THE DEVELOPMENT AND USABILITY OF MYBIOPROJECT TEACHING MODULE FOR SELECTED TOPICS IN FORM FOUR BIOLOGY

NATASHA KAUR A/P MINDAR SINGH

SULTAN IDRIS EDUCATION UNIVERSITY

2025

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NATASHA KAUR A/P MINDAR SINGH

DISSERTATION PRESENTED TO QUALIFY FOR A
MASTER OF EDUCATION (BIOLOGY)
(RESEARCH AND COURSEWORK MODE)

FACULTY OF SCIENCE AND MATHEMATICS
SULTAN IDRIS EDUCATION UNIVERSITY

2025

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ACKNOWLEDGEMENT

With immense gratitude and humility, I acknowledge the divine grace of Waheguruji that enabled me to complete this master's dissertation. I wish to express my deepest appreciation and heartfelt thanks to Dr. Nurhaida Binti Kamaruddin, my supervising lecturer. Her unwavering support, guidance, encouragement, and invaluable advice were instrumental in my successful completion of this study.

I extend my sincere thanks to the Ministry of Education Malaysia (KPM), Jabatan Pendidikan Negeri Perak, and all the Pejabat Pendidikan Daerah in Perak, especially PPD Manjung, for approving my request to conduct this research among biology teachers in schools across Perak state. This study greatly benefited from the expertise of professionals at UPSI and the dedicated biology teachers in Perak who participated in the data collection process. Their assistance in evaluating the modules and research instruments was crucial in refining the MyBioProject module and developing robust instruments.

I am deeply grateful to the administrative and academic staff at my university for their support and resources throughout my academic journey. Their dedication to creating a conducive learning environment has been invaluable.

Finally, I wish to acknowledge the unwavering support and patience of my beloved husband, Reshpal Singh Chinger. His understanding and encouragement throughout the challenging journey of completing this study have been a constant source of strength and inspiration. His belief in me has been a driving force behind my perseverance and success.

ABSTRACT

This study aimed to develop and determine the usability of the MyBioProject teaching module, which uses the Project-Based Learning (PjBL) approach for four selected topics within the Form Four KSSM biology syllabus in Malaysia. This study employed a quantitative approach with a developmental design. The module was developed using the ADDIE Model and encompassed five phases: analysis, design, development, implementation, and evaluation. The instruments used in this study were the expert validation form for the MyBioProject module, the expert validation form for the usability questionnaire, and the usability questionnaire. The module's face and content validity were assessed through expert agreement percentages and the Content Validity Index (CVI) values. The findings indicate that the module has excellent face and content validity, with an average expert agreement percentage of 92.2% for face validity and 100% for content validity, achieving I-CVI and S-CVI values of 1.00. The reliability of the questionnaire was measured using Cronbach's Alpha coefficient in a pilot study among 16 biology teachers in the Manjung district who overall scored 0.987, an excellent Cronbach's Alpha value. A total of 60 biology teachers from Perak with a minimum of one year of teaching experience, participated as respondents to determine the module's usability. The usability questionnaire analysis revealed that respondents found the module highly usable, with average mean scores for suitability, efficiency, and satisfaction of 3.34 (SD = .47), 3.34 (SD = .48), and 3.31 (SD = .47), respectively. In conclusion, the MyBioProject teaching module demonstrates high validity and usability. This study implies that the module can be an alternative teaching aid and additional reference for biology teachers to facilitate PjBL implementation in their classrooms.

PEMBANGUNAN DAN KEBOLEHGUNAAN MODUL PENGAJARAN MYBIOPROJECT BAGI TOPIK TERPILIH DALAM MATA PELAJARAN BIOLOGI TINGKATAN EMPAT

ABSTRAK

Kajian ini bertujuan untuk membangunkan dan menentukan kebolehgunaan modul pengajaran MyBioProject, yang menggunakan pendekatan Pembelajaran Berasaskan Projek (PjBL) bagi empat topik terpilih dalam sukatan pelajaran Biologi Tingkatan Empat KSSM di Malaysia. Kajian ini menggunakan pendekatan kuantitatif dengan reka bentuk pembangunan. Modul ini dibangunkan berdasarkan Model ADDIE yang merangkumi lima fasa: analisis, reka bentuk, pembangunan, pelaksanaan, dan penilaian. Instrumen yang digunakan dalam kajian ini ialah borang pengesahan pakar bagi modul MyBioProject, borang pengesahan pakar bagi soal selidik kebolehgunaan, dan soal selidik kebolehgunaan. Kesahan muka dan kandungan modul dinilai melalui peratusan persetujuan pakar dan nilai Indeks Kesahan Kandungan (CVI). Dapatan kajian menunjukkan bahawa modul tersebut mempunyai kesahan muka dan kandungan yang sangat baik, dengan purata peratusan persetujuan pakar sebanyak 92.2% untuk kesahan muka dan 100% untuk kesahan kandungan, mencapai nilai I-CVI dan S-CVI sebanyak 1.00. Kebolehpercayaan soal selidik diukur menggunakan pekali Alpha Cronbach dalam kajian rintis di kalangan 16 orang guru biologi di daerah Manjung yang mendapat markah keseluruhan 0.987, nilai Alpha Cronbach yang cemerlang. Seramai 60 orang guru Biologi di Perak dengan pengalaman sekurang-kurangnya setahun merupakan responden dalam menentukan kebolehgunaan modul. Analisis soal selidik kebolehgunaan mendedahkan bahawa responden mendapati modul tersebut sangat boleh digunakan, dengan purata skor min untuk kesesuaian, kecekapan, dan kepuasan masing-masing 3.34 (SD = .47), 3.34 (SD = .48), dan 3.31 (SD = .47). Kesimpulannya, modul pengajaran MyBioProject menunjukkan kesahan dan kebolehgunaan yang tinggi. Implikasi kajian ini menunjukkan modul ini boleh berfungsi sebagai alat bantu mengajar alternatif dan rujukan tambahan untuk guru biologi untuk memudahkan pelaksanaan PjBL di dalam bilik darjah mereka.

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LIST OF ABBREVIATION

AI	Artificial Intelligence
AL	Authentic Learning
BPK	*Bahagian Pembangunan Kurikulum*
BPPP	*Bahagian Perancangan dan Penyelidikan Pelajaran*
CL	Collaborative Learning
CVI	Content Validity Index
DSKP	*Dokumen Standard Kurikulum dan Pentaksiran*
DSL	Disciplinary Subject Learning
GPMP	*Gred Purata Mata Pelajaran*
HOTS	Higher Order Thinking Skills
HQPjBL	High-Quality PjBL Framework
ICT	Information and Communication Technology
I-CVI	Item Level Content Validity Index
IL	Iterative Learning
IoT	Internet of Things

IPO	Input Process Output
ISO	International Standards Organization
JPN	*Jabatan Pendidikan Negeri*
KBSM	*Kurikulum Bersepadu Sekolah Menengah*
KPM	*Kementerian Pendidikan Malaysia*
KSSM	*Kurikulum Standard Sekolah Menengah*
PjBL	Project Based Learning
PPD	*Pejabat Pendidikan Daerah*
S-CVI	Scale Level Content Validity Index
SPSS	Statistical Package for the Social Sciences
SD	Standard deviation
SPM	*Sijil Pelajaran Malaysia*
STEM	Science, Technology, Engineering and Mathematics
UPSI	Universiti Pendidikan Sultan Idris
ZPD	Zone of Proximal Development

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In today's times, the education world is witnessing the advancement of technology for improving the student's experience in the learning process. There is a drastic transformation and demands of the Industrial Revolution 4.0 for developing the learning method and education system (Barus, Simanjuntak & Resmavasari, 2021). Therefore, technological advancement and various advanced technological applications, such as artificial intelligence (AI) and the Internet of Things (IoT), are being utilised in the learning and teaching process. However, the education system cannot be the same as it was 10-15 years ago for students. Currently, everything has been modified, which can also nurture the learning process and knowledge of the

students in their respective fields and help them develop their educational careers (Mutakinati, Anwari & Kumano, 2018). The consistent development in the learning process and the implementation of advanced technologies in the education system are aligned with the National Education Philosophy (1988). Thus, this can also improve the ability of the students to adapt to the learning process and gain better knowledge related to their respective fields.

This introductory chapter outlines the background of the study, which includes transitions from conventional teaching methods to project-based teaching methods followed by the problem statement which consisting of the hurdles and issues of project-based learning. This chapter also covers core elements of research objectives and research questions regarding developing a Project-Based Learning (PjBL) teaching module in form four Biology. Moreover, the importance of this research is also mentioned in this chapter from the perspective of teachers and form four students who are taking Biology. Also, the limitation in developing the module has been highlighted in this chapter. Finally, this chapter ends with a summary of the chapter.

1.2 Research Background

The education world is constantly changing drastically to meet the demand of industrial revolution 4.0. The advancement of technology with a variety of applications based on artificial intelligence are being used, and the teaching and learning process can no longer be the same as it was twenty years ago. This is supported by Housand (2018), saying that twenty years ago, teachers were the primary source of information in the

classroom, and today, the Internet plays an increasingly important role in the classroom, and students are able to access information and knowledge instantly from anywhere in the world. Thus, in the era where students can get all information from the tips of their fingers, it is no longer suitable for teachers to conduct lessons solely based on content knowledge. According to the National Education Philosophy (1988), education in Malaysia is an on-going effort towards nurturing the potential of individuals in a holistic and integrated manner.

Furthermore, students today generally do not follow the stereotypical system in the learning and education process as they are distinct from those of previous years. They are considered "digital natives" who possess unique ways of learning and processing information due to their familiarity with technology and these changes in student characteristics require a shift in teaching approaches to meet their specific needs and preferences (Bell, 2018). Students in the present era are not limited to textbooks for broadening their critical thinking and knowledge of content, rather they actively participate in creating and enhancing their own educational experiences (Reynolds, 2018). Therefore, rather than remembering points mentioned in the textbook, a student needs to use those points in their personal life for the practical application of those points to understand better (Varghese, Ramesh & Veeraiyan, 2019). This highlights the importance for students to not just comprehend the materials from the books, but also being able to use it creatively to solve problems and improve their situation, as per the context.

Thus, the latest activity in 2017, "Kurikulum Standard Sekolah Menengah" (KSSM curriculum), was presented to transform the (KBSM) that is "Kurikulum

Bersepadu Sekolah Menengah" based on the Malaysia Education Blueprint 2013-2025 is also done so that we can focus on student's centred and differentiated teaching, but with greater emphasis on problem-based and project-based work, a streamlined set of subjects or themes, and formative assessments. The change in the syllabus is so that teachers can focus less on predicting what topics and questions will come out and drilling for content recall. Instead, students will be trained to think critically and to apply their knowledge in different settings (Malaysia Education Blueprint 2013-2025). However, further evaluation over time will be necessary to determine the success of the KSSM syllabus and its impact on students' academic achievements (Tan, Chia & Jusoff, 2019).

To uphold the shift of the KSSM syllabus, Project-Based Learning (PjBL) has been implemented in various subjects in Malaysian schools, including science and mathematics, and has been found to be effective in enhancing students' critical thinking skills, problem-solving skills, and academic achievements (Rohaida & Zamri., 2015). Hence, students should be trained to be critical thinkers and be able to apply the knowledge learned to their daily life (Chen & Yang, 2019). Therefore, the PjBL activities planned in this module will be based on project work which includes problem solving methods in all classroom assessment which will be helpful in students' learning processes. The transformation in the classroom activities is for the teachers as well as this can make them feel reliable and also, for them to concentrate less on the prediction of the topics and questions that can come in exams and can be better for the content that has been taught to the students (Guo, Saab, Post & Admiral, 2020).

Additionally, comparing PjBL with traditional teaching methods shows that PjBL has a positive influence on an increased academic success, making learning more fun and more endearing and building the skills most needed by the students (Sulong & Sulong, 2022). Thus, the shift to KSSM expects the transformation of the teaching methods in the educational institutions and focusing on the learning methods by developing the teaching methods to enable the teachers to provide developed learning and in the developed methods (Almulla, 2020). These developed methods can help the teachers provide modified learning methods to make students capable of grabbing the learnings provided by the teachers in the educational institution. According to Chen and Yang (2019), the implementation of the KSSM syllabus has had a positive impact on students' learning outcomes. The KSSM curriculum's modified teaching methods have led to improved learning outcomes by helping students better focus on their education and syllabus, while also catering to diverse learning needs and abilities (Chen & Yang, 2019). By providing personalized learning experiences and enabling students to achieve their full potential, the KSSM syllabus has facilitated better teaching and learning experiences for students across educational institutions in Malaysia.

Biology is a branch of science focused on the systematic study of nature, emphasizing not only the acquisition of knowledge through facts, concepts, and principles but also the process of discovering new insights. It is taught in schools to help students understand concepts, solve related problems, and appreciate the marvels of creation (Syafii & Yasin 2013). Recognizing the importance of Biology, teachers should adopt effective methods and techniques to actively engage students and create a more meaningful learning experience. Innovation in teaching practices is essential to enhance the quality of education, and this can be achieved through the use of innovative

learning models. These models, such as Project-Based Learning (PjBL), can help students develop problem-solving skills, deepen their conceptual understanding, and apply their knowledge to real-life situations effectively

In today's times, teachers are expected to execute project-based learning to make the students learn more appropriately and precisely, which can help them provide better learning and teachings in educational institutions (Fidan & Tuncel, 2019). PjBL is an instructional method that allows students to build skills and gain knowledge through projects, cooperative learning and hands-on techniques (Keleman, Mohamad Sattar Rasul, Nur Atiqah Jalaludin, 2021). A previous study by Kelemen et al. (2021) has proven the advantages of PjBL compared to traditional learning methods as it can help students to achieve learning outcomes and master the topic better. In addition, it can expose students to organizational skills and time management, forming teamwork, using high-level thinking skills, increasing academic achievement, individual learning of students and academic personality of students (Keleman et al., 2021). Overall, the implementation of PjBL in Malaysia has the potential to not only benefit students but also contribute to the development of a more skilled and innovative workforce in the country (Kiong, Rusly, Hamid, Singh & Hanapi, 2022).

1.3 Problem Statement

The adoption of the KSSM syllabus represents a crucial advancement in aligning Malaysia's education system with global standards and addressing the demands of 21st-century learning. Despite this progress, challenges persist, particularly in ensuring

equitable access to quality education and equipping teachers to meet new pedagogical expectations. Research by Pazilah et al. (2024) highlights that while the integration of 21st-century learning pedagogies is underway, gaps in teacher training, access to resources, and digital literacy remain significant barriers, reflecting broader issues of professional development within the teaching workforce.

Malaysia's education system has long faced criticism for being overly exam-oriented. Chin, Thien, and Chiew (2019) note that the focus on high test scores often overshadows the development of critical skills such as problem-solving and analytical thinking. Teachers frequently adopt a teacher-centred approach aimed at exam preparation, limiting opportunities for student engagement and active learning (Ichsan et al., 2019). Similarly, Ramlee Mustapha et al. (2020) report that classroom instruction is often dominated by topics expected in exams, leaving little room for broader exploration or application of Higher Order Thinking Skills (HOTS). While the KSSM syllabus has increased the proportion of HOTS-related questions in the SPM examination—from 20% in 2014 to 50% in 2021 (Lembaga Peperiksaan, 2022)—only 53% of students were proficient in answering these questions in the 2021 SPM. This highlights the need for alternative teaching strategies to bridge this gap.

The decline in science stream enrolments further underscores the challenges within the education system. The Malaysian Education Blueprint 2013–2025 reported that only 36% of students opted for science streams in 2012. By 2020, this figure had marginally improved to 47.18%, yet only 20.51% pursued pure science subjects, including Biology, while 26.67% chose TVET pathways (Idris, Govindasamy & Nachiappan, 2023). This trend reflects a pressing need for innovative interventions such

as Project-Based Learning (PjBL) to cultivate interest in STEM fields and prepare students for future career demands (Jaafar & Maat, 2020).

A critical factor contributing to these issues is the prevalent reliance on traditional teaching methods. Hamid (2006) observed that lessons often focus on factual delivery, with limited opportunities for critical engagement. This emphasis on rote learning and memorization restricts the development of problem-solving skills and HOTS (Abdullah, Abidin & Alin, 2015). Moreover, students in Malaysia have limited exposure to innovative approaches like PjBL, and a lack of specialized assessment tools for HOTS exacerbates the problem. In contrast, STEM education, when implemented effectively, has demonstrated significant potential to enhance students' higher-order thinking and foster interest in STEM fields (Wahono, Lin & Chang, 2020).

Given these challenges, the development of a Biology Project-Based Learning (PjBL) module, such as MyBioProject, is essential. Although the Curriculum Development Department (BPK) introduced the PjBL STEM Integrated Implementation Module in 2022, it lacks subject-specific examples for Biology, omits detailed guidance on the teacher’s role in PjBL, and does not include assessment tools. MyBioProject addresses these gaps by incorporating teacher roles and assessment questions alongside hands-on activities, making it a structured and practical resource for Biology education.

A survey of 30 biology teachers revealed unanimous support for such a module, with all participants expressing willingness to integrate it into their teaching practices. By fostering critical thinking, creativity, and problem-solving skills, this module has

the potential to elevate the quality of Biology education and inspire greater interest in STEM fields. The initiative represents a significant step toward transforming Malaysia's education system, equipping students with the skills needed to excel in a rapidly evolving global landscape.

1.4 Research Objectives

The primary objective of this research is to develop an effective teaching module for four topics within the biology Form Four KSSM syllabus in Malaysia. This module aims to improve the overall learning experience of students, promoting the development of their educational careers. By focusing on the specific topics outlined in the syllabus, this research aims to develop a comprehensive and targeted module that caters to the needs and abilities of teachers. The module will be designed to enhance understanding and retention of key concepts and principles, promoting critical thinking and problem-solving skills.

The research objectives are as follows:

1. To develop a MyBioProject teaching module for four topics under the Biology Form four syllabus with good validity.
2. To determine the usability of the developed MyBioProject teaching module based on the perception of Biology teachers.

1.5 Research Questions

This study was carried out to answer the following research questions:

1. Does the developed MyBioProject teaching module for four topics under the Biology Form four syllabus have good validity?
2. Does the developed MyBioProject teaching module have good usability based on the biology teacher's perception?

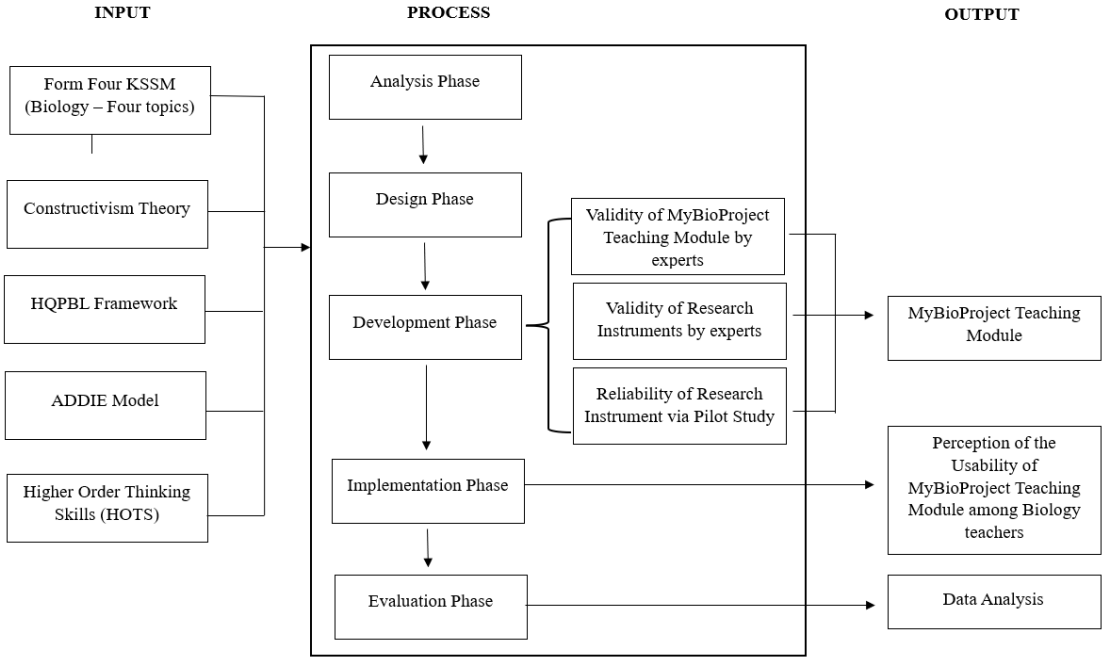
1.6 Conceptual framework

A conceptual framework as shown in Figure 1.1 is developed to assist in the development of the project-based teaching module, the underlying learning theories and to identify the usability for this developed module on form four Biology syllabus (KSSM).

