as an intervention approach. According to Rahman (2017), the learning framework using flipped classroom through previous studies is not very detailed regarding implementing learning activities inside the classroom. In this study, learning activities inside the classroom through flipped classrooms will be more detailed using PBL inside the classroom.

Adaptation of flipped classroom model, O-PITRAS by Guo (2019), which focuses on lower and higher-level objectives, is also included in this module to complement the flipped classroom learning framework in more detail regarding activities carried out outside and inside the classroom. The O-PITRAS model was initially implemented among university students compared to most flipped classroom models initially implemented at the school level. No recent study in Malaysia using the O-PITRAS model in flipped classrooms prompted researcher to apply this model. This module is expected to impact matriculation students' thinking skills and mathematics achievement positively as well as motivation and engagement since the process of developing the module will consider the appropriate activities, reasonable materials and involve experts and tested its effectiveness experimentally.

1.3 Research Objectives

This study aimed to develop a module. Then, this study will determine the effect of the module among matriculation students. The main objectives of this study are to:

1. Determine the elements required in module development through the needs analysis phase in ADDIE model.
2. Determine the value of validity and reliability of the module developed through the ADDIE model.
3. Determine the difference in achievement test scores (post-test and delayed post-test) based on the modules.
4. Determine the differences in mathematical critical thinking skills scores (post-test and delayed post-test) based on the modules.
5. Determine the differences in mathematical creative thinking skills scores (post-test and delayed post-test) based on the modules.

6. Determine the differences in motivation scores (post-test) based on the modules.

7. Determine the differences in student engagement scores (post-test) based on the modules.

1.4 Research Questions

The research questions are developed based on objectives 1 and 2. The research questions are as follows:

Q_1 : What elements are found in the module needs analysis?

Q_2 : What is the validity and reliability coefficient value of the module?

1.5 Research Hypotheses

The research hypotheses are developed based on objectives 3, 4, 5, 6, and 7. The research hypotheses are as follows:

H_{a1} : There is a significant difference in the mean post-test scores among matriculation students using the i-ProMaths, ProMaths, i-Maths, and ConventMaths modules.

H_{a2} : There is a significant difference in the mean delayed post-test scores among matriculation students between using the i-ProMaths, ProMaths, i-Maths, and ConventMaths modules.

H_{a3} : There is a significant difference in the mean score of overall mathematical critical thinking skills in post-test among matriculation students between the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a4} : There is a significant difference in the mean score of mathematical critical thinking skills domains (identifying & interpret information and

evaluating evidence & argument) in post-test among matriculation students between the use of the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a5} : There is a significant difference in the mean score of overall mathematical critical thinking skills in delayed post-test among matriculation students between the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a6} : There is a significant difference in the mean score of mathematical critical thinking skills domains (identifying & interpret information and evaluating evidence & argument) in delayed post-test among matriculation students between the use of the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a7} : There is a significant difference in the mean score of overall mathematical creative thinking skills in post-test among matriculation students between using the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a8} : There is a significant difference in the mean score of mathematical creative thinking skills domains (fluency and flexibility) in post-test among matriculation students between using the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a9} : There is a significant difference in the mean score of overall mathematical creative thinking skills in delayed post-test among matriculation students between the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a10} : There is a significant difference in the mean score of mathematical creative thinking skills domains (fluency and flexibility) in delayed post-test among matriculation students between using the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a11} : There is a significant difference in the mean motivation score in post-test among matriculation students between using the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a12} : There is a significant difference in the mean score of overall student engagement in post-test among matriculation students between using the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

H_{a13} : There is a significant difference in the mean score of student engagement domains (cognitive engagement, affective engagement, and behavioral engagement) in post-test among matriculation students between using the i-ProMaths module, ProMaths module, i-Maths module, and ConventMaths module.

1.6 Significance of the Study

The study of the development of the i-ProMaths module provides valuable input for the development of teaching and learning in Malaysia, especially at matriculation. Therefore, the findings from this study are considered a guide and beneficial to matriculation students, matriculation lecturers, and matriculation division KPM. The i-ProMaths module, which focuses on strategies to enhance understanding of calculus for integration and first-order differential equations, assists students in answering calculus questions effectively. In addition, the i-ProMaths module also emphasizes the development of critical and creative thinking skills in calculus among matriculation students. Due to the use of modules based on the O-Pitras flipped classroom model that has never been used in Malaysia, it is hoped that this study can provide a different perspective in answering calculus questions for integration-related topics. In addition, using this module is also a form of promotion to attract matriculation students to answer mathematics questions, especially involving calculus.

Teachers are agents in shaping a higher community of thinking. Therefore, it is hoped that educators in matriculation, known as matriculation lecturers, can use these findings to improve the quality of teaching in the classroom by developing practical modules. Lecturers can help students in mastering the skills of solving mathematical problems related to calculus and improve students' thinking skills through the i-ProMaths module.