The PjBL teaching module is developed using ADDIE instructional model which include 5 phases; Analyse Phase, Design Phase, Development Phase, Implementation Phase and Evaluation phase. This ADDIE model is an instructional model that act as guide to the development of software and learning materials which is used by many researchers to develop software or applications related to education field (Wang & Hsu, 2009). The theory that is involved in this module development is constructivism theory.

Figure 1.1

Conceptual framework



1.7 Significance of Research

The purpose of this study is to enhance the learning process by utilizing Project-based learning methods to enhance the skills of both teachers and students. In this research, four topics that were identified as the most challenging among the two themes of the KSSM Biology Form Four syllabus are chosen to develop a project-based learning lesson activity for teachers as a source to refer to while planning their lesson plan. The PjBL teaching module is important for several stakeholders in secondary school education. Students and teachers are two essential stakeholders in the project-based learning process (Yustina, Syafii & Vebrianto, 2020).

1.7.1. Teachers

Project-Based Learning (PjBL) has been identified as an effective method for teachers to provide improved learning opportunities that enhance students' learning process (Beier et al., 2019). This research provides a comprehensive understanding of the PjBL process, equipping teachers with the necessary skills to help students adopt PjBL techniques and enhance their knowledge of various biology subjects. By utilizing the developed module, teachers can confidently enhance students' understanding and interest in Biology. This study has the potential to contribute to the existing body of knowledge on improving current classroom strategies.

These innovative teaching methods enable teachers to provide customized learning approaches that enable students to effectively comprehend the learning materials provided in educational institutions (Martins & Gresse, 2022). The proposed teaching method leverages project work and problem-solving methods for subjective and formative assessments, helping students adapt to the learning process effectively. Furthermore, this approach motivates teachers to improve their teaching techniques and knowledge, resulting in more confident and effective classroom activities, particularly those related to PjBL (Guangul, Suhail, Khalit & Khidhir, 2020). Consequently, this approach will help reduce the pressure of completing the syllabus and teaching solely to attain high examination scores.

This study aims to develop a project-based learning (PjBL) lesson activity for teachers, which will serve as a valuable reference material while planning their lesson plans. Specifically, the study focuses on four topics that were identified as the most

challenging among the two themes of the KSSM Biology Form Four syllabus during the need analysis phase. The module that is being developed through this study will enable teachers to effectively enhance their students' understanding and interest in Biology. The developed module is expected to make it easier for teachers to teach complex topics in Biology, by integrating PjBL strategies into their lesson plans. In addition, this research is anticipated to make a valuable contribution to the current knowledge base on enhancing classroom strategies, which could potentially have a positive impact on students' learning across various subject areas and education levels.

1.7.2 Students

In today's times, students generally do not follow the stereotypical system in the learning and education process. In fact, they take responsibilities for their learning and gain knowledge based on their personal experience (Kortam, Basheer, Hofstein & Hugerat, 2018). Project-based learning is an innovative approach to student-centred learning which involves exploring real-world problems and challenges and enables students to gain a deeper understanding of the subject matter. According to Zaharah and Nurulwahida (2021), the PjBL approach positively impacts students' learning process by improving their learning achievement, perception, and mastery of topics taught, as well as developing hands-on skills applicable outside the classroom, ultimately leading to positive outcomes in real-life situations. Hence, the development of this module is aimed at enhancing the students' learning process, which is expected to lead to an improvement in their academic performance.

Besides that, according to Siti Adilah, Sarani and Kamisah (2020), students at various educational levels enjoy participating in authentic projects associated with project-based learning courses, finding value in the experience and showing improved performance and retention. They also found that project-based learning strategies have the potential to cultivate creativity and innovation among students. This research suggests that the implementation of PjBL approach could potentially benefit students by increasing their interest in PjBL-related projects and competitions at various levels such as school, district, state, and national, ultimately enhancing their learning experience.

1.7.3 School

Schools are also important stakeholders in the teaching and learning process (Krisfalusy, George & Reed, 2018). Management of secondary schools needs to adopt PjBL techniques to provide high quality learning facilities for students. Secondary schools need to develop internal infrastructure and implement advanced technology to implement project-based learning methods effectively. Therefore, the present research plays a significant role in giving a better understanding of PjBL techniques. Other than that, this study could serve as a reference for other researchers who are working on improving the quality of PjBL in secondary schools especially in Biology subject.

1.8 Operational definition

There are several important terms that have been used in this research writing on the development of PjBL teaching module and its usability for teachers. The terms are, PjBL Teaching Module, MyBioProject and usability

1.8.1 PjBL Teaching Module

There are a lot of different definitions for project-based learning (PjBL). According to Aksela and Haatainen (2019), it is a model that organises learning around projects. It is also defined as an interdisciplinary, student-centred activity with a clearly defined project outcome (Han, Yalvac, Capraro & Capraro, 2015). In this research, a PjBL teaching module refers to a developed teaching module for Biology teachers. It is designed to assist teachers in integrating student-centred activities and conducting projects based on the four topics outlined in the Biology KSSM syllabus into their lesson plans which are:

1. Movement of Substances across the Plasma
2. Nutrition and the Human Digestive
3. Metabolism and Enzyme
4. Cellular Respiration

1.8.2 MyBioProject

MyBioProject is the designated title for the project-based teaching module conceptualized and developed through this research. The term "Bio" signifies its focus on the biology subject, while "Project" emphasizes the integration of Project-Based Learning (PjBL) methodologies. This module is specifically designed to enhance the teaching and learning experience in Biology by promoting critical thinking, creativity, and problem-solving skills through structured, hands-on projects aligned with PjBL principles.

1.8.3 Usability

According to the International Standards Organization (ISO) usability refers to the size limit of a product that can be used by the user to achieve specific goals appropriately, efficiently, and achieve satisfaction in context its use (Ismail Sulaiman, 2018). In this study, the usability of the module obtained from the perception of biology teachers on the developed PjBL teaching module, which is based on a usability questionnaire that includes the module format, module content, accessibility objectives, feasibility of the teaching and learning process and satisfaction.

1.9 Limitation of Research

This study aims to improve the PjBL method to assist teachers in adapting to the transformed biology syllabus and advanced teaching processes in Malaysia. However, there are several limitations that affect the research process. Firstly, the study only focuses on testing the usability of the module among Biology teachers in Perak, serving as a pioneering effort to establish a foundational module for the Biology department under JPN Perak. Furthermore, the validity of the module needs further verification to ensure the success of the module development.

Secondly, this research focuses specifically on developing a project-based learning (PjBL) method tailored to the Form Four Biology syllabus under the KSSM curriculum. Based on a thorough needs analysis identifying the most challenging topics for students, the scope of this study is intentionally narrowed to the creation of four PjBL lesson plans centered on two key themes:

1. Movement of Substances across the Plasma Membrane
2. Nutrition and the Human Digestive System
3. Metabolism and Enzyme Function
4. Cellular Respiration

While this targeted approach allows for a detailed exploration of these complex topics, it inherently limits the breadth of the study, as other equally important themes within the syllabus are not addressed. This focus ensures depth but restricts the

applicability of the findings to these selected areas, emphasizing the need for further research to extend the PjBL approach to other aspects of the biology curriculum.

This limitation presents a significant shortcoming in the study, as it also does not address the development of PjBL in other educational subjects or the impact of such an approach on the learning environment for students. Thus, the present research may not provide a comprehensive understanding of the potential benefits of PjBL and its impact on overall student learning.

Furthermore, the study fails to concentrate on developing educational institutions to promote learning and facilitate students in adapting to the advanced learning process. These limitations are significant and hinder the overall quality of the research. Thus, improving the environment of educational institutions to support student development in adapting to advanced learning methods is a critical area that requires attention.

Additionally, the study relies solely on primary quantitative methods, limiting the researcher's ability to gather qualitative data and explore effective PjBL strategies. These limitations constrain the information available on proper PjBL strategies and undermine the study's reliability. Therefore, future research should address these limitations to obtain a more comprehensive understanding of the benefits and impact of PjBL.

1.10 Summary

In conclusion, this study focuses on developing a PjBL teaching module based on the KSSM biology syllabus in Malaysia. The research objectives and aims are well-suited to the topic, and the chapter explores the benefits and effects of PjBL for advanced learning. The study aims to evaluate the usability of PjBL as a teaching method and enhance the abilities of both students and teachers to improve the educational standards of Malaysia.

The significance of the module development to improve the learning process and critical thinking of the students is highlighted in this chapter. Additionally, the background of the form four biology syllabus and the transformation of the syllabus are discussed to provide context for the study. The traditional method of learning is identified as a potential problem statement in the research work, emphasizing the importance of the PjBL process in the learning method for the better development of students' academic careers.

Finally, the chapter outlines the appropriate questions for the research work, which can benefit the researcher in fulfilling the objectives and requirements of the study effectively. Overall, this study offers valuable insights into the potential benefits of PjBL for advanced learning in Malaysia, and its findings may be useful for educators and policymakers seeking to improve educational standards in the country.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the literature review, previous research can reflect an affordability standard of proper learning connected to project-based learning (PjBL) in understanding Biology. Therefore, in this chapter, PjBL approach will be further discusses alongside its underlying aspects such as the integration of technology, the existing teaching and learning strategies in Biology and teacher's role in creating a High-Quality Project Based Learning (HQPjBL) framework. Other aspects discussed in this chapter will be on the constructivism theory that promotes PjBL. Further discussion is conducted on the instructional design model ADDIE that is used to develop the 'MyBioProject' module; a PjBL teaching module that is based on the latest KSSM syllabus .

.2.2 Project-Based Learning: An Overview

Project-Based Learning (PjBL) is a student-centered teaching approach that emphasizes active learning, collaboration, and the application of knowledge to solve real-world problems. This method has gained considerable attention for its ability to foster 21st-century skills, such as critical thinking, creativity, communication, and collaboration, while simultaneously engaging students in meaningful and authentic learning experiences. Numerous scholars have investigated the theoretical foundations, implementation practices, and outcomes of PjBL across different disciplines and contexts, highlighting its advantages, challenges, and transformative potential.

Aksela and Haatainen (2019) conducted a study exploring the perspectives of active teachers on the advantages and challenges of PjBL. They found that teachers viewed PjBL as a highly engaging and practical method for integrating knowledge across disciplines and enhancing students' problem-solving and critical thinking skills. However, they also reported challenges, such as time constraints, curriculum alignment, and the need for teacher training in implementing PjBL effectively. Similarly, Almulla (2020) emphasized the effectiveness of PjBL in engaging students, noting that it enhances intrinsic motivation and deepens their understanding of subject matter by allowing them to connect theoretical concepts with practical applications.

The effectiveness of PjBL in STEM education has been extensively studied. Beier et al. (2019) examined the impact of authentic PjBL experiences on students' attitudes and career aspirations in STEM fields. Their findings indicated that PjBL not only improved students' understanding of STEM concepts but also positively

influenced their interest and aspirations in pursuing STEM careers. Similarly, Han et al. (2015) highlighted how in-service teachers' understanding and implementation of STEM-based PjBL improved students' learning outcomes and engagement in science, technology, engineering, and mathematics. The integration of STEM with PjBL has also been shown to enhance students' scientific competencies and literacy (Intan Saidaturrahmi et al., 2021), as well as their science process and creative thinking skills (Lestari et al., 2018).

Another critical benefit of PjBL is its potential to foster creativity. Chen et al. (2022) explored the effect of PjBL on students' creative thinking development and found that it significantly enhanced their ability to generate novel ideas and apply them to problem-solving contexts. Additionally, Chen and Yang (2019), through a meta-analysis, demonstrated the positive effects of PjBL on students' academic achievement, highlighting its effectiveness across various educational levels and disciplines. They also noted the importance of contextual factors, such as teacher expertise and curriculum alignment, in determining the success of PjBL implementation.

In terms of module development, Pengestuti et al. (2023) emphasized the importance of designing teaching modules that incorporate PjBL to support student engagement and understanding of complex scientific topics. Their study on the development of PjBL modules for high school biology students demonstrated improved learning outcomes in the areas of the human circulatory and movement systems. Similarly, Kiong et al. (2022) discussed the need for innovative problem-solving strategies in PjBL module design, particularly in design and technology education,

underscoring the importance of needs analysis in ensuring effective module development.

Despite its numerous advantages, implementing PjBL poses challenges. According to Aksela and Haatainen (2019), teachers often face difficulties in managing time, aligning PjBL activities with standardized curricula, and assessing student performance effectively. These challenges highlight the need for professional development programs that equip educators with the necessary skills and strategies to implement PjBL successfully. Moreover, as noted by Lestari et al. (2018), a well-structured PjBL model, combined with STEM integration, can address these challenges by providing clear guidelines for lesson planning and execution.

In conclusion, Project-Based Learning is a powerful instructional approach that promotes active engagement, critical thinking, and real-world problem-solving skills among students. While it offers significant advantages, such as enhancing creativity, scientific literacy, and career aspirations, its successful implementation requires careful planning, teacher training, and alignment with curriculum objectives. The growing body of research on PjBL underscores its transformative potential in fostering 21st-century skills and preparing students for the demands of an ever-changing world. Future studies should focus on addressing the challenges associated with PjBL implementation and exploring its impact across diverse educational contexts and disciplines.

2.3 Constructivism Theory

There are many theories residing the project-based learning (PjBL). The main theories are credibly credited by Piaget theory of Constructivism (Piaget, 1929) and Vygotsky's theory of social constructivism (Vygotsky & Cole, 2018) that has been adjusted and adapted by many constructivist theorists. However, the notion of constructivism was pioneered by John Dewey. After Dewey another notable constructivist is Jean Piaget. Piaget (1929) emphasizes the importance of employing the correct methods to assess a child's statement accurately, as minute precautions are necessary to avoid falsifying the meaning of the analysis.

However, Piaget's theory did not comprise of the social aspect of the learning environment. Based on that, the social constructivism theory by Vygotsky would add on to the social aspect of the constructivism development. Vygotsky believed in learning by experience and doing through social and interpersonal interaction (Kwietniewski, 2017). Also, according to Kwietniewski, (2017), Vygostsky led to the development of the Zone of Proximal Development (ZPD) which is described as the "current or actual level of development of the learner and the next level attainable through the use of meditating semiotic and environmental tools and capable adult or peer facilitation". There is a limitation to what a student can accomplish individually, but they are able to accomplish a higher-level task which may be out of their ZPD by collaborating with different or higher-levels of peers or with guidance from adults like teachers. So, the next time a student needs to be able to carry off a higher-level task, it will be within their ZPD and they can then accomplish on their own.

Scaffolding, a concept derived from Vygotsky's sociocultural theory, plays a pivotal role in the learning process by emphasizing the support and guidance provided to learners within their zone of proximal development (ZPD). This concept suggests that learners can achieve tasks beyond their current abilities with appropriate assistance, which gradually decreases as they gain independence (Vygotsky, 1978). Bruner (1985) elaborated on scaffolding as the process where tutors or peers provide interim support to enable learners to accomplish what they cannot manage alone, effectively bridging the gap until mastery is achieved.

In the context of PjBL, scaffolding is essential to help students tackle complex, real-world problems. PjBL aligns closely with Vygotsky's theory as it creates opportunities for collaborative learning, where teachers act as facilitators, guiding students through the problem-solving process. For instance, teachers can scaffold PjBL activities by structuring tasks, providing frameworks for inquiry, and gradually reducing assistance as students become more competent (Bell, 2010). Through scaffolding, learners not only develop cognitive and problem-solving skills but also foster self-regulation and autonomy, as they internalize the strategies modeled by their teachers or peers.

Research has demonstrated that scaffolding in PjBL enhances student engagement, critical thinking, and the ability to apply knowledge in meaningful contexts (Simons & Klein, 2007). The iterative nature of PjBL, where students brainstorm, design, execute, and reflect on projects, benefits greatly from scaffolded support. For example, structured milestones and guided questioning can help students navigate challenges while encouraging them to take ownership of their learning

journey. By integrating Vygotsky's scaffolding principles into PjBL, educators can create dynamic and supportive learning environments that empower students to construct knowledge collaboratively and effectively.

In conclusion, constructivism is a learning theory that rope importance to the search for knowledge done by the students themselves. Learning only will happen when students are actively involved in the topic and build own knowledge base. Therefore, many lessons in constructivism such as project-based learning uses various directed activities. So, learning based on constructivism theory requires students to be actively involved, try and independent to build their own knowledge. In this study approach Constructivism learning is aimed at students' abilities to relate existing knowledge to abstract concepts in biology to help students generate their creative minds.

2.4 Module Development Design Model

Different models are utilized as a framework for creating teaching modules, each with its unique approach, but all working towards the same objective of developing high-quality modules that are useful for students. Some of the commonly used models include the ASSURE Model and the ADDIE Model.

2.4.1 ASSURE Model

The ASSURE model is a model designed for classroom settings and focuses on the systematic utilization of media in teaching and learning (Heinich, Molenda, Russell & Smaldino, 2002). According to Heinich (1996), the ASSURE model consists of six structured steps to ensure instruction is learner-centred and outcomes-focused. Below is a summary of the key points related to the ASSURE model:

1. Analyse Learners

This phase involves analysing the students to determine their needs and levels of ability, which includes identifying their general characteristics, specific initial skills such as knowledge, skills, and attitudes towards topics, as well as their learning styles.

2. State Objectives

The learning objectives in the module must align with those available in the syllabus, curriculum guide, textbook, or developed by the instructor. Objectives should be based on knowledge, skills, and a new attitude towards learning.

3. Select Methods, Media and Materials

During this phase, three main things are considered in selecting appropriate methods, media, and materials for teaching and learning. These include determining the appropriate method for teaching and learning, selecting suitable media, and developing media that has been chosen.

4. Utilise Media and Materials

The use of media and materials involves five steps, which includes previewing materials, preparing materials, preparing the environment, preparing students, and facilitating the learning experience.

5. Require Learner Participation

Learner participation is essential, and this phase involves engaging students in activities such as presentations, simulations, and quizzes before they are formally assessed.

6. Evaluate and Revise

Evaluation is carried out to identify the effectiveness of the learning process, which includes assessing the achievements of students, learning outcomes, selection of methods and media, media quality, as well as the teacher and student use.

The ASSURE model is primarily designed for planning and delivering individual lessons, making it unsuitable for developing comprehensive modules and conducting usability tests. Its focus is on integrating instructional media and meeting specific learning objectives within single lessons, rather than addressing the broader scope of module development, which involves content organization, scaffolding, and diverse assessments. Furthermore, the ASSURE model lacks explicit guidelines for usability testing, which requires evaluating user experience, accessibility, navigation, and functionality through iterative feedback and structured methodologies. Unlike frameworks such as ADDIE, which emphasize iterative design and refinement, the ASSURE model follows a linear process and does not account for module-level needs or user interface considerations. While effective for lesson planning, it is limited in

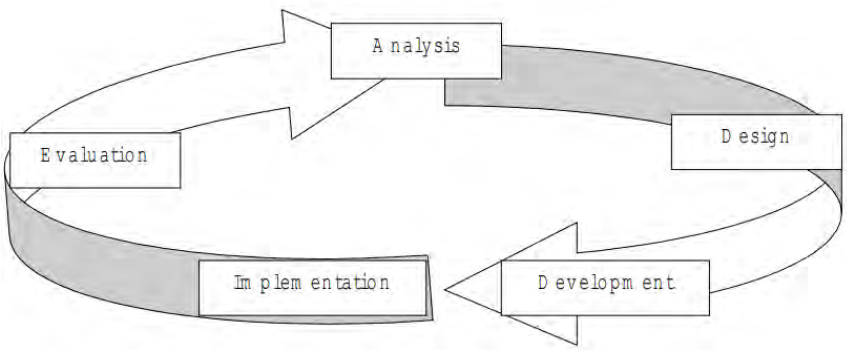
scope for module development and usability evaluation, making more comprehensive frameworks like ADDIE better suited for such tasks.

2.4.2 ADDIE Model

Branch (2009) proposed that the ADDIE concept can be employed to develop performance-based learning with a student-centred, innovative, authentic, and inspirational approach. This approach remains one of the most effective tools in creating educational products as it provides a guiding framework for complex situations. The ADDIE model is commonly used in instructional design to facilitate the construction of knowledge and skills during episodes of guided learning (Budoya et al., 2019). The ADDIE model is highly adaptable and systematic, making it an efficient and effective tool for instructional designers and teachers to create a teaching design for any instructional product (Adri, Wahyuni, Zakir & Jama, 2020). The ADDIE model is chosen as an instructional design model for its flexibility and systematic approach to developing a PjBL teaching module that facilitates effective teaching and learning.

Figure 2.1

ADDIE Framework



The ADDIE framework can be a highly effective method for conducting microteaching that meets the specific needs of students (Ratnawati et al., 2021). For training and development purposes, Project-based Learning (PjBL) can be integrated with the ADDIE model to create a systematic approach to learning and to develop strong analytical skills (Adri et al., 2020). Adri et al. (2020) also found that using the ADDIE Instructional Model can lead to the development of a Production-based Blended PjBL Model, with clear, directed steps that can enhance student learning outcomes. By adopting the PjBL-centric ADDIE framework, collaboration can be accelerated, and a sharing and caring standard can be established (Sukariasih, Erniwati & Salim, 2019). The framework is practical and skilful, with a focus on reality-based approaches.

In Biology, students are often faced with high-level concepts and complex projects that require a focused approach and a strategic data collection method (Cruz & Rivera, 2022). PjBL syntax can provide a clear way to initiate understanding, with project channelization and a more analytical process that leads to a higher level of comprehension (Intan & Gufron, 2021). As highlighted by Yazici and Sözbilir (2022), incorporating the ADDIE framework can simplify the structure of different Biology concepts, such as Metabolism, Genetics, or the Immune system. This can be invaluable in creating a strong learning process that emphasizes operational elements within the PjBL structure (Yazici & Sözbilir, 2022). Overall, the ADDIE model provides effective learning guidance that can be integrated with a definitive learning design, leading to significant impacts in generating valid knowledge for learners.

ADDIE instructional designs by Branch (2009) include:

1. Analyse

To identify the probable causes for a performance gap where the common procedures include validating the performance gap, determining the instructional goals, confirming the intended audience, identifying the required sources, determining the potential delivery system (including cost estimates) and composing a project management plan. Regarding the analysis, the ADDIE model effectively estimates learning gaps and the problem statement related to the subject area. Moreover, the analysis increases the tendency to understand the difficulty standard and the standard project framework.

2. Design

To verify the desired performances and appropriate testing methods, common procedures include conducting a task inventory, composing performance objectives, generating testing strategies and calculating return on investment. A definite design can justify the validity of the project with development criteria in a better way. The necessary PjBL implementation can control the systematic overview in controlling the project assistance and proceeding with the implied idea towards a 100% perfection standard (Sri Ningsih, Marwadi Effendi & Nurhasan Syah, 2019). Following the systematic approach, the ADDIE structure is effective in understanding the validated issues and the changing implementations in the market scenario.

3. Develop

To generate and validate the learning resources, common procedures include generating the content, selecting or developing supporting media, developing guidance for the student and teacher and conducting formative revisions. According to the development criteria, the PjBL can improve estimation through more project frameworks. All the project assistance can accelerate the intended project tools and guidance like teachers, researchers or project guides. Necessary motives for relevant the integrated results, subject assistance and formative control through the Pilot Testing sequences.

4. Implement

To prepare the learning environment and engage the students where the common procedures include preparing the teacher and student. With more acceleration of project tools, equivalent topics, and project guidance for making PjBL a successful attempt, the students and the assigned teachers can concentrate on the implementation framework (Wijaya, Arnyana & Citrawathi, 2022). Sudden changes in topic-related approaches and the crediting responses can be effective with more relevance in the implementation process, especially for PjBL of Biology in this recent context.

5. Evaluate

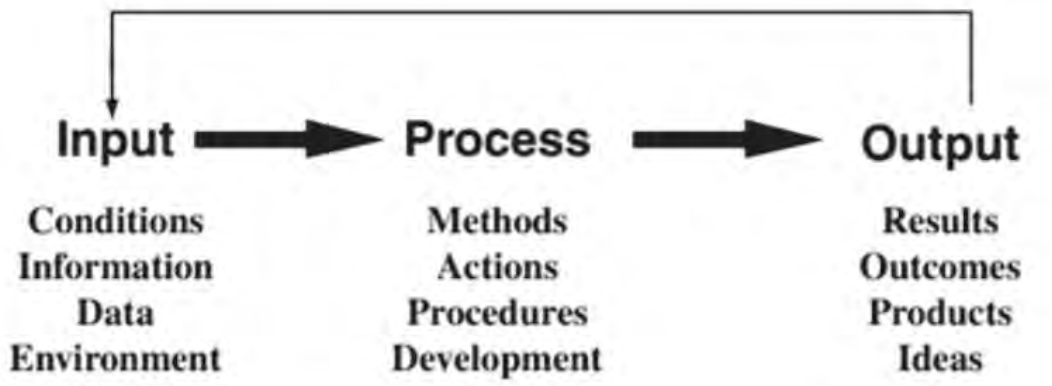
To assess the quality of the instructional products and processes, both before and after implementation, the common procedures include determining evaluation criteria for all aspects of the ADDIE process, selecting or creating evaluation tools and conducting evaluations. Implementation and project execution cannot be sufficient. Instead, they need an evaluative approach following the ADDIE structure. Therefore, the

accessibility standard can help understand the practical contexts as per the project assimilation and the knowledge-based studies.

The ADDIE model aligns with the Input-Process-Output (IPO) paradigm, making it highly effective for developing PjBL modules. In the Input phase, the researcher gathers data such as students' prior knowledge, curriculum goals, and learning objectives to ensure the module addresses relevant needs. The Process phase involves designing and developing PjBL activities that foster creativity, critical thinking, and collaboration, aligning tasks with real-world problems. Finally, the Output phase encompasses implementing the module and evaluating its usability by assessing outcomes like suitability, efficiency and satisfaction of the module developed. This structured approach ensures that PjBL modules are learner-centred and outcome-oriented, enabling teachers and students to apply theoretical knowledge in practical, meaningful contexts.

Figure 2.2

Input Process Output (IPO) paradigm by Branch (2009)



2.5 Project-based Learning approach promotes 21st-century skills

One of the aspirations in KSSM is to develop pupils with 21st century skills, while focusing on thinking skills as well as life and career skills strongly rooted in noble values and practices (DSKP KSSM, 2019). The PjBL approach is an effective way to develop 21st-century capabilities by promoting critical thinking, problem-solving, interpersonal communication, information and media literacy, cooperation, leadership and teamwork, innovation, and creativity (Almulla, 2020). Studies examining the impact of the PjBL approach on student teachers have shown that the PjBL method improves problem-solving abilities and academic performance and influences a positive perception of the learning profession (Almulla, 2020). It seems that the PjBL approach is promoting 21st-century skills. It can also help develop and promote problem-solving and critical-thinking skills. Besides that, it can also help students in improving their communication, teamworking, interpersonal, and collaboration skills so on.

Other than that, Biology in the 21st century requires interdisciplinary collaboration with engineering, computer science, physics, chemistry, and mathematics to tackle complex problems in health, food, energy, and the environment (Lee & Kamisah, 2013). Accordingly, to solve complex interdisciplinary problems, students must have a broad understanding that goes beyond their biology content knowledge. They need to comprehend the connections that exist across different disciplines and learn how to establish those connections.

2.5.1 Implementing the problem-solving approach through Project-based Learning

The 21st-century learning skill can also help students in gaining problem-solving approaches. Besides that; it can also help the students in developing design thinking skills. Studies by Mukherjee and Mitra Thakur (2022), examining the impact of the PjBL approach on student teachers have shown that the PjBL method improves problem-solving abilities and academic performance and influences a positive perception of the learning profession. Besides that, project-based learning can also be recognised as the innovative approach to learning that teaches a multitude of strategies critical for success in the twenty-first century. In addition, the 4C's of 21st-century classroom activities can help in improving learning capabilities. The 4C's of 21st-century learning skills include skills which are; communication, collaboration, critical thinking and creativity.

To effectively implement the PjBL approach, it is crucial that a teaching module is designed to incorporate these 21st-century skills in a structured and accessible manner. A well-crafted PjBL module would provide teachers with the necessary tools and frameworks to embed problem-solving scenarios within project-based tasks, ensuring that students are equipped with the cognitive skills required to address real-world challenges. Such a module would also enable teachers to seamlessly integrate collaborative activities, enhance communication within the classroom, and promote creative problem-solving through structured group work (Creswell & Plano Clark, 2023).

Figure 2.3

4C's of the 21st teaching model (Source: Pilpe, 2020)

It seems that effective communication is required within the workforce of the learning environment. Effective teaching skills can also help teachers communicate with their students (Anagün, 2018). Besides that, effective communication can also help in developing collaboration skills within the classroom environment.

Collaboration among students happens when they work together in groups to create something. According to Stehle and Peters (2019), it involves taking leadership roles, making decisions, communicating, and managing conflicts. These students who collaborate will then solve problems better than those who work alone because they can respond to feedback and questions (Lee & Kamisah, 2013). Collaboration improves knowledge building and problem-solving skills, and peer conversations can support self-regulated learning (Stehle & Peters, 2019).

Critical thinking can assist with education by boosting students' abilities and highlighting their future potential. It is also known as the application of problem-solving techniques. It can aid educators in organizing, understanding, and optimizing

the subject matter. One of the essential abilities for instructors in the twenty-first century is communication (Nouri, Zhang, Mannila & Noren, 2020). They can use it to encourage teamwork, which boosts efficiency and competence. Additionally, it can aid teachers in quickly expressing their concepts.

Teachers can enhance their lesson plans by using creativity. By using creativity and ingenuity, they may readily integrate technological components into the teaching setting (Nacu, Martin & Pinkard, 2018). Students can readily hone their creative abilities by putting brainstorming, group discussions, debating, and other activities to use. The development of pupils' design thinking abilities can also be aided via creative thinking. Teachers can develop their innovative and cognitive skills by being more creative.

To effectively implement PjBL, a well-designed teaching module should integrate 21st-century skills, including problem-solving, communication, collaboration, critical thinking, and creativity. Such a module would provide teachers with frameworks to structure classroom activities that foster these skills in students. This involves providing tools for managing collaborative tasks, promoting effective communication, stimulating critical thinking through challenging problems, and encouraging creativity through student-driven projects (Bell, 2010). Additionally, the module should be adaptable to different learning environments, ensuring that teachers can guide students in developing key competencies necessary for success in the 21st-century workforce (Stehle & Peters, 2019). Practical strategies like group discussions, peer evaluations, and design challenges should be included to enhance the learning

experience, making it more engaging and aligned with real-world applications (Anagün, 2018).

2.5.2 Characteristics of the 21st-century learning

The PjBL approach of the 21st century can also help in improving the coursework. Therefore, the advantages are as students master content while producing, synthesising and analysing information from a wide variety of subjects and sources with an understanding of and respect for other cultures, this may be said about the 21st-century learning process (Care, Kim, Vista & Anderson, 2018). This teaching and learning technique have promoted effective learning skills, creativity, originality, teamwork, flexibility, and other attributes.

It appears that technology has become one of the most important aspects of life. Technology integration in the classroom environment can enhance student learning. Additionally, using multimedia can assist teachers in engaging their students (Menggo, Suastra, Budiarsa & Padmadewi, 2019). According to the Biology KSSM DSKP (2019), technology can be used as a powerful tool to make science learning more exciting and effective. By using tools like computers, animations, and simulations, difficult concepts can be easily understood. Software applications like word processors, graphic presentation software, and electronic spreadsheets can help analyse and present data. Effective management of activities and interactions between teachers and students can help improve thinking skills.

In the 21st-century model, students can also talk about their inquiries. It can help the students develop their problem-solving skills (Mamman & Oyinloye, 2018). Other than that, it can also help improve the student's decision-making approach. Their curiosity helps them to achieve their goals and objectives. This approach can also help them in improving their skills and attributes.

It seems that the 21st-century learning process can help in improving the authenticity of the course module. It can also help make the curriculum more relevant (Motallebzadeh, Ahmadi & Hosseinnia, 2018). Besides that, it can also help implement creative and innovative factories within the workforce of the educational environment. On the other hand, the research study by Motallebzadeh et al. (2018) also stated that the transmission and note memorization of factual knowledge can increase the irrelevance of the subject matter.

There are a variety of numbers that teachers can readily use to boost their pupils' passion for learning during class time. Putting design learning into practice can also improve student collaboration and knowledge. Additionally, requiring practice for exams and discussions from the students might improve their analytical and problem-solving abilities (Mamman & Oyinloye, 2018). Students can develop analytical skills by talking through mathematical problems. On the other hand, teachers can also employ a number of fresh strategies and methods to motivate kids. To increase their students' level of originality and creativity, teachers use brainstorming

The findings from the literature on PjBL and its integration with 21st-century skills highlight several key areas that are directly relevant to the development of a PjBL

teaching module for Biology education. The emphasis on content mastery through the synthesis and analysis of diverse information aligns with the goals of the proposed module, which aims to enhance students' ability to critically engage with complex biological concepts while fostering creativity, teamwork, and problem-solving skills (Care et al., 2018). Furthermore, the integration of technology, as highlighted by Menggo et al. (2019), offers a crucial opportunity for the PjBL module to incorporate digital tools such as simulations, graphic software, and interactive media, making challenging biology topics more accessible and engaging for students. The focus on enhancing students' decision-making and problem-solving abilities (Mamman & Oyinloye, 2018) supports the module's aim to promote higher-order thinking skills, empowering students to make informed decisions in real-world scientific contexts. Additionally, by aligning the module with 21st-century pedagogies that prioritize relevance and innovation, as outlined by Motallebzadeh et al. (2018), this study ensures that the PjBL module not only addresses the curriculum’s needs but also creates a more dynamic and authentic learning experience. Ultimately, this approach will equip both students and teachers with the tools necessary for engaging in modern, interactive, and meaningful biological education, aligning with global educational trends and expectations.

2.6 Teaching Strategies and Project-Based Learning

As per the Biology KSSM DSKP (2019), the teaching and learning strategies for KSSM Biology focus on thoughtful learning, which helps pupils acquire knowledge and develop their minds to their full potential (Kementerian Pendidikan Malaysia, 2019).

This is also said to be achieved through various learning approaches such as inquiry, constructivism, science, technology, and society, contextual learning, and mastery learning space. It is important to promote critical and creative thinking skills in pupils through learning activities and to make them aware of the thinking skills and strategies used in their learning. It was also stated that using higher order questions ad problems in teaching can encourage pupils to enhance their critical and creative thinking abilities. The teaching and learning process should actively engage pupils in the acquisition of knowledge, mastery of skills, and development of scientific attitudes and moral values. PjBL is one of the DSKP recommended learning approaches that teachers can apply in the classroom (Kementerian Pendidikan Malaysia, 2019).

However, in the field of biology education, various teaching and learning strategies have been developed to enhance students' knowledge and practical skills. One such approach is to provide real-life scenarios to students, which allows them to gain practical knowledge about different biological subjects (Wohano, Lin & Chang, 2020). Furthermore, teachers can encourage students to participate in various biological projects, which can help to enhance project-based learning and academic success (Yustina, et al., 2020). Mastery learning and peer tutoring are popular teaching strategies in biology education as they help students grasp biological concepts and answer exam questions more effectively (Animola & Bello, 2019). Additionally, team-based learning environments have been set up by some teachers to promote interpersonal and teamwork skills while acquiring biological knowledge (Hills, 2023). The use of interactive and visual teaching strategies is also common among teachers, as it helps to present biological concepts and practical examples in an engaging and effective manner (Beier et al., 2019). By providing team-based learning facilities and

utilizing different teaching methods, teachers can help students develop communication and group work skills while also improving their biological knowledge.

To enhance their understanding of biology, students in the classroom are provided with various methodological approaches such as game-based learning, problem-based learning, flipped classroom models, quizzes, and written assessments. Additionally, a modelled syllabus is often provided to help students prepare for examinations, but this may limit their creativity and skill development. Almulla (2020) highlights the importance of project-based learning (PjBL) with assigned projects to assimilate the implied learning approach, which can have a strong impact on learners. These PjBL strategies can effectively enhance students' understanding of the practical context, making changes elaborate and applicable for all students and improving their academic performance. By providing access to appropriate content and utilizing effective teaching strategies, students can achieve a better learning outcome in biology education.

Besides, to ensure effective teaching and learning, educational accessibility standards can be used, particularly in biology education. Sulistyawati, Indriyanti, and Yuniastuti (2019) suggest that providing students with a "Time to Write" facility can improve their confidence and ability to answer difficult questions. Additionally, activities such as "Hand Raising" and "random calling using index cards" can create an engaging classroom environment, which can be incorporated into the development of project-based learning (PjBL) modules. PjBL can facilitate the implementation of sports-based learning and instructional conversations in scientific studies, while also promoting inquiry-based learning and creating an advanced learning framework

(Damopolii, Paiki & Nunaki, 2022). Moreover, PjBL can also integrate traditional teaching methods such as models, charts, graphs, graphic organizers, and teamwork into its activities.

Basith et al. (2020) suggest that intrinsic motivational standards can be associated with the use of graphical presentations and their feedback systems in mass presentations and credit scoring. This approach can aid in project assistance and help students better understand project demands, topic elaborations, and necessary levels of support. PjBL (project-based learning) can lead to more lasting learning outcomes in reality-based analysis compared to memorizing a subject through reading alone. Therefore, project control requires a specific framework to ensure progress and make necessary adjustments to implemented studies. Perdana, Wibowo and Budiarto (2021) further propose that PjBL can provide learners with multiple resources to develop understanding, self-confidence, and a strong foundation for future studies.

2.7 The Impact of Project-Based Learning in Biology Education

PjBL is characterised by students' autonomy, constructive investigations, goal-setting, collaboration, communication and reflection within real-world practices (Kokatsaki, Menzies & Wiggins, 2016). The principle of student-centred, group dynamics and active learning are ingrained in Project-Based Learning. The Project-Based Learning approach is a typical form of cooperative and research-based learning technique, characterized by active student engagement and comparative learning (Almulla, 2020). This is supported by Keleman et al. (2021) that Project-Based Learning (PjBL) is a

method of learning with the concept of students studying in depth about an issue or topic to produce a product.

Amulla (2020) also supported that students who learn through the PjBL method usually work together to solve a specific problem, develop a product for a specific audience, and then evaluate the project and development process. In Project-Based Learning, students are given a real problem or an actual situation in which they are asked to find the solutions by gathering various inputs from books, journals, handbooks, manuals, brochures, the Internet and so on. The learning process in PjBL begins with guided questions and an understanding of the core concepts and principles of learning. When completing a project, students will use inquiry, research, planning, critical thinking and problem-solving skills (Kelemen et al., 2021). Teachers only act as guides or catalysts to the students.

Moreover, the PjBL approach has a positive impact on Collaborative Learning (CL), disciplinary subject learning (DSL), iterative learning (IL), authentic learning (AL), and student engagement (Almulla, 2020). Project-Based Learning is an essential constituent of the teaching and learning experience among students and teachers in this generation. The approach helps improve students' learning environment in managing their studies efficiently. The interaction in the PjBL approach helps accomplish academic goals and maintain the relationship between students and teachers through CL, DSL, IL, and AL, which in turn engage students in learning (Almulla, 2020). In addition, with this technique, learners can formulate their own learning requirements and eventually become autonomous and engaged learners who can solve problems (Almulla, 2020).

According to Keleman, et al. (2021), there are several steps to implement PjBL, namely; (1) construct the questions used to carry out the project, (2) select the main question or determine the project to be carried out, (3) read and find material related to the issue to be solved, (4) design the problem, (5) design the method appropriate for problem solving, (6) writing a project proposal paper, (7) executing and documenting pre-drafted assignments, (8) analysing data and making inferences, (9) making a final report, (10) presenting a final project. Therefore, these steps were taken into consideration while developing the PjBL teaching module in this research.

The PjBL structure in learning Biology effective in understanding the reconstruction purpose and understanding the already existing propositions. As per the analysis by Sigit, Ristanto and Mufida (2022), the generalized idea can give a proper acceleration in the sequential identification of the researched matters in a scientific way with logical feedback. PjBL can incorporate students to implement their prior knowledge and develop their ideas with further addition in a reality-based context. It can help the learners to develop their general ideas and skilled behaviour with accurate knowledge for making the learning process effective in a future professional context. In-depth analysis of anything can create a practical-based context, even in the case of Biology as applied by the learners using PjBL. In the 21st century, PjBL has become an applied procedure to incorporate proper learning among students in their academic fields (Intan Saidaturrahmi, Susilo & Gufron Amirullah, 2021). Thus, this research aims to create a PjBL module that can facilitate the development of crucial skills like collaboration, communication, and project management among students. The module is designed to allow students to apply their understanding of biological principles and concepts to real-world issues, leading to a deeper comprehension and appreciation of

the subject matter. Moreover, this approach is expected to spark an interest in scientific inquiry and research among students through experiential and interactive learning opportunities.

The extended opportunities for the learners to understand and experience new things can create a knowledge ascendency approach through PjBL. According to Rini, Adisyahputra and Sigit (2020), to incorporate PjBL in Biology, the project allocators must follow a certain step that can include “learning outcome, teaching material, skill training, project theme, proposal, execution, and presentation”. Accordingly, to teach biology in a practical way, instructors can assign subject-specific projects to their students. The KSSM new syllabus offers a range of project-based learning activities, such as modelling, mini-projects during field trips, case studies that challenge students to invent solutions to real-world problems, and role-playing exercises for problem-solving. Additionally, students can incorporate diverse physiological entities into their PjBL assessments as part of the academic process. The structure of PjBL allows for the integration of learning outcomes and project analysis, enhancing the overall effectiveness of the learning experience. As per the reflection by Santyasa, Rapi and Sara (2020), with the pedagogical research as per the PjBL-based adaptation standard, the learners can have proper access to fundamental science as a primary approach towards understanding Biology. Different biological factors can be experimented with and retained in memory with appropriate control of the PjBL structure.