Besides, this study can help curriculum drafters regarding topics or concepts that promote thinking skills among matriculation students. The findings of this study should be helpful in ministry curriculum planners, particularly those in the Matriculation Division, in developing future curriculum frameworks. Besides, they should also be able to spot weaknesses in the curriculum as it is being drafted while also improving the quality of mathematics teaching and learning in matriculation. Changes in the design of a mathematics curriculum may be considered to diversify teaching materials and enhance thinking skills among matriculation students.

1.7 Limitation of the Study

Even though every effort has been taken to eliminate errors in this study's design and analytical components, several limitations must be acknowledged. This study is conducted using an experimental study involving matriculation students of one -year science program. Therefore, the study's findings would differ from other studies not conducted experimentally. This study is conducted based on a module developed by a researcher focusing on calculus on integration and first-order differential equations. The use of modules focusing on other topics will yield different findings. Besides, this study is limited to one-year science program students at Kolej Matrikulasi Kelantan.

The findings may differ with students from other matriculation programs and other locations. Besides, the timeframe of this study is set at six weeks. A more extended period of instruction may yield a different result.

In addition, HOTS in this study is only limited to critical and creative thinking skills. This study only focuses on two domains in critical thinking skills, namely identify and interpret information and evaluate evidence and argument. Firdaus et al. (2015), Bahurudin (2017) and Setambah et al. (2019), only included the domains of identify and interpret information as well as evaluate arguments and evidences in mathematics subjects since it appeared more suitable than other domains that may be tested in other subjects. Besides, the limitation of this study is that it only focuses on two domains in creative thinking skills, namely fluency and flexibility. A few researchers only included the domains of fluency and flexibility in mathematics subjects above their suitability compared to other domains that can be tested in other subjects, such as in studies by Hästö et al. (2019), Bye et al. (2022) and Shaw et al. (2020). While the limitation for motivation in this study is focusing only on the questionnaire developed by Butler and Dedrick (2021) which contains 15 items and specifically designed for mathematics. The final limitation student engagement only focuses on the cognitive, affective and behavioral domains which adapted from Gunuc and Kuzu (2015). The use of different domains and instruments may give different study results.

1.8 Definition of Terms

The term definition is the explanation process of each term found in the research. The following are definitions of terms for the study:

1.8.1 Module -Based Learning

The module can be defined as a teaching and learning unit that discusses specific topics systematically and successively to enable students to learn alone so that they can master a learning unit easily and accurately as stated by Noah and Ahmad (2005). Meanwhile, Yusop et al. (2018) state module is a set of learning or programs designed and systematically organized to achieve several objectives. In this study, module-based learning refers to developing the i-ProMaths module in calculus for integration and first-order differential equations among one-year science program matriculation students and is implemented using flipped classroom and PBL approach.

1.8.2 Conventional Learning (Convent)

Conventional learning refers to a teaching approach involving teachers and students interacting face-to-face in a classroom where students receive information passively (McCarthy & Anderson, 2000). Meanwhile, Yap (2016) states that conventional learning refers to teachers' emphasis on using textbooks and notes. In this study, conventional learning refers to using an instructional module in which the materials are the same as the treatment module but not using flipped classroom or PBL.

1.8.3 Flipped Classroom

Flipped classroom is a learning strategy occurring outside of the classroom and homework and learning are switched (Adnan, 2017). Meanwhile, Kurup and Hersey (2013) define flipped classroom as one of the most recent learning strategies for implementing online technology on blended learning. In this study, flipped classroom is used as strategy on two treatment groups for matriculation students.

1.8.4 Problem-Based Learning

Problem-based learning (PBL) is a student-centered strategy that encourages students to learn collaboratively through active association with teachers and friends (Norman & Schmidt, 2000). According to Razali et al. (2017), PBL uses an approach by identifying problems from existing knowledge and referencing various sources as a starting point to shape the learning process. PBL in this study is the strategy applied as strategy during in-class learning on two treatment groups for matriculation students.

1.8.5 Achievement Test

An achievement test is a test that assesses a person's performance on a given assignment (Fraenkel et al., 2019). Meanwhile, based on Creswell and Guetterman (2018), the achievement test is being constructed using a 'norm,' which means that the test score will be compared between individuals who have completed the test. This study's achievement test is based on the pre-test, post-test, and delayed post-test, which the researcher developed to assess mathematical achievement by matriculation students in calculus.

1.8.6 Critical Thinking Skill

Critical thinking skill is the ability to make successful reasoning and detect connections across systems, concepts, and disciplines to solve issues and make judgments (Germaine et al., 2016). Critical thinking skill is also defined as cognitive process and skills involve interpretation, analysis, evaluation, inference, and explanation (Facione, 1990). In this study, critical thinking skill refers to the critical thinking skill score obtained by students after being taught using four different

modules based on total scores of domain of identify and interpret information and domain of evaluate arguments and evidences.