2.8 High-Quality PjBL Framework

The High-Quality Project-Based Learning (HQPjBL) framework is a transformative approach that redefines traditional instructional methodologies to better prepare students for the complexities of the 21st century. Through a critical analysis of key works, including Petrokubi et al. (2020), Evans (2019), and Son & Penry (2022), this review evaluates the framework's application, impact, and potential limitations.

Petrokubi et al. (2020) underscore the scalability of HQPjBL and its potential for fostering deeper learning across diverse educational contexts. They identify essential components of scaling HQPjBL, including professional development for teachers, collaborative learning environments, and the necessity of district- and school-level leadership. Their research emphasizes equity in education, suggesting that HQPjBL creates opportunities for marginalized students to access meaningful and authentic learning experiences. However, challenges such as the lack of teacher preparation and insufficient time for project development are highlighted as significant barriers to effective implementation.

Evans (2019) provides a case study illustrating the positive outcomes of HQPjBL on student learning and engagement. The study highlights how HQPjBL fosters skills such as critical thinking, problem-solving, and collaboration while simultaneously improving academic achievement. By engaging students in authentic, real-world tasks, HQPjBL aligns with the principles of constructivist learning, ensuring that students apply knowledge in practical contexts. While Evans (2019) effectively

demonstrates the benefits of HQPjBL, the case study's narrow focus on specific schools limits the generalizability of its findings to broader educational contexts.

Son and Penry (2022) explore variations in project-based course design, offering insights into how HQPjBL can be tailored for higher education. Their study emphasizes the importance of flexibility in implementing HQPjBL, particularly in addressing diverse disciplinary needs and learning objectives. The authors argue that the effectiveness of HQPjBL lies in its adaptability, as it allows educators to integrate core elements—such as sustained inquiry and reflection—within specific institutional frameworks. However, Son & Penry (2022) note that the success of HQPjBL in higher education is contingent upon institutional support and the willingness of faculty to adopt innovative practices.

Collectively, these studies highlight the potential of the HQPjBL framework to revolutionize teaching and learning. Its emphasis on authentic tasks, student agency, and collaboration equips learners with skills that are essential for success in an increasingly complex world. Nevertheless, the framework faces significant challenges, including the need for teacher training, adequate time and resources for project development, and institutional support. Furthermore, while HQPjBL promotes equity, achieving consistent implementation across socioeconomically diverse contexts remains a persistent issue.

In conclusion, the HQPjBL framework represents a promising shift toward meaningful, student-centered learning. However, realizing its full potential requires addressing systemic barriers and ensuring that educators are adequately supported in its

implementation. Future research should focus on long-term studies of HQPjBL's impact across diverse educational settings and explore strategies to overcome challenges in scaling this innovative framework.

2.9 Teacher's role in Project-Based Learning

In PjBL, the teacher's role involves guiding the learning process (Ubben, 2019). The driving question and the problem will lead the students to learn and look for solutions to the challenges and problems (Cruz & Rivera, 2022). It is then the reason why Project-Based Learning is considered as a student-centred methodology.

PjBL associates several development processes implied by the teachers in the subjects like Biology. According to the opinion articulated by Cruz and Rivera (2022), regarding subject collaboration, the teacher can come across several challenging scenarios, such as – "converting curriculum into the project" or "having insufficient knowledge-based training". Therefore, the teachers require accelerating a standard facility of "Collegial Pedagogy*"* applied to Biology in the educational process. It can collaborate with the idea or concept, developing attributes for the students. According to the analysis by Kasabov (2019), the applied methods can attract students in creating a stronger interest level about Biology.

Furthermore, teachers often struggle to align their teaching goals with appropriate teaching approach and the learning model such as PjBL for the benefits of the students (Wohano, Lin & Chang, 2020). Thereby, they require understanding the

teaching-learning context appropriately and proceeding with necessary actions respectively. According to Palatnik (2022), PjBL can solve reality-based challenges by making the students oriented to the subject matter, especially in difficult cases like Biology. Consequently, this study emphasizes the importance of establishing a clear teaching approach and desired learning outcomes to ensure the effectiveness of a PjBL module.

The crucial role that is equivalent to the teachers' responsibilities can accelerate PjBL's paradigm shift for making the implemented project control effective regarding Biology. The student-centric methodology is a significant accessibility standard for managing PjBL in students' academic performance. As per the reflection of Vanhala (2018), the students benefit, and the teachers can play the role of mediators in growing performance and interest levels by showing past reports, YouTube videos or animation clippings. Following the academic standard, the teachers must implement a good effort towards initiating critical thinking levels through PjBL. Helping the students consider the questions they need to cover in the project and determining their research processes is important for completing PjBL.

Regarding the PjBL standard and making the learning process more successful, the teachers can take help from various quarters for implementing a standard teaching-learning activity. As per the analysis done by Fachrunnisa et al. (2020), the teachers can take up the assistance of 3D medals, paintings, and flashcards for effective biological usage in making the students aware of their project's importance. Initiating a standard marking rubric to help learners to score well can make them more confident and experimental, which can satiate their curiosity about certain factors. According to

Sormunen, Juuti and Lavonen (2020), academic assistance alongside contemporary digital help can create an authentic learner base for students. As per the scientific problems, Biology-related questions and practical confusion can be resolved accordingly. Therefore, all these factors are essential in circulation among the guiding teachers and the potential students effectively.

According to Rubrica (2018), the teachers require to follow a HQPjBL to make them true mentors in guiding and directing students for good project execution. Teacher requires to fulfil intellectual challenges and accomplishments by their subordinate learners in the case of PjBL of Biology. The other responsibilities are authenticity, public product, collaboration, project management, and reflection (Manosuttirit, 2019). Regarding these analytical factors, the PjBL structures are important in the subject estimations of biology-related topics. Implementing a futuristic teaching methodology is another valid entity that the teachers need to practice. This dynamism is important for the teachers to make PjBL more successful in channelling the subject knowledge amongst the students. Therefore, the teacher's role in PjBL can be considered a critical thinker, problem solver, and innovator (Cooper & Kotys-Schwartz, 2022).

2.10 Technology Integration in PjBL

Several researchers believe technology enhances Project-Based Learning (Ramlee Mustapha et al., (2020). According to Rahmawati, Suryani and Akhyar (2020), one of the factors that successfully facilitate the implementation of PjBL is modern digital technology with the instructor’s guidance, followed by student’s ability in

communication including the ability in English. The integration of technology in PjBL teaching often involves the creation of specialized tools, such as software programs designed to improve the grouping of students or websites that facilitate collaboration and evaluation (Shpeizer, 2019). The aim of effective project-based learning (PjBL), particularly in this study involving secondary school students, is to establish frameworks for achieving deeper levels of learning. According to the KSSM Biology DSKP (2019), technology, including TV, radio, video, computers, and the internet, can make science teaching more engaging and effective. Animation and computer simulations are useful for learning complex concepts. Software like word processors, graphic presentation software, and spreadsheets can also aid in analysing and presenting data.

Furthermore, to incorporate various technological assimilations in PjBL, the learners or project moderators can include video quizzing, flipped classroom, course gamification, data visualization or whiteboard animation (Halimah, Sanjaya, Tresnawati & Nurdiani, 2019). In this study, to ensure the effectiveness of project-based learning (PjBL), the module development incorporates the integration of technology, such as Google tools, and educational applications like Quizizz and Kahoot. This integration is crucial for generating interest in the project and capturing the learning outcomes associated with the assigned tasks. Moreover, Artificial Intelligence (AI), such as the latest innovation of ChatGPT, can be utilized to facilitate supportive communication and active learning. Regarding the analysis by Sari and Dewi (2020), the integrated components can include question formation, product finalization, communication, and final presentation. All these factors are significant in validating the project constructions related to Biology in this recent context. These processes can be

effective in making the students easily understand the difficult context related to Biology.

Hajar and Fauzan (2021) have found that project-based learning (PjBL) can enhance a standard Learning Management System by providing equal access to data sources and project information. By utilizing software tools, learners can effectively comprehend and implement project details, along with contemporary issues in PjBL, leading to a better understanding of concepts. Furthermore, Permana, Chamisijatin and Zaenab (2021) suggest that an ICT can increase the accuracy of authentic data and project experimental methods with scientific approaches. Learners can use advanced web search engines and official websites to gather reliable information for their projects and prepare well-researched project reports. This approach can lead to better project outcomes and a deeper understanding of the subject matter.

2.11 Summary

This chapter critically explores the implementation of Project-based Learning (PjBL) in the academic process for assessing critical thinking skills in Biology. The literature reviewed in this chapter provides insights into the situational challenges that may arise during module development and research methodology. The key takeaway from this chapter is that PjBL requires a student-centric approach, with teachers serving as guides to students' task completion, as it involves the initiation of the HQPjBL Framework to make credible changes and assess value sources.

The chapter also discusses the theory of constructivism, which emphasizes that knowledge is built by students through their existing knowledge and experiences. The understanding of concepts is achieved through active student engagement in the learning process and interactions with teachers, peers, and the environment. The knowledge and understanding that are constructed by students are embodied in their cognitive structures through the production of products. To ensure effective teaching, this module has been systematically developed based on the ADDIE Model, which involves analysis, design, development, implementation, and evaluation.

CHAPTER 3

METHODOLOGY

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3.1 Introduction

The methodology chapter provides information regarding the research methodology, population and sample, data collection and data analysis process. In addition, this chapter elaborates on the methods and models used in the research design. The study employed a quantitative research approach, which involved developing a Project-Based teaching module and testing its usability. The validity, reliability and usability also explained in detail. On the other hand, the SPSS data analysis process was used. The research study has also taken into account the ethical considerations of Malaysia.

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3.2 Research Design

The study is developmental research using a quantitative approach that involves the development of a project-based teaching module. The ADDIE model is used as the instructional design model in developing the Project-Based teaching module, comprising analysis, design, development, implementation and evaluation phases (Adri et al., 2020).

3.3 Population and Sample

The population selected for this study is Biology teachers in Perak. A purposive sampling technique was used to select targeted participants based on the researchers' assessment for conducting a survey. The purposive sampling technique is a type of non-probability sampling in which researchers pick individuals from the public to take part in their surveys based on their own judgment (Serra, Psarra & O'Brien, 2018). Purposive sampling helps to get efficient participants to conduct a study and collect in-depth information on project-based learning methods for Form Four Biology.

Teachers with a minimum of one year of teaching experience were set as the criteria as they would be aware of the curriculum design and instruction, and are able to carry out project-based learning to test the usability of the PjBL module. With the experience of teaching in school, they are in the best position to provide the researcher with accurate information to answer the research question of this research. Apart from

that, the reason for selecting biology teachers as the respondents is to assist the biology department of the secondary school in developing a pioneering module.

There are 180 schools in Perak offering Biology as an elective subject, and 60 Biology teachers have participated in the study to test the module's usability. In addition, the pilot study was conducted among 16 Biology teachers in Manjung, Perak and mostly were the head teacher of Biology in their respective schools. According to Isaac and Michael (1995), the number of respondents between 10 and 30 people is sufficient for a pilot study. Julious (2005) proposes that, for pilot studies, a sample size of 12 participants per group is often considered a reasonable and practical rule of thumb. The rationale behind this recommendation is based on statistical considerations that provide enough data to estimate the variability within the population, while still being small enough to manage in terms of cost and resources. Julious (2005) also suggests that pilot studies with 12 participants per group are typically sufficient to identify any major problems with the design or instrument being tested.

3.3.1 Respondent Background

The number of respondents in this research is 60 biology teachers in Perak with a minimum of one-year teacher experience. The respondents background in this study are shown in Table 3.1.

Table 3.1

Respondent Background

Demography		Frequency (f)	Percentage (%)
Gender	Male	12	20
	Female	48	80
Teaching Experience	1-5 years	6	10
	6-10 years	18	30
	More than 10 years	36	60
Field of Expertise	Head Teacher of Biology	38	63.3
	Biology teacher	22	36.7

Based on Table 3.1, the total male Biology teachers in this study are 12 (20%) whereas female Biology teachers are 48 (80%). Most of the respondent in this study are teacher with more than 10 years of teaching experience which is about 60% followed by teacher with 6-10 years of experience (30%) and 1-5 years of experience (10%). Majority of the respondents are also the head of subject teacher (*Ketua Panitia*) about 63.3.% followed by subject teachers (36.7%)

3.4 Research Instruments

In this study, we used three instruments: the expert validation form for the MyBioProject module, the usability questionnaire, and the expert validation form for the usability questionnaire (*refer to the appendix* C, D *and* E). Expert validation was

obtained for all three instruments. The expert's validation form for the MyBioProject module and questionnaire is mainly to answer the research question, which are:

1. Does the developed MyBioProject teaching module for four topics under the Biology form four syllabus have good validity?
2. Does the developed MyBioProject teaching module have good usability based on the Biology teacher's perception?

The module usability questionnaire used a four-point *Likert* scale with a score of one to four. According to Li (2013), the Likert scale is used to collect data on the degree of respondents' agreement with each item used. In this study, the respondent's degree of agreement is interpreted in terms of the mean score for each item. The details of the four-point Likert scale are shown in Table 3.2

Table 3.2

Four-point Likert scale

Scale	Degree of respondents' agreement
1	Strongly disagree
2	Disagree
3	Agree
4	Strongly agree

A module validity assessment questionnaire was constructed to obtain the validity of the content in the developed module. Construction of the validity evaluation questionnaire was adapted from Sidek Mohd Noah and Jamaludin Ahmad's

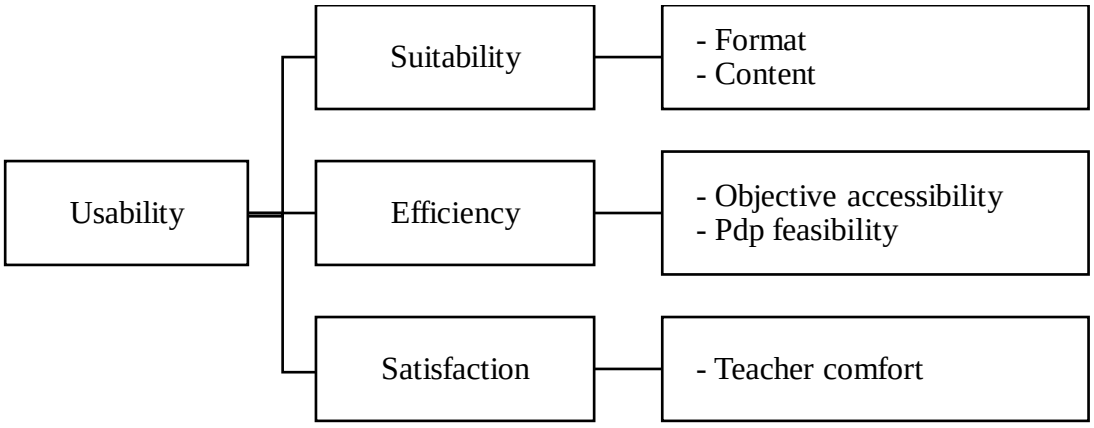
questionnaire (2005). A good validity evaluation module should be guided by five things, namely meet the target population, the use of the module is appropriate to implement in teaching and learning, the time allocated for the implementation of the module is sufficient, student achievement can be improved and student attitude can be improved changed for the better (Roslan et al., 2019). The expert validation form contains three sections, namely: demographic of the experts, face validity and content validity

The usability questionnaire was adapted from the example questionnaire shown in Lund (2001). Questionnaire items were created based on the content in the module to determine the teacher's ability to follow each step of the module activity.

The module usability questionnaire (*refer appendix* D) was adapted and modified by referring to a previous research questionnaire by Ismail Sulaiman (2018). This survey contains 33 items consisting of three main parts: Part A, Part B, and Part C. Part A contain background information on respondents. Part B includes five constructs, namely format, content, achievement of objectives, feasibility of the teaching and learning process and satisfaction. The constructs of appropriateness and competence each comprise a format and content and module objective accessibility and process feasibility teaching and learning. Part C contains opinions and suggestions from respondents. The usability questionnaire that will be used in this study aims to know the teacher's perception of the usability of the project-based module among Form four students. Figure 3.1 shows the relationship model of constructs and criteria in the usability questionnaire.

Figure 3.1

Construct relationship model and module usability questionnaire criteria.



Adapted from Ismail Sulaiman (2018)

3.5 Module Development

The MyBioProject module was developed based on the ADDIE development model according to the five phases, namely: Analysis, Design, Development, Implementation and Evaluation phases**.** A more detailed discussion of the phases is discussed in Chapter Four.

3.5.1 Analysis Phase

In the first phase, analysis was done to identify the problems and need of the module. The researcher conducts an analysis of the difficult topics found in the Biology Curriculum Specification and the need of developing a PjBL teaching module among

30 Biology teachers via Google Form (*Appendix* F). It was sent out through various Telegram and WhatsApp group related to the subject.

3.5.2 Design Phase

The design phase (Design) involves determining learning theory of constructivism, the module format planning as well as choosing learning methods and materials based on the HQPjBL framework and is discussed further in Chapter 4. This phase was important to ensure the quality and effectiveness of the module built. This second phase of the research was conducted by using the findings of the analysis phase to guide in the design. In the design phase, researcher drafted the ideas and components in the module for Form four Biology teachers and students on the four subtopics chosen. The idea of producing a complete package of the PjBL module have resulted in the sections of lesson plan, notes, videos, exercises and quiz.

3.5.3 Development Phase

In the development phase, several software and applications were employed, including Microsoft Office Word 2013 and Canva. The module is structured into four comprehensive sections to facilitate effective project-based learning (PjBL) for Form Four Biology students.

The first section encompasses the cover page, the table of contents, an introduction to the module, and an overview of project-based learning. This foundational part aims to familiarize users with the module's objectives and the principles underlying PjBL, setting the stage for the detailed content that follows.

The second section delves into the practical implementation of PjBL. It outlines the 10 essential steps for implementing PjBL, clearly defining the roles of both teachers and students which are further elaborated in Chapter 4. Additionally, this section includes a module usage guide, providing educators with the necessary instructions to integrate the module seamlessly into their teaching practices.

The third section is divided into four subtopic plans, each meticulously crafted (*refer Chapter 4*) to enhance student learning. For each subtopic, the module specifies the content standards, learning standards, objectives, and outcomes. It also incorporates problem-based questions specifically designed to develop higher-order thinking skills, including analysis, evaluation, and creation, while aligning seamlessly with the SPM questioning format. Detailed instructions and procedures are provided to guide teachers in conducting the projects effectively. To reinforce learning, students are given exercises to complete after the project, with answer keys available from the teacher's sample.

Lastly, the fourth section includes a rubric for assessing student projects, (*also further discussed in Chapter 4*) based on guidelines provided by *Bahagian Pembangunan Kurikulum* (BPK). This rubric ensures a standardized and objective evaluation of student work, promoting consistency and fairness in assessment.

3.5.4 Implementation Phase

In the implementation phase, the well-developed module was provided to experts for validation. The validity of the PjBL module and the accompanying questionnaire was assessed by five experts. All suggestions and opinions from these experts were considered to refine and improve the module draft. According to Siti Nabila Khalid (2019), the validity of a module is defined by its ability to produce the intended outcomes. This view is supported by Wan Nasriha Wan Mohd Salleh (2016), who states that higher module validity refers to modules that effectively achieve their objectives.

Once the validation confirmed the module and instrument's validity, a pilot study was conducted. The pilot study aimed to gather general information about the developed module and assess the draft in terms of suitability, efficiency and satisfaction of the module

Approximately 16 experienced Biology teachers from Manjung participated in the pilot study. These teachers were not involved in the subsequent real study. The results of this pilot study provided the researcher with valuable insights into the module's shortcomings and weaknesses, allowing for further refinement. The final PjBL module, in PDF format, can be downloaded via Google Drive links.

3.5.5 Evaluation Phase

The evaluation phase is the final step in the ADDIE model. In this phase, the module, previously validated by five experts, is assessed for usability. This evaluation focuses on understanding teachers' perceptions of the PjBL module's usability across the four selected subtopics.

After achieving good validity, an actual survey was conducted with 60 experienced Biology teachers from Perak. The data collected from validity forms and the survey were analysed using descriptive statistical analysis with SPSS. The analysis aimed to measure various constructs such as format, content, achievement of objectives, feasibility of the teaching and learning process, and overall satisfaction.

3.6 Validity

According to Sidek and Jamaludin (2005) the validity of the measurement tool should be able to measure the content accurately and systematically. In this study, the appointed experts validated the MyBioProject module and usability questionnaires based on face and content validity. These two types of validity are important in research related to the education field (Oluwatayo, 2012).

The instruments that were used in this study was validated by five experts. The goal of the standardization is to ensure the instrument's interpretative validity (Cohen, Manion & Morrision, 2002) and eliminate errors caused by misinterpretations of the

items. A team of five experts, three experts are lecturers from the Faculty of Science and Mathematics of Sultan Idris Education University or any other public universities in Malaysia, and two Biology teachers with at least a Master's degree were asked evaluate the instruments. Besides, all experts were knowledgeable in biological content and have experience in teaching and evaluating biological content material especially one related to project-based learning.

3.6.1 Face Validity

Face validity is a subjective assessment of the presentation and relevance of the instrument. It is to determine if the instrument appears relevant, rational, unambiguous and easy to understand. In this research, the assessment of face validity was achieved by having experts to evaluate the suitability of the instrument for its intended use. A few criteria need to be evaluated, such as correct spelling of difficult words, the clarity and unambiguity of items, the instrument structure in terms of construction and well-considered format, appropriateness of difficulty level for respondents and so forth (Oluwatayo, 2012).

The data collected through the experts' validation form was analysed by using the percentage of agreement. One of the requirements is to have at least five experts to validate each aspect (Polit and Beck, 2006). The method to calculate the agreement percentage is by using the formula:

$$\frac{\text{Total score given by experts (x)}}{\text{Maximum score (y)}} \quad X \quad 100\%$$

Source: (Tuckman and Waheed, 1981)

According to Taherdost (2016), the agreement scale reflects the percentage reading on the validity obtained, as shown in Table 3.3.

Table 3.3

Experts' Percentage of Agreement and the Interpretation

Percentage, %	Interpretation
0 – 20 %	Very low
21 – 40 %	Low
41 – 60 %	Valid enough
61 – 80 %	Valid
81 – 100 %	Very valid

Adapted from Taherdoost, 2016

The total score given by the expert is summed (x) and this score is divided by the maximum Likert scale score (y) and then multiplied with 100%. If the percentage obtained exceeds 70 percent, then this module has good content validity (Sidek Mohd Noah & Jamaludin Ahmad, 2005). A detailed description of module face validity is discussed in chapter 5

3.6.2 Content Validity

Content validity focuses more on the item's domain than the theoretical concept. Cohen, Manion & Morrison (2002) define content validity as a type of validity that assures the parts of a research's major problem are a fair reflection of the wider issue under investigation. The emphasis is on determining whether a measuring instrument is properly constructed or whether its items represent a fair sample of the whole potential content. The Content Validity Index (CVI) is divided into two types: CVI for items (I-CVI) and CVI for scale (S-CVI). I-CVI is the proportion of experts giving items a relevance rating of 3 and 4. In contrast, S-CVI is the average of I-CVI scores for all items on the scale or the average of proportion relevance judged by all experts (Yusoff, 2019).

In this study, the data collected by experts' validation form was calculated by using I-CVI, which refers to the proportion of content experts who rate an item as 3 or 4 relevant. (*Appendix C & D*). Prior to calculating CVI, the relevance rating will be recorded as 1 relevance scale of 3 and 4) and 0 (relevance scale or 1 and 2). The formula used was:

$$\frac{\text{Agreed item (relevance scale of 3 and 4}}{\text{Number of experts}}$$

Source: (Lyn, 1986)

According to Polit and Beck (2006), the instrument validated by three to five experts should obtain a CVI value of ≥ 0.78. The result obtained was interpreted based

on Polit and Beck (2006), as shown in Table 3.4. A detailed description of module content validity is discussed in chapter 5

Table 3.4

Number of Experts and Its Acceptable Content Validity Index (CVI) values

Number of experts	Acceptable I-CVI value	Acceptable S-CVI value
Three to five	≥ 0.78	≥ 0.80
Six or more	slightly less than 0.78 may be acceptable	≥ 0.80

Adapted from Polit & Beck, 2006

According to Sidek and Jamaludin (2005), the content validity of a module must meet the following criteria:

i. The module needs to meet the target population
ii. The module implementation method is satisfactory
iii. The time allocated to implement the module is sufficient
iv. Able to improve student achievement
v. Able to change students toward a positive attitude

Table 3.5

Example of expert validation item according to Sidek and Jamaluddin

	Criteria		Item
1	Module presentation	1	Use of language
		2	Use of text
		3	Graphic quality
2.	Integrated approach	4	Student-centred
		5	Real world issues
		6	Application of STEM
3.	Time allocation	7	Time allocation to complete the projects is rationale
4.	Suitability to target population	8	Module is suitable for Form four students
5.	Ability to develop 21st century skills	9	Digital age literacy
		10	Inventive thinking
		11	Communication skills
		12	High productivity
6.	Ability to inculcate higher order thinking skills (HOTS)	13	The module is able to inculcate HOTS

Adapted from *Nurul Huda Kasim, Che Nidzam Che Ahmad*, 2017

3.6.3 Validity Analysis of Usability Questionnaire

Three of the five experts have experience in module construction will evaluate the module usability questionnaires. Evaluation is done using an agreement scale of 'Agree' and 'Disagree' to evaluate the items in the questionnaire. Validity analysis of the instrument is done by getting the percentage of expert agreement that using the formula:

$$\frac{\text{Total score given by experts (x)}}{\text{Maximum score (y)}} \quad X \quad 100\%$$

Source: (Tuckman and Waheed, 1981)

Results of percentage analysis of expert agreement for the module usability questionnaire is shown as in Table 3.6.

Table 3.6

Validity Analysis of the Module Usability Questionnaire

Item	Construct	Percentage of agreement	Expert evaluation
Section A: Demographic			
1.	Gender	100%	Accepted
2.	Teaching Experience	100%	Accepted
3.	Institution (School/University etc.)	100%	Accepted
Section B: Questionnaire Questions			
Format			

Item	Construct	Percentage of agreement	Expert evaluation
4.	The MyBioProject teaching module size is suitable and easy to carry	100%	Accepted
5.	The order of the submodules is appropriate.	100%	Accepted
6.	The instructions in the MyBioProject teaching module are clear.	100%	Accepted
7.	The attachments in the MyBioProject teaching module are easy to refer to.	100%	Accepted
8.	The activities provided are appropriate.	100%	Accepted
Content			
9.	The content in each submodule is aligned with the DSKP.	100%	Accepted
10.	The project guidelines in the MyBioProject teaching module are aligned with the concept.	100%	Accepted
11.	The objectives of the MyBioProject teaching module are clearly understood.	100%	Accepted
12.	The activities provided are in line with the project-based learning approach.	100%	Accepted
13.	The term used in the MyBioProject teaching module are easy to understand.	100%	Accepted
Achievement of Objectives			

Item	Construct	Percentage of agreement	Expert evaluation
14.	Teaching activities help achieve the objectives set.	100%	Accepted
15.	Teaching activities are in accordance with the level of form four students.	100%	Accepted
16.	The exercises given can test students' understanding of lesson content.	100%	Accepted
17.	The module's learning activities can help students apply higher-order thinking skills (HOTS)	100%	Accepted
18.	Learning activities encourage students to work together with group members.	100%	Accepted
Feasibility of Teaching and Learning Process			
19.	Suggested time for teaching each subtopic is appropriate.	100%	Accepted
20.	The provided lesson plan with the complete learning cycle phase helps to teach the four topics using the project-based learning approach.	100%	Accepted
21.	Learning activities are structured and easy to follow.	100%	Accepted
22.	The use of handouts in activities increase students' interest.	100%	Accepted

Item	Construct	Percentage of agreement	Expert evaluation
23.	Suggested answers for activities can help the teacher.	100%	Accepted
Satisfaction			
24.	This module fulfils my need as a teacher to implement project-based learning in the class	100%	Accepted
25.	I enjoy using this module.	100%	Accepted
26.	This MyBioProject teaching module can save teaching preparation time for me.	100%	Accepted
27.	This MyBioProject teaching module helps students learn biological concepts more effectively.	100%	Accepted
28.	The activities carried out can attract students' interest learn the topics.	100%	Accepted
29.	I wish there were modules like this for other topics.	100%	Accepted
Section C: Opinions and Suggestions			
30.	State the special features of this module.	100%	Accepted
31.	State the weakness of this module.	100%	Accepted
32.	Specify suggestions for the improvement this module.	100%	Accepted
33.	Comments / Suggestions:	100%	Accepted

Item	Construct	Percentage of agreement	Expert evaluation
Overall Average Percentage Agreement		**100%**	**Accepted**

Based on Table 3.6, the validity of the module's usability questionnaire obtained high validity based on the overall average percentage at 100%. This shows the validity of the questionnaire is accepted and can be used in this research. All three experts have evaluated all the items based on the construct in this questionnaire and determine the appropriateness of the items for this study. There were some words in this questionnaire being modified based on the suggestions given by expert. Next, Table 3.7 shows the findings of the expert agreement percentage analysis of each criterion for the module usability questionnaire.

Table 3.7

Validity Analysis of each criterion of the Module Usability Questionnaire

Criteria	Percentage of agreement	Expert evaluation
Format	100%	Accepted
Content	100%	Accepted
Achievement of objectives	100%	Accepted
Feasibility of the Teaching and Learning Process	100%	Accepted
Satisfaction	100%	Accepted
Overall Average Percentage Agreement	**100%**	**Accepted**

Based on Table 3.7, the validity of the module usability questionnaire obtained high validity based on the overall average percentage at 100%. As a result of the evaluation by all three experts, there were modifications and additions of items made for the questionnaire and was re-evaluated. Based on the views of Taherdoost (2016), the percentage of agreement for the validity of the questionnaire is necessary to be more than 61% for an instrument to be valid and can be used in the study. Therefore, the usability questionnaire of this module is valid and can be accepted as instrument for this study

3.7 Reliability

The reliability test was conducted for helping researchers to measure the internal consistency of research instruments to get the desired research outcomes (Sürücü & Maslakçi, 2020). The reliability test gives the value of "Cronbach's Alpha", which indicates how closely all the research items are interrelated (Cronbach, 1990).

Therefore, this research uses Cronbach's alpha to test the data acquired through the questionnaire. Cronbach's alpha measures internal consistency, or how closely related a set of things is to one another. It is used as a scale dependability indicator (Ames, Glenton & Lewin, 2019). The metric might not be one-dimensional even if alpha has a "high" value. If the researcher wants to do more than evaluate the internal consistency of the scale in issue, they can do further analyses to demonstrate its one dimensionality. Cronbach's alpha is a coefficient of dependability rather than a statistical test from a technical perspective (Sürücü & Maslakçi, 2020). High

Cronbach's alpha levels demonstrate the consistency of participant response values across a set of questions.

Additionally, when participants give positive reactions to one of the questions, they are more likely to do the same for the other items. This agreement demonstrates the validity of the measurements and raises the possibility that the items measure the same characteristic. On the other hand, low scores indicate that the collection of things fails to test the same notion correctly. High scores on one question don't always mean that participants also thought highly of the other items (Ames et al., 2019). It is unlikely that the questions will measure the same attribute because of the inaccuracies in the measurements. According to the statistics, a reliability test can aid in the study's analysis of Cronbach's alpha.

Furthermore, it demonstrates that the reliability test may be used to examine the scale of each item and the link between each study variable. The SPSS reliability test makes it easier to assess each study variable's dependability for data interpretation (Pilpe, 2020). However, it can also be used to measure internal consistency in the study. The scale set as it relates to the dependability test. The reliability test can aid the researcher in figuring out how two variables are related to one another.

According to Lund et al. (2010), internal reliability is appropriate with limited data. Alpha values above 0.7 are generally regarded as acceptable and satisfactory, above 0.8 as quite well, and above 0.9 as indicating exceptional internal consistency (Cronbach, 1951). The reliability test shows that the questions are reliable to be answered by the respondents. Therefore, if the value is more than 0.7 in this manner,

the estimating instruments are better. Table 3.8 shows Cronbach's Alpha value and its interpretation.

Table 3.8

Interpretation of Cronbach's Alpha Value

Cronbach's alpha	Internal consistency
≥ 0.90	Excellent
0.80 – 0.89	Good
0.70 – 0.79	Acceptable
0.50 – 0.69	Fair
< 0.50	Poor

Adapted from Cortina, 1993

3.8 Pilot study

After completing the validity test, a pilot study was conducted to minimise challenges when conducting the actual survey (Blessing et al., 2009). The reliability is obtained through a pilot study to test the research instruments' reliability. In this study, a pilot study was conducted with 16 respondents of Biology teachers from Manjung, Perak through questionnaire distribution via Google Forms before starting the actual survey.

According to Lancaster, Dodd, and Williamson (2004), 15 respondents for the pilot study is sufficient. Thus, 16 Biology teachers were surveyed for the pilot study.

Those who participated in the pilot study were not included in the actual survey. Table 3.9 shows the reliability statistics obtained from the pilot study.

Table 3.9

Reliability Statistics

No. of sample	No. of items	Cronbach's Alpha
16	26	At least $0.8 > \alpha \geq 0.7$ or more

3.8.1 Reliability Analysis of Usability Questionnaire

The reliability of the instrument was tested from a pilot study conducted. The respondents involved evaluated the reliability of the module usability questionnaire. Table 3.10 shows the reliability coefficient for the module usability questionnaire.

Table 3.10

Reliability Analysis of the Module Usability Questionnaire

Criteria	***Cronbach's Alpha* Value**
Format	0.969
Content	0.959
Achievement of objectives	0.910
Feasibility of the Teaching and Learning Process	0.911
Satisfaction	0.927

Criteria	*Cronbach's Alpha* Value
Overall Average of *Cronbach's Alpha* Value	**0.987**

Based on Table 3.10, there are five criteria tested to identify the module usability questionnaire's reliability. Cronbach's Alpha coefficient value for the first criterion which is the format is the highest which is 0.969. It shows the level the reliability obtained is excellent. While for the criteria for content, achievement of objectives, feasibility of the teaching and learning process and satisfaction, Cronbach's Alpha coefficient value obtained was 0.959, 0.910, 0.911 and 0.927 respectively. Reliability level for all of these criteria is also excellent. Overall Cronbach's Alpha coefficient value obtained is 0.987 which shows a very high level of excellent reliability according to Cortina (1993) as shown in Table 3.8.

3.9 Data Collecting Methods

This study adheres to established procedures to ensure successful and ethical research. The initial stage involves a needs analysis to identify development requirements and identify any challenging topics that may fit into the module. Module development work follows the ADDIE model along with constructing a content validity questionnaire, reliability questionnaire, and module usability questionnaire.

The constructed module undergo validation by experts before the pilot study, and the researcher had obtained permission from the Planning and Research Division of Education (BPPP) (*Appendix G*) and Perak State Education Department (JPN Perak)

(*Appendix H*) before conducting the pilot and actual studies at secondary schools in Perak.

Additionally, data were collected through online means where the researcher had shared the research instruments and module via a link transfer, making it easier for the respondents to complete the survey.

3.10 Data Analysis

Descriptive statistical analysis was carried out through SPSS to get a better understanding of the reliability of the independent and dependent variables within the research process. Descriptive statistical analysis plays a significant role in the present research process to get statistical information on each research variable to get the desired research outcomes effectively (Pallant, 2020). The reliability test through SPSS gives the value of Cronbach alpha and indicates whether all research variables are reliable for the research model or not. Descriptive statistical analysis also allows researchers to measure the pattern of data and each variable to conduct the research successfully to gain the desired research output.

The interpretation of the mean values, as shown in Table 3.11, follows the classification into three levels: low, medium, and high. This classification is based on the interpretation guidelines provided by Ghani, as referenced in Norhafiza Idris and Noor Rulhanim Mohamad Ariffin (2018). The results from this evaluation phase

provide critical insights into the effectiveness and practicality of the PjBL module from the teachers' perspectives.

Table 3.11

Interpretation of mean value

Mean value	Interpretation of mean value
1.00 – 2.00	Low
2.01 – 3.00	Medium
3.01 – 4.00	High

Source: *Ghani in Norhafiza Idris dan Noor Rulhanim Mohamad Ariffin* (2018)

The interpretation of the standard deviation values is summarized in Table 3.12 with values ranging from low to medium indicate a small difference in the mean distribution. According to Rasul, Abd Rauf, Sulong and Mansor (2012), very low standard deviation values on items suggest a very high consensus among respondents. Conversely, high to very high standard deviation values indicate a lack of consensus among respondents. This is supported by Mustapha (1999) which interprets that a low standard deviation shows that the data is more reliable as the data falls closely to the mean value (Mustapha, 1999).

Table 3.12

Interpretation of Standard Deviation Value

Standard Deviation	Interpretation
0.00 – 0.25	Very low

Standard Deviation	Interpretation
0.26 – 0.50	Low
0.51 – 0.75	Average
0.76 – 1.00	High
➢ 1.01	Very high

Source: *Mustapha*, 1999

Apart from that, this research also uses thematic analysis to analyse the opinion and suggestion provided by the respondent. Thematic analysis, as described by Braun and Clarke (2012), is a flexible and foundational qualitative research method used to identify, analyse, and interpret patterns or themes within data. This approach is particularly useful for exploring the underlying meanings of qualitative data, whether from interviews, focus groups, or in this case the open-ended surveys.

The process is conducted in six phases as described by Braun and Clarke (2012): familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report. Thematic analysis can be both inductive, where themes emerge directly from the data, or deductive, driven by pre-existing theories. The flexibility of thematic analysis allows researchers to work within a variety of theoretical frameworks, making it accessible for novice researchers while also providing a comprehensive tool for uncovering deeper insights. By organizing data into meaningful themes, this method enables a detailed understanding of the research topic, ensuring the findings are relevant to both the research questions and the broader context.

3.11 Summary

This chapter reviewed the elements for developing and designing appropriate research methods and approach that was carried out in this research. Most suitable approach for this research was in consideration of existing literature and research objective. Population and sample selection followed by research instruments to be used have been highlighted. Based on data collection instrument, percentage of agreement, Content Validity Index (CVI) and Cronbach's alpha were considered to be the most suitable analysis method for this research.

CHAPTER 4

MODULE DEVELOPMENT

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4.1 Introduction

This chapter provides a detailed account of the development process for the MyBioProject teaching module, a project-based learning (PjBL) module focusing on four selected topics in Form Four Biology. Developed using the ADDIE model, the chapter covers the five phases of module development which are analysis (Analyse), design (Design), development (Develop), implementation (Implement), and evaluation (Evaluate). The chapter further contributes to enhancing our understanding of creating an effective and engaging module on project-based learning.

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4.2 Module Development Phase

The development of the Project-based teaching module is based on the ADDIE model. The ADDIE model has 5 significant phases which are Analyse, Design, Develop, Implement and Evaluate phase (Branch, 2009). Table 4.1 summarises the activities conducted during MyBioProject module development based on the instructional model ADDIE.

Table 4.1

Methodology and phases of ADDIE model

Phase	Methodology
Analyse	Need analysis
Design	Determination of learning theory, module format, module content, lesson plans dan learning materials
Develop	The development of MyBioProject is based on the characteristics determined during the design phase.
Implement	Validity of MyBioProject module and research instruments
Evaluate	Usability of MyBioProject module

4.2.1 Analyse Phase

In the first phase, the researcher carried out an analysis to identify the research problems and needs. The researcher analysed the difficulty of the topics found in the Biology

Curriculum Specification of Form Four Biology among 30 Biology teachers via Google Form (*refer Appendix F*). It was sent out through various Telegram and WhatsApp group related to the subject. Table 4.2 depicts the percentage of teachers' agreement on topic difficulty.

Table 4.2

Percentage of Teachers' Agreement on Topic Difficulty

No	Topic	Teacher's Agreement	Percentage of Teacher's Agreement
1	Introduction to Biology and Laboratory Rules	3	10.0%
2	Cell Biology and Organisation	4	13.3%
3	Movement of Substances across the Plasma Membrane	25	**83.3%**
4	Chemical Composition in a Cell	3	10.0%
5	Metabolism and Enzyme	14	**46.7%**
6	Cell Division	9	30.0%
7	Cellular Respiration	10	**33.3%**
8	Respiratory System in Humans and Animals	7	23.3%
9	Nutrition and the Human Digestive System	19	**63.3%**
10	Transport in Humans and Animals	5	16.7%
11	Immunity in Humans	4	13.3%
12	Coordination and Response	2	6.7%
13	Homeostasis and the Human Urinary System	5	16.7%
14	Support and Movement in Humans and Animals	6	20.0%

No	Topic	Teacher's Agreement	Percentage of Teacher's Agreement
15	Sexual Reproduction, Development and Growth in Humans and Animals	5	16.7%

Based on the findings from the needs analysis study, the highest percentage, 83.3%, chose the Movement of Substances across the Plasma Membrane. This was followed by 63.3% of teachers who chose Nutrition and the Human Digestive System, 46.7% chose Metabolism and Enzyme, and 33.3% chose Cellular Respiration. Therefore, the researcher decided to include the four topics in the module development based on the percentage of teachers who agreed on the difficulty.