Identify and Interpret Information

Identify and interpret information requires comprehension of the relevance of diverse experiences, circumstances, facts, judgments, views, rules, procedures, and criteria (Facione, 1990). Meanwhile, Renjith and James (2015) defined identify and interpret information as evaluating whether each proposed conclusion is logical or not beyond reasonable doubt from the information given. In this study, identify and interpret information based on scores on the ability to extract important information from the given problems and present it in the form of mathematical equations.

Evaluate Arguments and Evidences

Evaluate arguments and evidences is defined as evaluating the arguments or evidence given whether strong or weak, should be accepted or rejected (Renjith & James, 2015). Facione (2011) defined arguments and evidences evaluation as assessing the trustworthiness of assertions that reflect an individual's perception, experience, circumstances, judgment, belief, or opinion, as well as the logical coherence of actual. In this study, evaluating arguments and evidences refers to the scores of producing correct and exact solutions and answers after analyzing the information presented through problems and doing precise cross checks.

1.8.7 Creative Thinking Skill

Creative thinking skill is the ability to digest and produce original and generative ideas (Jakpar, 2015). Meanwhile, Krupiah and Kannadasan (2021) define creative thinking

skill as the ability to produce something new and valuable by using the imagination naturally and thinking out of the ordinary. In this study, creative thinking skill is based on creative thinking skill score achieved by students after being taught using four different modules according to total domain of fluency and flexibility.

Fluency

Fluency is demonstrated when a student generates numerous ideas that are relevant to the inquiry problem (Siswono, 2011). Meanwhile, Firdaus (2016) defined fluency is based on a variety of answers made in response to a certain problem. In this study, fluency is according to the score of capacity to provide more than one mathematically accurate solution.

Flexibility

Flexibility is the ability of students to solve problems in many different ways (Firdaus, 2016). Meanwhile, Siswono (2011) defined flexibility as capacity to address an issue in a variety of ways. In this study, In this study, flexibility is based on the score of capacity to demonstrate more than one accurate mathematical solution.

1.8.8 Motivation

Motivation is defined as a behavior with direction and magnitude in explaining the purpose a person chooses to pursue (Keller, 2009). Tohidi and Jabbari (2012) define motivation as the ability to drive people to high levels of achievement and overcome obstacles to change. In this study, motivation is referred to the motivation score of matriculation students who are taught using four different modules in calculus.

1.8.9 Student Engagement

Student engagement is defined as the time and effort students dedicate to activities which empirically connected to preferred college outcomes and what institutions undertake to encourage students to participate in these activities (Kuh, 2009). Axelson and Flick (2010) describe student engagement as how interested students seem in their learning and how they interact with their courses and institutions. In this study, student engagement is referred to as engagement in the classroom dimension of matriculation students who are taught using four different modules. Student engagement is measured based on three aspects, including behavioural, affective, and cognitive as mentioned by Fredricks et al. (2004).

Cognitive Engagement

How students approach and understand their learning is linked to their cognitive engagement (Gunuc & Kuzu, 2015). It is related to putting effort into learning, appreciating learning, motivating learning, setting learning goals, self-regulation, and planning (Appleton et al., 2006). In this study, cognitive engagement is referred to student's concentrated effort to understand the material being taught through the score filled by matriculation students who are taught using four different modules.

Affective Engagement

Affective engagement relates to affective response to the instructor, classmates, course material, and class are linked to their attitudes, interests, relationships, and values. (Bryson & Hand, 2007). Gunuc and Kuzu (2015) defined affective engagement as positive feelings, such as students' interest and satisfaction in the classroom. Meanwhile, affective disengagement manifests as negative feelings, like students'

boredom and anxiety. During this study, affective engagement is referred to as students' interactions with others in college, involving the feeling of interest, boredom or irritation through the score filled by matriculation students who are taught using four different modules.

Behavioural Engagement

According to Appleton et al. (2006), behavioural engagement involves students' efforts, attendance, and participation in class as well as their involvement in academic, extracurricular educational activities. Students who experience positive behavioural engagement ask questions, participate actively in class, pay attention to what is being said, and make an effort (Fredricks et al., 2004). In this study, behavioural engagement is referred to the efforts, concentration, and persistence of students through the score filled by matriculation students who are taught using four different modules.

1.9 Conclusion

This chapter introduces issues related to the topic studied. This chapter briefly describes the issue in mathematical achievement, HOTS, including critical and creative thinking skills, motivation, and student engagement. Based on the arguments presented, the study's objectives, the expected contributions, the operational definition, and the overall structure of this research are outlined.

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