The study intends to create a practical PjBL teaching module named "MyBioProject" to address the challenges and issues related to implementing PjBL in Biology education. It seeks to equip teachers with the necessary knowledge and skills to effectively incorporate PjBL strategies into their lesson plans, making Biology more engaging and relevant to students. By embracing PjBL, teachers can create a dynamic and interactive learning environment that encourages students to participate actively in their own education. Overall, this module contributes to the ongoing development of teaching methods and the improving classroom strategies.

Furthermore, student achievement factors in the SPM examination are carefully considered to ensure that the module is tailored to the proficiency level of all form four Biology students. This approach aims to foster motivation and engagement, encouraging teachers for much guided lesson and for students to actively participate in the activities provided within this module.

4.2.2 Design Phase

MyBioProject module aims to introduce Project-Based Learning (PjBL) as an effective teaching method for Form Four Biology. PjBL allows students to actively engage in projects, cooperative learning, and hands-on techniques, enabling them to develop essential skills and acquire knowledge (Kelemen et al., 2021). The adoption of PjBL aligns with the National Education Philosophy's goal of holistic and integrated development.

The design phase (Design) comprises the module concept, characteristics, content and front cover. According to concept of the constructivism theory, learning only happens when students are actively involved in the topic and build their knowledge base (Kwietniewski, 2017). Therefore, in this MyBioProject module, the activities designed took account of students' active learning, whereby group hands-on activities, presentations, and creating products based on their learning knowledge were included. Through that, students are aimed to be able to relate existing knowledge to abstract concept in biology to help them be more critical and creative.

The content of the module involves determining learning approach, the module format planning as well as choosing learning methods and materials. This phase important to ensure the quality and effectiveness of the modules built. This second phase of the research was conducted by using the findings of the analysis phase to guide in the design. In the design phase, researcher drafts the ideas and components in the module for Form Four Biology students on the four subtopics chosen. The idea of

producing a complete package of the PjBL module have resulted in the four submodules of each topic selected from the need analysis which includes:

1. A complete lesson plan
2. Pre-lesson HOTS questions with answer schemes
3. Problem scenarios and step by step instructions to carry out PjBL
4. Product assessment rubric
5. Post-lesson HOTS questions with answer schemes

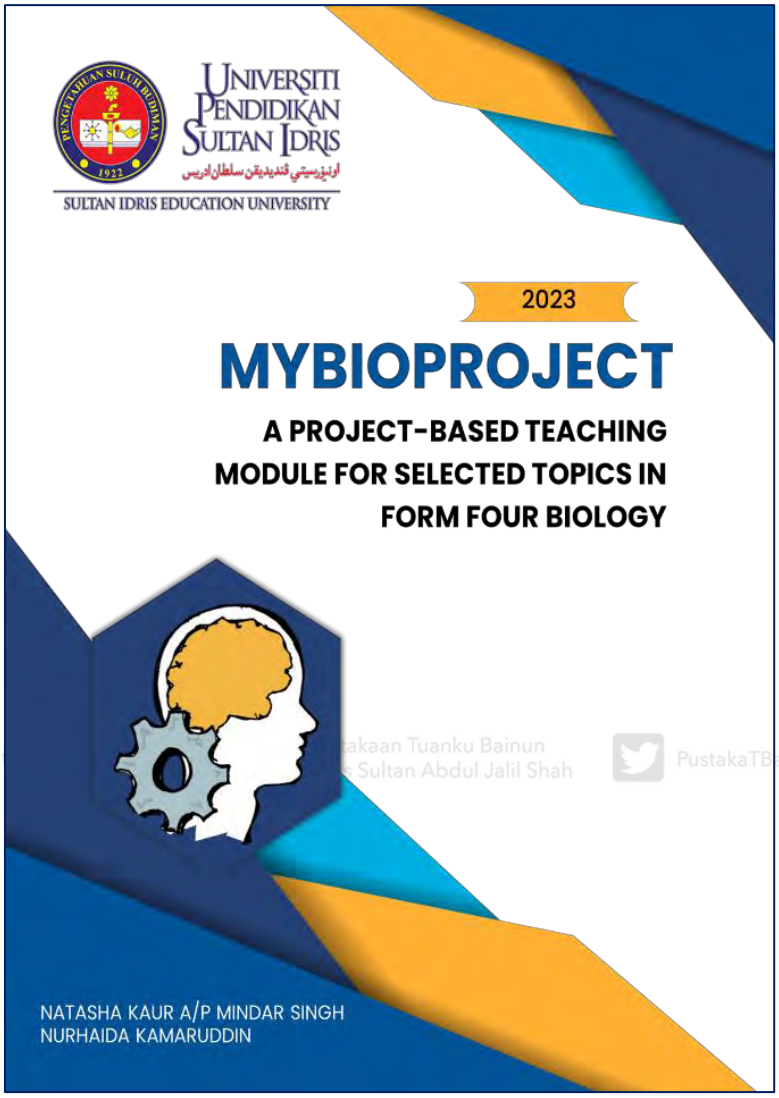
4.2.3 Development Phase

In the development phase, the module was developed based on the design crafted. The development of the module involves usage of some software and applications such as Microsoft Office Word 2013 and Canva.

The front cover of the MyBioProject module boasts a minimalist yet engaging design, featuring a prominent title rendered in a modern and inviting font. Beneath the title, a concise subtitle at the module's immersive project-based learning experience. The use of a cohesive colour palette and subtle visual elements like icons or imagery adds depth and intrigue to the cover while maintaining a clean and uncluttered layout. Figure 4.1 illustrates the front cover design of the teaching module.

Figure 4.1

Front cover of the module



The module's content encompasses an introductory section, providing an overview of the module itself and an introduction to project-based learning (PjBL). It further details ten systematic steps for implementing PjBL, delineates the distinct roles of teachers and students within this framework, and includes a guide for navigating module usage. Following this, it is also shown through this page that the teaching module is organised into four submodules, each comprising a lesson plan, a pre-lesson segment featuring Higher Order Thinking Skills (HOTS) application questions for both

students and teachers with answer schemes, comprehensive project instructions, an appendix (*refer to Figure* 4.5), encompassing a KWL (Know-Want-Learn) or FILA (Facts-Ideas-Learning outcomes-Action) chart , an evaluation form in the form of a rubric, and a post-activity segment featuring HOTS questions for both students and teachers with answer schemes. This information serves a dual purpose: providing a comprehensive overview of the teaching module while also serving as a practical guide for its effective utilization. Refer *Appendix A1* for the content pages of the module.

The next section comprised of an introduction to the module where it emphasized the need for student-centred approaches and introduces Project-Based Learning (PjBL) for form four Biology. PjBL benefits, alignment with education philosophies, goals, along with the module's aim to equip teachers for effective implementation, are discussed. On the other hand, the introduction section on Project-Based Learning (PjBL) emphasised its effectiveness in fostering authentic learning experiences. It also proposed integrating the ADDIE instructional design model for a systematic PjBL module. PjBL's benefits in promoting comprehension, 21st-century skills, and problem-solving abilities are discussed, along with teachers' roles as facilitators. The module's aim to enhance critical thinking, collaboration, and interdisciplinary skills in Biology students is highlighted. Refer to *Appendix A2* for the introduction to the module and an introduction to PjBL.

Additionally, the module guideline comprising the 10 steps to implement PjBL in classroom. Also, the role of teacher and students was also added, serving as a point of reference for biology educators incorporating the module into their lessons. This was to ensure that the activities designed can be implemented more effectively.

Subsequently, this section was then followed by the module usage guide section which further explains on the structure and contents of the submodules. Figure 4.2 shows 10 steps to implement PjBL, and Figure 4.3 shows the section on teacher's and students' role in PjBL. Figure 4.4 shows the section on the module usage guide.

Figure 4.2

Section on the 10 Steps to Implement PjBL

Figure 4.3

The Teacher's and Students' Role in PjBL

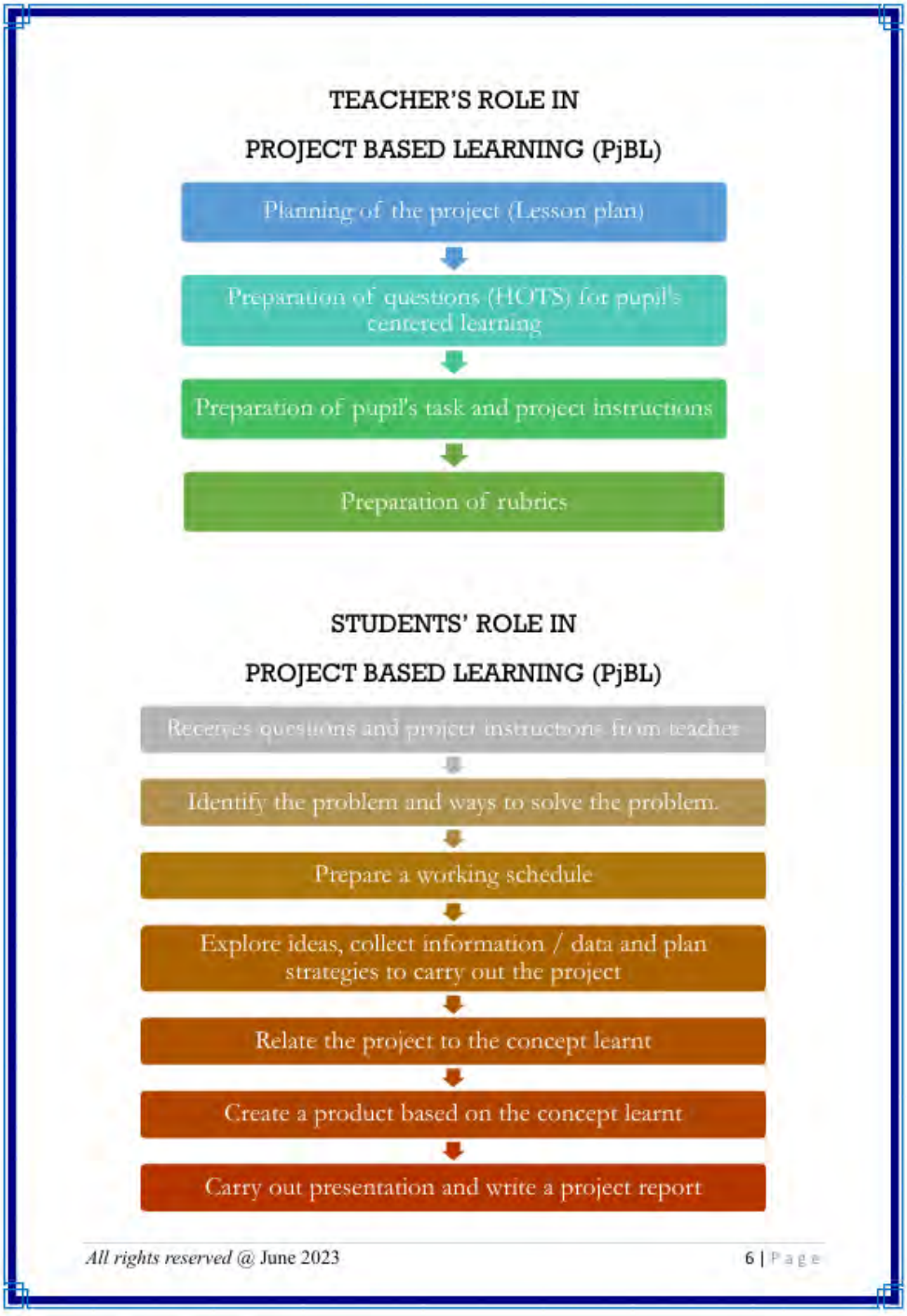
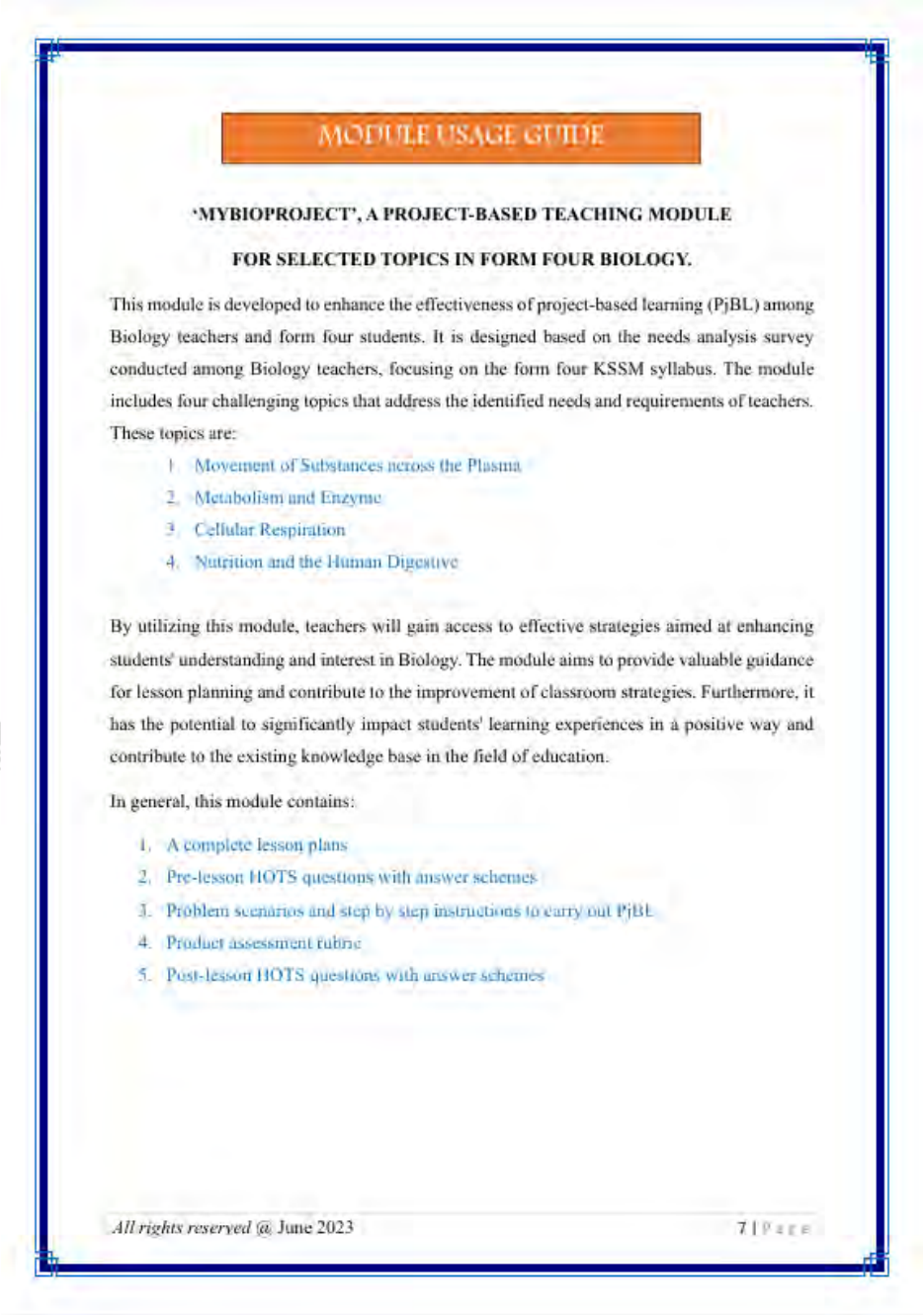


Figure 4.4

Section on the module usage guide



MODULE USAGE GUIDE

'MYBIOPROJECT', A PROJECT-BASED TEACHING MODULE

FOR SELECTED TOPICS IN FORM FOUR BIOLOGY.

This module is developed to enhance the effectiveness of project-based learning (PjBL) among Biology teachers and form four students. It is designed based on the needs analysis survey conducted among Biology teachers, focusing on the form four KSSM syllabus. The module includes four challenging topics that address the identified needs and requirements of teachers. These topics are:

1. Movement of Substances across the Plasma
2. Metabolism and Enzyme
3. Cellular Respiration
4. Nutrition and the Human Digestive

By utilizing this module, teachers will gain access to effective strategies aimed at enhancing students' understanding and interest in Biology. The module aims to provide valuable guidance for lesson planning and contribute to the improvement of classroom strategies. Furthermore, it has the potential to significantly impact students' learning experiences in a positive way and contribute to the existing knowledge base in the field of education.

In general, this module contains:

1. A complete lesson plans
2. Pre-lesson HOTS questions with answer schemes
3. Problem scenarios and step by step instructions to carry out PjBL
4. Product assessment rubric
5. Post-lesson HOTS questions with answer schemes

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In the third section, the module is systematically organised into four distinct subtopics, each aligned with key topics from the form four KSSM curriculum. These subtopics include:

1. Submodule 1: Movement of Substances across the Plasma Membrane
2. Submodule 2: Metabolism and Enzymes
3. Submodule 3: Cellular Respiration
4. Submodule 4: Nutrition and the Human Digestive System

For each subtopic, essential components such as themes, learning areas, content standards, learning standards, learning outcomes, success criteria, and the performance level of classroom-based assessment (PBD) are specified in the lesson plan.

Table 4.3

Titles and Content Summary of each Submodule

Submodule 1: Movement of Substances across the Plasma (‘*OsmoMosaic’ Products*)	
Theme:	Fundamentals of Biology
Learning Area:	3.0 Movement of Substances Across a Plasma Membrane
Content Standard:	3.4 Movement of Substances Across a Plasma Membrane and its Application in Daily Life.
Learning Standard:	3.4.3 Explain by using examples the application of the concept of movement of substances across a plasma membrane in daily life

Submodule 1: Movement of Substances across the Plasma (‘*OsmoMosaic’ Products*)	
Learning Outcomes:	Pupils will be able to produce and market food products produced by using the application of the concept of movement of substances across a plasma membrane in daily life
Success criteria:	Pupils can produce a product using the concept of movement of substances across a plasma membrane in daily life and market the food product in their community.
Performance level of classroom-based assessment (PBD)	Performance Level 6 Create using knowledge and scientific skills related to movement of substances across a plasma membrane in the context of problem solving and decision making or carrying out an assignment in a new situation creatively and innovatively giving due consideration to the social values/ economy/ culture of the community

Submodule 2: Metabolism and Enzyme (*Day-to-Day Enzymes*)	
Theme:	Fundamentals of Biology
Learning Area:	5.0 Metabolism and Enzymes

Submodule 2: Metabolism and Enzyme (*Day-to-Day Enzymes*)	
Content Standard:	5.3 Application of Enzymes in Daily Life
Learning Standard:	5.3.1 Explain by using examples the application of enzymes in daily life.
Learning Outcomes:	Pupils will be able discuss the use of enzyme immobilisation technology in industries.
Success criteria:	Pupils can produce an educational mini documentary video to show the use of enzyme immobilisation technology in industries. Examples of the uses of enzymes in bio-detergent, fish processing, leather production, medicine, lactose-free milk and fruit juices.
Performance level of classroom-based assessment (PBD)	Performance Level 6 Create using knowledge and scientific skills related to metabolism and enzymes in the context of problem solving and decision making or carrying out an assignment in a new situation creatively and innovatively giving due consideration to the social values/ economy/ culture of the community.

Submodule 3: Cellular Respiration (*Gassy Ferment the Fundraiser*)	
Theme:	Fundamentals of Biology

Submodule 3: Cellular Respiration (*Gassy Ferment the Fundraiser*)	
Learning Area:	7.0 Cellular Respiration
Content Standard:	7.3 Fermentation
Learning Standard:	7.3.2 Explain by using examples of energy production from glucose during fermentation in yeast.
Learning Outcomes:	Students will be able to produce and market food products produced through fermentation
Success criteria:	Pupils can produce a product using the concept of fermentation and market the food product in their community.
Performance level of classroom-based assessment (PBD)	Performance Level 6 Create using knowledge and scientific skills related to cellular respiration in the context of problem solving and decision making or carrying out an assignment in a new situation creatively and innovatively giving due consideration to the social values/ economy/ culture of the community.

Submodule 4: Nutrition and the Human Digestive (*Influential Eating Habits*)	
Theme:	Physiology of Humans and Animals

Submodule 4: Nutrition and the Human Digestive (*Influential Eating Habits*)

Learning Area:	9.0 Nutrition and Human Digestive System
Content Standard:	9.7 Health Issues Related to Digestive System and Eating Habits
Learning Standard:	9.7.3 Correlate health issues that are related to eating habits
Learning Outcomes:	Pupils will be able to produce an awareness video on the various health issues related to digestive system and eating habits
Success criteria:	Pupils can produce an awareness video on the various health issues related to digestive system and eating habits.
Performance level of classroom-based assessment (PBD)	Performance Level 6 Create using knowledge and scientific skills related to nutrition and human digestive system in the context of problem solving and decision making or carrying out an assignment in a new situation creatively and innovatively giving due consideration to the social values/ economy/ culture of the community

To start off, each lesson plan incorporates various teaching strategies, 21st-century teaching approaches, and the cultivation of scientific attitudes and values. Furthermore, a comprehensive outline of each lesson which can also be modified by teachers depending on their students' level, includes an end product for the project, as well as detailed steps and activities for both teachers and students. These steps are thoughtfully designed, including:

1. Induction Set and Idea Development
2. Construction and Reconstruction of Ideas
3. Idea Application
4. Reflection and Conclusion

Moreover, the lesson plans are enriched with suggested teaching materials and recommended assessment methods to facilitate effective and engaging instruction, offering a robust framework for teaching these fundamental biological concepts (*Appendix A3*). The module planning is kept flexible to allow teachers to modify the activities based on students learning abilities. Refer to *Appendix A3* for a complete lesson plan example from submodule 1 on the topic Movement of Substances across the Plasma Membrane

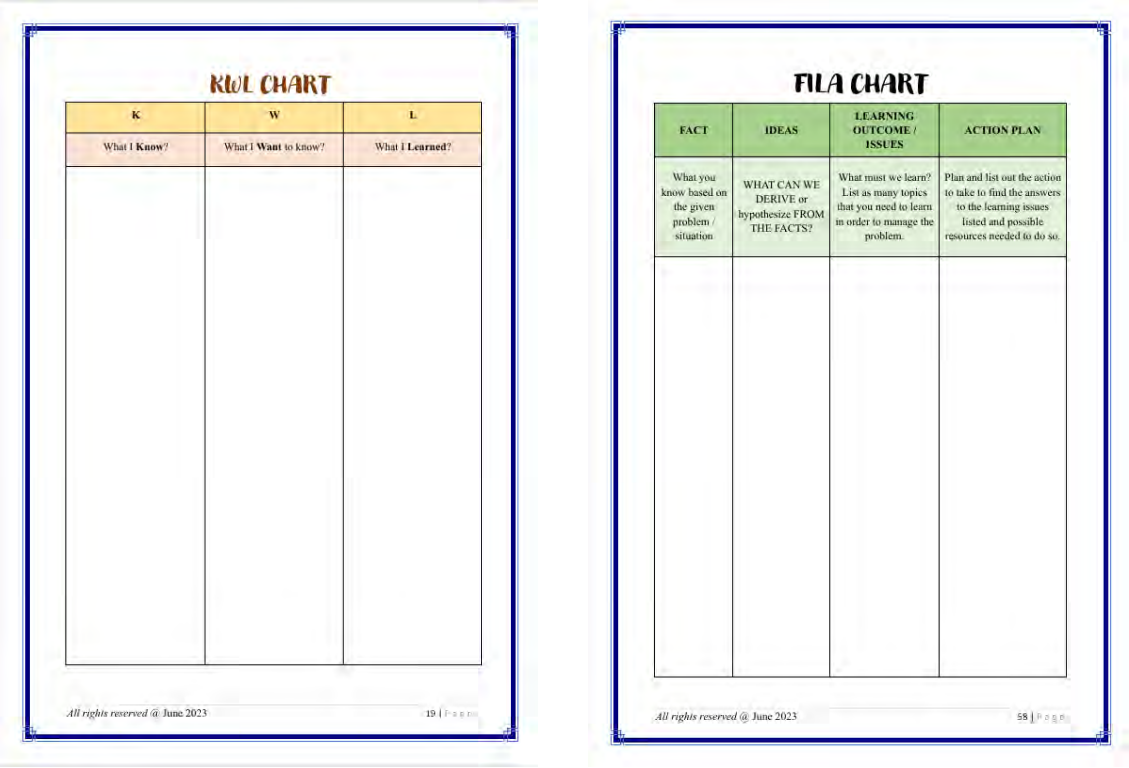
Additionally, for each submodule, a set of thought-provoking problem questions is presented as a pre-lesson activity. These questions are strategically crafted to engage higher-order thinking skills (HOTs), adhering to the structured SPM (Sijil Pelajaran Malaysia) questioning format. Notably, an answer scheme is thoughtfully included to aid educators in assessing and guiding students' critical thinking and problem-solving abilities. *Appendix A4* illustrates pre-lesson activity from submodule

1 on the topic Movement of Substances across the Plasma Membrane with its answer scheme.

Subsequently, the module furnishes students with comprehensive instructions and procedures to successfully execute the project. These guidelines encompass critical steps, including project planning, content for proposal writing, and step-by-step project implementation procedures. Moreover, to support students in their learning journey, a Knowledge, Want-to-Know, Learned (KWL) chart is provided for Submodule 1, while for Submodules 2, 3, and 4, a Facts, Ideas, Learning and Application (FILA) chart is introduced. These tools serve as invaluable aids for addressing the problem questions and scenarios outlined in the lesson plans, ensuring a structured and effective approach to the learning process. Figure 4.5 display sample KWL and FILA charts

Figure 4.5

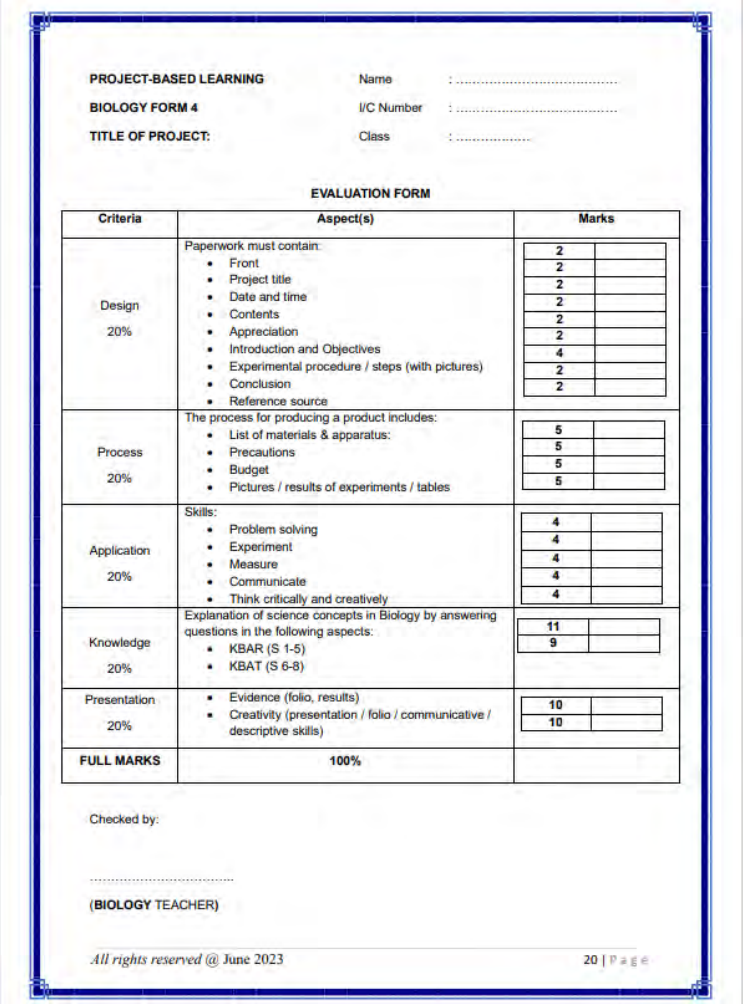
Sample KWL and FILA charts



The fourth section encompasses the assessment rubric for evaluating students' project work, which is aligned with the rubric provided by *Bahagian Pembangunan Kurikulum* (BPK). The rubric comprises several assessment criteria, each contributing to the overall evaluation. These criteria encompass design, accounting for 20% of the assessment, the production process of the products (20%), application, which assesses skills (20%), knowledge, specifically the explanation of scientific concepts (20%), and students' presentation skills (20%). Figure 4.6 shows the PjBL rubric used across the four submodules within teaching module.

Figure 4.6

PjBL rubric



PROJECT-BASED LEARNING Name : .....
BIOLOGY FORM 4 I/C Number : .....
TITLE OF PROJECT: Class : .....

EVALUATION FORM

Criteria	Aspect(s)	Marks	
Design 20%	Paperwork must contain: • Front • Project title • Date and time • Contents • Appreciation • Introduction and Objectives • Experimental procedure / steps (with pictures) • Conclusion • Reference source	2 2 2 2 2 2 4 2 2	
Process 20%	The process for producing a product includes: • List of materials & apparatus: • Precautions • Budget • Pictures / results of experiments / tables	5 5 5 5	
Application 20%	Skills: • Problem solving • Experiment • Measure • Communicate • Think critically and creatively	4 4 4 4 4	
Knowledge 20%	Explanation of science concepts in Biology by answering questions in the following aspects: • KBAR (S 1-5) • KBAT (S 6-8)	11 9	
Presentation 20%	• Evidence (folio, results) • Creativity (presentation / folio / communicative / descriptive skills)	10 10	
FULL MARKS	**100%**		

Checked by:

.....

(**BIOLOGY** TEACHER)

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Finally, within each submodule, there is a post-lesson question for students to complete after finishing the project. These post-lesson questions are intentionally more challenging than the pre-lesson questions, demanding a comprehensive understanding of the subtopic based on the project they've undertaken. These questions also prompt higher-order thinking skills at an advanced level. Students have the opportunity to obtain answers from the teacher's provided samples, thereby enriching their critical thinking and problem-solving skills. *Appendix A5* provides a visual presentation of the post lesson question with sample answer.

4.2.4 Implementation Phase

At implementation phase, the well-developed module was given to the experts to gain validity. According to Siti Nabila Khalid (2019), validity of a module is described as how far can the module produces what it should produce. This opinion is supported by Wan Nasriha Wan Mohd Salleh (2016) where higher module validity refers to modules that can achieve its objectives well. In this study, the validity of the PjBL module was assessed by five designated experts, consisting of three lecturers and two biology teachers. Furthermore, the questionnaire's validity was verified by same three appointed lecturers from module validation. The suggestions and opinions provided by these experts were carefully considered and subsequently integrated to enhance the initial draft of the module. Table 4.4 shows the general profile of experts involved to validate the PjBL module and questionnaire in this research. A detailed description of the module's validity results is discussed in Chapter 5, Findings.

Table 4.4

General Profile of Module and Questionnaire Validation Experts

Expert	Designation
1	UPSI lecturer 1
2	UPSI lecturer 2
3	UPSI lecturer 3
4	Biology teacher 1
5	Biology teacher 2

As the validation obtained for both the product and instrument are valid, a pilot study was carried out. A pilot study was conducted to determine the reliability of the instrument used in this study. About 16 respondents who are experienced Biology teachers from Manjung were be asked to participated in the pilot study who were not involve in the real study via Google form. The results of this pilot study have helped researcher to identify the shortcomings and weaknesses that may be in the instrument. The MyBioProject module in pdf format were downloaded via Google drive links. A detailed description of the instrument's reliability results is discussed in Chapter 3, Methodology.

4.2.5 Evaluation Phase

The evaluation phase is the last phase in the ADDIE model. In this phase, the module that was evaluated in terms of validity by five experts was evaluated in terms of usability. We identified the teacher's perception of the MyBioProject module's

usability on the four subtopics selected. After a good validity is obtained, the actual survey was carried out with 60 experienced Biology teachers from Perak. The data was further analysed using descriptive statistical analysis using data from validity forms and SPSS. Construct measurement of format, content, achievement of objectives, feasibility of the teaching and learning process and satisfaction are based on the interpretation of the mean value shown. The interpretation of this mean value consists of three levels i.e., low, medium and high according to Ghani's view in Norhafiza Idris and Noor Rulhanim Mohamad Ariffin (2018). A detailed description of the teachers' perceptions of the module's usability is discussed in Chapter 5, Findings.

4.3 Conclusion

The primary focus of this study is module development, emphasizing adherence to established rules, models, and a sequence of steps. This is vital to ensure the correctness, effectiveness, and high quality of the module, delivering optimal benefits to its users. The development process is guided by the ADDIE model, which comprises five key phases: analysis (Analyse), design (Design), development (Develop), implementation (Implement), and evaluation (Evaluate). Expert validation is the initial step in confirming the quality of the developed modules, followed by a pilot study to assess instrument reliability and gather feedback from lecturers regarding any module weaknesses and deficiencies. The final version of the module undergoes a usability evaluation through a questionnaire. The upcoming chapter will delve into a detailed discussion of the findings related to validity, reliability, and usability.

CHAPTER 5

FINDINGS

5.1 Introduction

This chapter discusses research questions related to validity of module and module usability based on perception of Biology teachers in Perak. Percentage of agreement and CVI value is used to determine the face and content validity of the module. Other than that, Statistical Package for Social Studies (SPSS) software is used to further facilitate the process of analysing the data. The data analysis method used is the determination of Cronbach's Alpha coefficient value and descriptive statistics which involves calculating the mean value and standard deviation.

5.2 Validity of MyBioProject Module

The first research question for this study is to identify the validity of the developed MyBioProject module. In this study, the module is examined based on its face and content validity. The research question is measured by using a module's face and content validity questionnaire adapted and modified from Sidek Mohd Noah and Jamaludin Ahmad (2005).

5.2.1 Face Validity of MyBioProject Module

A few criteria have been evaluated in determining the module face validity such as font size, writing style, spelling accuracy, vocabulary selection, colour scheme, instructions clarity, and module structure. The data was then analysed through the expert's percentage of agreement. Table 5.1 shows the expert's percentage of agreement and interpretation based on Tuckman and Waheed (1981) formula and Taherdoost (2016) interpretation as discussed in Chapter 3.

Table 5.1

Expert's Percentage of Agreement and Interpretation for Face Validity of Module

Expert	Total Score	Percentage of Agreement	Interpretation of Face Validity
Expert 1	25	89%	Very Valid
Expert 2	28	100%	Very Valid
Expert 3	24	86%	Very Valid
Expert 4	28	100%	Very Valid
Expert 5	24	86%	Very Valid
Overall Average Percentage		**92.2%**	**Very Valid**

The module's face validity, as reflected in Table 5.1, demonstrates a remarkably high overall average exceeding 81% for each expert, indicating a robust level of validity according to Taherdoost (2016). This finding underscores the MyBioProject module's efficacy, employing the PjBL approach. Additionally, a detailed scrutiny of experts' ratings for individual items further reinforces the module's face validation. Table 5.2 presents a comprehensive analysis of expert face validation for each questionnaire item, affirming the module's credibility and presentation.

Table 5.2

Analysis of Expert Face Validation for Each Questionnaire Item

Item	Statement	Total Score	Score Percentage
1	The font size used in MyBioProject teaching module is suitable and clear.	20	100%
2	The writing style used in the MyBioProject teaching module is easy to understand.	19	95%
3	There is no spelling error in words used.	17	85%
4	The vocabularies used in the MyBioProject teaching module are appropriate	17	85%
5	The colour used in MyBioProject teaching module is suitable and attractive.	17	85%
6	The teaching and learning instructions in the module are clear.	19	95%
7	The structure of the MyBioProject teaching module in terms of construction and well-thought-out format.	19	95%
	Overall Average Percentage		**91.4%**

Table 5.2 further illustrates the module's face validity, with each item boasting an overall average exceeding 81%, indicating a high level of validity (Taherdoost, 2016). This robust validation is evident across various facets, including font size, writing style, spelling accuracy, vocabulary selection, colour scheme, instructions clarity, and module structure within the MyBioProject framework. Hence, these findings substantiate the module's commendable face validity across multiple dimensions critical for user engagement and comprehension.

5.2.2 Content Validity of MyBioProject Module

The MyBioProject module, rooted in the PjBL approach, underwent evaluation based on several criteria to ascertain its content validity. These criteria encompassed the content's alignment with the learning standards in the DSKP for Biology Form 4, its suitability for implementation in teaching and learning Biology, the content's appropriateness in relation to the time allocation, its capacity to foster students' creativity and innovation, and its promotion of scientific attitude and noble values. The data was then analysed based on the I-CVI value based on Lyn (1988) formula and Polit and Beck (2006) interpretation as were discussed in Chapter 3. Table 5.3 presents the module content validity results for each item.

Table 5.3

Content Validity Results for Each Item

Item	Total Expert Agreement	Percentage of Agreement	I-CVI Value	Interpretation of Content Validity
Item 1	5	100%	1.00	Acceptable
Item 2	5	100%	1.00	Acceptable
Item 3	5	100%	1.00	Acceptable
Item 4	5	95%	1.00	Acceptable
Item 5	5	90%	1.00	Acceptable
Overall Average		**100%**	**1.00**	**Acceptable**
			S-CVI = 1.00	

Table 5.3 reveals that every item in the module attained an I-CVI value of 1.00. According to Polit and Beck (2006), when a validation instrument involves three to five experts, an I-CVI value of 1.00 indicates acceptable content validity. Hence, the data indicates that the MyBioProject module exhibits strong content validity. Additionally, the analysis extended to the percentage of total scores allocated by each expert to individual items. Table 5.4 provides a comprehensive overview of the total scores by experts assigned to each item in the content validity questionnaire.

Table 5.4

Analysis of Expert Content Validation for Each Questionnaire Item

Item	Statement	Total Score	Score Percentage
1	The content of this module is aligned with learning standards in the Standard Document for Curriculum and Assessment (DSKP) for Biology Form 4.	20	100%
2	The content of this module is suitable for implementation in teaching and learning biology.	20	100%
3	The content of this module is relevant to the time allocated.	20	100%
4	Module content encourages students' creativity and innovation.	19	95%
5	The content of the module applies elements of a scientific attitude and noble values.	18	90%
	Overall Average Percentage		**97%**

Table 5.4 provides further evidence of the module's content validity, as each item demonstrates an overall average exceeding 81%, aligning with Taherdoost's (2016) criteria for high validity. This comprehensive validation spans various aspects, such as adherence to Biology Form 4 standards, suitability for educational implementation, alignment with time allocations, promotion of student creativity and innovation, and the cultivation of scientific attitudes and noble values all in line with

Sidek Mohd Noah and Jamaludin Ahmad (2005) criteria of a good module content validity. These results affirm the module's strong content validity across essential dimensions crucial for enhancing user engagement and understanding.

Furthermore, the feedback from experts collectively praises the developed module for its effectiveness in meeting students' needs and enhancing understanding of Biology topics. It is lauded for its clear presentation of information, engaging teaching methods, and its ability to facilitate a strong grasp of the subject matter, resulting in a valuable learning experience. Furthermore, experts affirm the module's suitability for Biology Form 4 education, highlighting its potential to guide students in project-based learning and its role in promoting increased enrolment in science streams.

> “The module design and content are spot-on and effectively cater to students’ needs in understanding the selected Biology topics.” (Expert 1)

> “The biology module is excellent and highly efficient for students. It presents information clearly, engages students effectively and promotes a strong understanding of the subject matter, resulting in valuable learning experience.” (Expert 4)

> “The MyBioProject teaching module is suitable to be used in teaching and learning Biology form 4. This module can be a meaningful guideline in promoting and guiding students for doing projects in learning biology. Furthermore, we hope this module also can be a useful tool to promote more students entering science stream class.” (Expert 5)

The experts also offered valuable insights for enhancing and refining the module's quality. Here are some of their key recommendations:

"Use actual and more colours in module instead of black and white" (Expert 3)

Other than that, there were some spelling errors and vocabularies rectified in the Bahasa Melayu version of the module by Expert 5.

Muka surat / Page 37: Pektinase, pektin

Muka surat / Page 73 & 75: panjang (lowercase for "p")

Muka surat / Page 15: Rajah 1: Mengupas dan P4: potensi air (istilah tak tepat), **keupayaan** air (istilah tepat)

Muka surat / Page 25:

- P3: Larutan garam pekat adalah hipertonik terhadap sel daging/ Concentrated salt solution is hypertonic to the meat cell.
- P4: air meresap **keluar**/ water diffuses **out**
- P5: air juga meresap **keluar**/ water also diffuses **out**

Every feedback and suggestion from experts were taken into consideration for the improvement of this module before testing the usability of the module. Findings for the content validity of this module answers the first research question. All experts agree that the MyBioProject module which uses the PjBL approach managed to meet the five conditions expressed by Sidek Mohd Noah and Jamaludin Ahmad (2005) and has very good validity.

5.3 Usability of MyBioProject Module

The second research question investigates the usability of the module from the perspective of Biology teachers in Perak. This inquiry is evaluated through a module usability questionnaire, adapted and modified from a previous research questionnaire by Ismail Sulaiman (2018). The survey results are analysed based on three key constructs: suitability, efficiency, and satisfaction, as outlined in Table 5.5.

Table 5.5

Average mean for Suitability, Efficiency and Satisfaction Construct

Construct	Mean Average	Standard deviation	Interpretation of mean value
Suitability	3.34	0.47	High
Efficiency	3.34	0.48	High
Satisfaction	3.31	0.47	High

Based on the findings presented in Table 5.5, it is evident that the average mean value for the suitability construct stands at 3.34, accompanied by a standard deviation of 0.47. This indicates a notably high level of suitability for the module, as elaborated upon in Chapter 3. Similarly, the efficiency construct exhibits an average mean value of 3.34, mirroring the robustness observed in the suitability construct, with a standard deviation of 0.48. These findings reinforce the notion of high efficiency within the developed module. Furthermore, the satisfaction construct portrays a substantial mean value of 3.31, with a standard deviation of 0.47, further attesting to the module's efficacy. Collectively, the consistently high mean values across all three constructs

affirm the usability of the developed module, meeting the predefined evaluation criteria effectively.

5.3.1 Suitability of MyBioProject Module

Regarding the module's suitability, it achieves a high average mean score of 3.34. This aspect encompasses both the format and content of the developed module. Subsequently, Table 5.6 presents the average mean values specifically for the module's format and content criteria.

Table 5.6

Average Mean Value for Suitability Construct of Module's Format and Content

Criteria	Mean Average	Standard deviation	Interpretation of mean value
Format	3.35	0.479	High
Content	3.34	0.469	High

According to Table 5.6, the format criteria of the module have an average mean value of 3.35, with a standard deviation of 0.479. Meanwhile, the content criteria score an average mean value of 3.34, with a standard deviation of 0.469. These results indicate that both criteria exhibit a high mean value and high consensus based on the interpretation of a low standard deviation value. Further analysis of these criteria will be provided based on the data presented in *appendix B1 and B2.*

The format criteria within the suitability construct comprise five items in the questionnaire designed to assess the usability of the module. Detailed analysis for each item regarding the format of the module is presented in *Appendix B1*. According to the table, both item A1 and A2, which assess the module's size and the order of submodules, respectively, garnered 100% agreement with high mean values of 3.33 and 3.30. Similarly, item A3, A4, and A5, focusing on the clarity of instructions, ease of reference for attachments, and appropriateness of activities, respectively, also achieved 100% agreement, with high mean values ranging from 3.32 to 3.43. Overall, all items received high mean values averaging 3.35 and unanimous agreement regarding the module's format. These results indicate that the developed module features suitable and well-organized formatting.

The analysis of the module's content revolves around several key aspects, including alignment with the DSKP, coherence with project guidelines, clarity of objectives, adherence to project-based learning principles, and comprehensibility of terminologies used. This content criteria encompasses five items, each evaluated and detailed in *Appendix B2*. Based on the table, item A6, which assesses the alignment of submodule content with the DSKP, achieved unanimous agreement with the highest mean value of 3.52. Similarly, items A7 to A10, focusing on alignment of project guidelines, clarity of objectives, consistency with project-based learning principles, and comprehensibility of terminologies, all attained 100% agreement. These items garnered high mean values ranging from 3.25 to 3.35. Overall, all items received high mean values averaging 3.34 and high consensus based on the interpretation of a low standard deviation value with a 100% agreement regarding the module's content which indicates that the developed module features suitable and well-aligned content.

5.3.2 Efficiency of MyBioProject Module

The module's efficiency is evident in its high average mean score of 3.34. This aspect covers both the achievement of objectives and the feasibility of teaching and learning process within the developed module. Table 5.7 provides detailed average mean values specifically for these two criteria.

Table 5.7

Average Mean Value for Efficiency Construct of Module's Achievement of Objectives and Feasibility of Teaching and Learning Process

Criteria	Mean Average	Standard deviation	Interpretation of mean value
Achievement of Objectives	3.37	0.477	High
Feasibility of Teaching and Learning Process	3.38	0.475	High

Based on Table 5.7, the achievement of objectives criteria of the module demonstrates an average mean value of 3.37, with a standard deviation of 0.477. Similarly, the feasibility of teaching and learning process criteria exhibit an average mean value of 3.38, with a standard deviation of 0.475. These findings suggest a consistently high mean value for both criteria. Further analysis of these aspects will be detailed using the data presented in *Appendix B3 and B4*.

The achievement of objectives criteria within the suitability construct consists of five items in the questionnaire aimed at evaluating the usability of the module. A detailed analysis for each item regarding the achievement of objectives of the module is outlined in *Appendix B3.* Based on the table, items B1, B2, and B3, which assess whether teaching activities aid in achieving set objectives, are in line with the level of form four students, and effectively test students' understanding of lesson content, all garnered 100% agreement with high mean values of 3.3, 3.33, and 3.27 respectively. Similarly, items B4 and B5, focusing on whether learning activities facilitate the application of higher-order thinking skills (HOTS) and encourage collaboration among students, achieved unanimous agreement with high mean values of 3.52 and 3.43 respectively. Overall, all five items received high mean values averaging 3.37 and 100% agreement regarding the achievement of objectives of the module. These results indicate that the module's objectives can indeed be attained through the implemented activities.

The feasibility of teaching and learning process criteria within the suitability construct consists of five items in the questionnaire also aimed at evaluating the usability of the module. A detailed analysis for each item regarding the feasibility of teaching and learning process of the module is outlined in *Appendix B4*. Based on the table, items B6, B7, and B8, which evaluate the appropriateness of suggested teaching times, the effectiveness of provided lesson plans utilizing the project-based learning approach, and the structure and clarity of learning activities, all achieved 100% agreement with high mean values of 3.25, 3.32, and 3.30 respectively. Similarly, items B9 and B10, focusing on the use of handouts to enhance student interest and the helpfulness of suggested answers for activities, attained unanimous agreement with

high mean values of 3.48 and 3.55 respectively. Overall, all five items received high mean values averaging 3.38 and 100% agreement regarding the feasibility of the teaching and learning process. These results indicate that teachers universally agree that the teaching and learning process using this module can be executed effectively and efficiently.

5.3.3 Satisfaction of MyBioProject Module

The satisfaction construct has six items in the questionnaire which is used to measure the suitability of the module. *Appendix B5* shows a detailed analysis for each item under the satisfaction construct. Based on the table, items C1 and C2, assessing whether the module fulfils the teacher's need to implement project-based learning and their enjoyment in using it, both achieved 100% agreement with high mean values of 3.27 and 3.22 respectively. Item C3, regarding whether the module saves teaching preparation time, attained a mean value of 3.27 with 98.3% agreement. Additionally, items C4, C5, and C6, focusing on the module's effectiveness in helping students learn biological concepts, its ability to attract student interest, and the desire for similar modules for other topics, all garnered 100% agreement with high mean values ranging from 3.33 to 3.40. Overall, all six items received high mean values averaging 3.31 and unanimous agreement regarding the satisfaction construct of using the module. These findings indicate that teachers universally agree that the module fulfils the needs of carrying out project-based learning lessons, is interesting, saves lesson preparation time, and helps students learn biological concepts.

5.3.4 Respondent's Opinions and Suggestions

The suggestions and opinions section are the last part of the questionnaire. This section has three aspects which are special features of the module, weaknesses module as well as module improvement suggestions. Of the 60 respondents who only 56 respondents responded to this part of the questionnaire and were analysed using thematic analysis as discussed in Chapter 3. Table 5.8 shows a summary of the results from the recommendations and opinions obtained in this study

Table 5.8

Summary of Respondent's Opinion and Suggestions

Item	Opinion / Suggestions
State the special features of this module.	Overall, 20 respondents found the module 'interesting', with six of them praising its comprehensiveness in terms of planning and guidelines for student project implementation. Additionally, five respondents appreciated its well-structured arrangement according to lesson scope, while eight respondents highlighted the suitability and clarity of activities provided, which are organized according to topics and student levels. Furthermore, four respondents specifically noted the clear instructions and guidelines provided, with one

Item	Opinion / Suggestions
	mentioning its potential to have a strong effect on memory and processing. Seven respondents appreciated its dual-language format and easy-to-understand concepts for long-term purposes. The module was also described as user-friendly and easy to apply by seven other respondents, with one mentioning the inclusion of helpful pictures to aid student understanding. Two respondents mentioned the module's provision of guidance for teachers in implementing Problem-Based Learning (PjBL) and its use of the 'Hands On' concept with easily obtainable materials. Additionally, three respondents found the teaching aid provided to be beneficial, and four respondents did not provide feedback on this aspect of the questionnaire
State the weakness of this module.	The main weakness identified by 27 respondents is time constraints. Reasons for this constraint vary, including the rush to complete a wide syllabus, time needed for product preparation, lengthy activities for each project, inability to finish the module during lessons and challenges balancing syllabus coverage with other

Item	Opinion / Suggestions
	responsibilities. Some respondents expressed concerns about the extended duration required to complete projects, resulting in the need to select only a few for implementation. Additionally, some teachers worry that time constraints may affect syllabus completion. Two respondents mentioned the lack of interactivity in the module, with one noting a heavy reliance on projectors and screens for activities. One respondent also mentioned a lack of pictures in the module. 30 teachers did not provide feedback on this aspect of the questionnaire.
Specify suggestions for the improvement this module	Four teachers suggested incorporating more visuals into the module, with one specifically mentioning the inclusion of pictures showcasing examples of producible items. Additionally, three teachers recommended increasing the number of questions in the module, particularly those focusing on Higher-Order Thinking Skills (HOTS). One respondent proposed constructing pre-HOTS questions based on real-life student experiences to enhance engagement. Other suggestions included diversifying teaching materials by

Item	Opinion / Suggestions
	linking existing resources to mitigate monotony, as well as incorporating interactive media through links or QR codes to enhance engagement. The use of tools like Quizziz for interactive sessions was also recommended. In terms of content, one teacher suggested including the frying process to illustrate the application of the osmosis concept and provide insight into the original taste of bananas. There were also recommendations to streamline activities, increase the focus on science process skills, and conduct usability testing in classroom settings. Additionally, feedback from six respondents emphasized the user-friendliness of the module but suggested allocating more time for implementation and developing similar modules for small group settings. However, a significant portion of respondents (42) did not provide specific suggestions for the module.

5.4 Conclusion

In summary, this chapter comprehensively examines the usability of the module, specifically focusing on its effectiveness, efficiency, and satisfaction constructs. Through the administration of a questionnaire survey to 60 Biology teachers in Perak, the module's usability was rigorously evaluated. The results elucidate a notable trend of high mean scores across all measured items, affirming the module's efficacy, efficiency, and ability to satisfy users. Notably, the MyBioProject module, grounded in the Project-based Learning (PjBL) approach, emerges as a robust educational tool capable of delivering effective learning outcomes.

Despite some suggestions for improvements, particularly regarding time allocation for activities, the consensus among teachers remains positive. Their collective endorsement of the activities provided underscores the module's practicality and relevance in the classroom setting. Moreover, the favourable perceptions expressed by respondents regarding the module's clear instructions, dual-language format, and user-friendly layout further reinforce its suitability and adaptability for widespread adoption in Biology education. In essence, the findings of this study underscore the 'MyBioProject' module's commendable level of usability and its potential to enhance the teaching and learning experience in Biology classrooms.

CHAPTER 6

DISCUSSION, IMPLICATIONS, RECOMMENDATIONS, AND CONCLUSION

6.1 Introduction

This chapter delves into a comprehensive analysis of the study's summary, research findings exploration, and research contributions delineation. These findings are meticulously discussed in alignment with the initially posited research questions. Furthermore, this chapter offers insightful recommendations for future studies, aimed at enhancing both the development and evaluation of modules, with a specific focus on fostering the adoption of project-based learning methodologies in Biology education.

6.2 Summary of Research

Project-based learning (PjBL) is an educational approach focused on students, where they acquire skills and knowledge through project work, collaborative learning, and practical activities which helps them to achieve learning outcomes and master the topic better (Kelemen et al., 2021). In addition, Zaharah and Nurulwahida (2021) note that PjBL has a beneficial effect on students' learning experiences, enhancing their academic performance, understanding, and practical skills, which can be applied beyond the classroom, resulting in favourable outcomes in real-world scenarios.

The primary objective of this research is to create an effective teaching module named the MyBioProject module for four selected topics within the Biology Form Four KSSM syllabus. The module is evaluated in terms of its validity by the five appointed experts and its usability among Biology teachers in Perak. The module was developed based on the ADDIE development model according to the five phases, namely: Analysis, Design, Development, Implementation and Evaluation phase. The ADDIE model, renowned for its adaptability and systematic approach, serves as an efficient tool for educators to create teaching designs for instructional products, while also offering integration potential with Project-based Learning (PjBL) to enhance systematic learning and foster robust analytical skills (Adri et al., 2020).

In the initial phase (Analyse), the difficulty of topics within the Form Four KSSM Biology Curriculum Specification was assessed among 30 Biology teachers nationwide. Based on the survey results, the four most challenging topics—Movement of Substances across the Plasma Membrane, Nutrition and the Human Digestive

System, Metabolism and Enzyme, and Cellular Respiration—were identified and subsequently incorporated into the module.

In the Design phase, crucial decisions are made regarding the learning theory, module format, and learning methods and materials selection to ensure the quality and presentation of the modules. Constructivism theory guides this phase, emphasizing student engagement and knowledge building based on their prior understanding (Anagun, 2018). In the MyBioProject module, activities were crafted to facilitate active learning, incorporating group hands-on tasks, presentations, and creation of products aligned with students' learning.

During the Development phase, the module was created according to the crafted design using various tools based on the output at Design phase. Subsequently, in the Implement phase, the developed module underwent evaluation by five experts to assess its validity. Following expert validation, adjustments were made and improvements were implemented based on the provided feedback. Following this, a pilot test was conducted among 16 Biology teachers in Manjung, Perak to gauge the reliability of the instrument (questionnaire) developed.

In the final Evaluation phase, the module, previously assessed for validity by five experts, underwent usability evaluation. Following confirmation of its validity, the revised module from the pilot study was disseminated to Biology teachers in Perak to assess its usability. A total of 60 Biology teachers participated as respondents, providing feedback through a module usability questionnaire which covered three primary constructs: suitability, efficiency, and satisfaction.

6.3 Discussion

This section will delve into the findings derived from the study, focusing on the validity and usability of the teaching module developed through the project-based learning approach.

6.3.1 Validity of the MyBioProject module

According to Sidek and Jamaludin (2005), the validity of the measurement tool should be able to measure the content accurately and systematically. Face and content validity examined in this research is important in education field (Oluwatayo, 2012) as is done in this research. The data analysis discussed in Chapter 5 results from five experts indicate that the teaching module developed using the project-based learning approach exhibits strong face validity, surpassing the recommended threshold of 81% agreement, with an overall agreement percentage of 92.2% (Taherdoost, 2016). Experts agreed that various aspects of the MyBioProject module, such as font size, writing style, absence of spelling errors, appropriateness of vocabulary, colour usage, clarity of teaching instructions, and overall module structure, were suitable and well-constructed. Therefore, this serves the purpose of developing the MyBioProject module for teachers to use as a reference material while planning their lessons.

Furthermore, the analysis also revealed that the teaching module demonstrates robust content validity, achieving a perfect agreement percentage of 100% and an I-CVI value of 1.00 for all items (Polit and Beck, 2006). This comprehensive validation

spans various aspects, such as adherence to Biology Form 4 standards, suitability for educational implementation, alignment with time allocations, promotion of student creativity and innovation, and the cultivation of scientific attitudes and noble values all in line with Sidek Mohd Noah and Jamaludin Ahmad (2005) criteria of a good module content validity. As the study focuses on the four most difficult topics that were identified through the need analysis, this result ensures that the module developed can help teachers to effectively teach these complex topics to enhance their students understanding and interest through PjBL lessons that can be carried out within the suggested time frame.

To further elaborate, this module consists of 10 implementation steps, adapted from Kelemen et al. (2021), aimed at guiding teachers in effectively implementing project-based learning in Form 4 Biology classrooms. These steps encompass various stages, including formulating project questions, selecting and designing projects, conducting research, proposal writing, executing assignments, data analysis, report writing, and final project presentation. Therefore, these findings affirm that the content of the developed module serves as a valuable resource for educators in facilitating project-based learning experiences for Form 4 Biology students. This approach can motivate teachers to improve their teaching techniques and knowledge which can result in more confident and effective classroom activities related to PjBL according to Guangul et al. (2020)

There is also a previous study conducted by Sari et al. (2021), which utilized the ADDIE model to develop Higher Order Thinking Skills (HOTS)-based biology learning tools focusing on motion systems, demonstrated feasible validation outcomes.

This validation process offers valuable insights into the quality of the developed product and its potential effectiveness in classroom settings. By employing a similar methodology in this research, the researcher aims to ensure that the MyBioProject module, validated for both face and content, is not just a product, but a valuable resource that resonates with educators and students alike, fostering meaningful learning experiences.

6.3.2 Usability of MyBioProject Module

To gauge the usability of the module, a questionnaire instrument was employed, structured around three primary constructs: suitability, efficiency, and satisfaction. Within these constructs, specific criteria were examined. Suitability and efficiency were each assessed based on two criteria: format and content, as well as achievement of objectives and the feasibility of the teaching and learning process.

This questionnaire was assessed by 60 Biology teachers in the Perak state, each with at least one year of teaching experience. The data gathered from this survey was analysed to fulfil the second research objective of this study. The data analysis involved employing statistical methods such as mean, standard deviation, and percentage. Overall, the study's findings reveal high mean average values for the three constructs: suitability, efficiency and satisfaction (see Table 5.5 in Chapter 5). These results indicate that the MyBioProject module, developed based on the PjBL approach, is deemed suitable, efficient, and satisfactory for utilisation by Biology teachers in instructing Form 4 Biology students.

To elaborate, teachers today often face challenges in STEM education, particularly in aligning their teaching goals with suitable approaches and models like PjBL for the benefit of students (Wohano et al., 2020). The MyBioProject module was developed with an emphasis on establishing a clear teaching approach and desired learning outcomes to ensure its effectiveness. With the new KSSM syllabus offering a range of PjBL activities, a module like MyBioProject, which is suitable, efficient, and satisfactory, can help challenge students to incorporate PjBL assessments as part of their academic process. As supported by Santyasa et al. (2020), pedagogical research based on PjBL standards can provide learners with proper access to fundamental science, facilitating a primary approach to understanding Biology. PjBL stands as an instructional method that empowers students to develop skills and acquire knowledge through engaging in projects, cooperative learning, and hands-on techniques, ultimately enhancing their mastery of subjects (Kelemen et al., 2021).

Moreover, PjBL fosters a connection between students and the world outside the classroom, equipping them with problem-solving abilities applicable to their personal lives and real-world situations (Salem et al., 2016). Consequently, the MyBioProject module integrates various activities that mirror real-life scenarios, encompassing project work facilitated by cooperative learning and hands-on techniques, thus fostering similar positive outcomes among students. Further discussion on the three main constructs are as follows:

i. Suitability construct

Pengestuti, Prajoko and Sukmawati (2023) stated that when selecting teaching materials, teachers should prioritize two main aspects: format and content. In this study, the results from the table *Appendix B1* demonstrated a consensus among respondents, with all items receiving high mean values and unanimous agreement regarding the module's format. Specifically, the assessment of the module's size and order of submodules, clarity of instructions, ease of reference for attachments, and appropriateness of activities achieved an overall 100% agreement, alongside elevated mean values. This aligns with research conducted by Putra, Zaini and Sari (2023), which indicates that a good module should be organized systematically, presented in an engaging manner, and convey information clearly. These findings collectively signify that the developed module exhibits appropriate and well-organized formatting, meeting the criteria set forth effectively.

Similarly, as depicted in the table in *Appendix B2*, all items received high mean values and unanimous agreement regarding the module's content. These items evaluate various aspects such as the alignment of submodule content with the DSKP, alignment of project guidelines, clarity of objectives, consistency with the project-based learning approach, and comprehensibility of terminologies. The MyBioProject module strictly adheres to the KSSM syllabus guidelines, meticulously aligning with its content standards, learning standards, and learning outcomes as detailed in Chapter 4. This adherence ensures that the module is not only relevant but also comprehensive in covering the essential curriculum requirements for Form Four Biology. By following

these guidelines, the module ensures that all instructional content is accurate, up-to-date, and aligns with national education standards.

In this study, the MyBioProject module is developed following the Form Four DSKP guidelines and adopting the PjBL model. In Chapter 4, it was discussed how the module's design integrates specific content standards to provide a thorough understanding of the four selected Biology topics: Movement of Substances across the Plasma Membrane, Nutrition and the Human Digestive System, Metabolism and Enzymes, and Cellular Respiration. Each submodule is crafted to meet designated learning standards, which outline the essential knowledge and skills that students need to acquire. Each of the submodule also includes a lesson plan whereby the objectives are stated, a specific product for students to create based on the topics covered accompanied by project guidelines and a standard assessment rubric. This will then enable teachers to evaluate the appropriateness of planned projects, students' project management skills, and the authenticity of the produced products (Sary et al., 2023).

By strictly following the KSSM guidelines, the MyBioProject module not only enhances the teaching and learning process but also ensures that the educational experiences provided are aligned with national educational objectives. This meticulous alignment helps in maintaining the quality and effectiveness of the module, making it a reliable resource for educators and a valuable learning tool for students. To conclude, these results suggest that the developed module encompasses appropriate and well-aligned content, meeting the requirements effectively.

ii. Efficiency construct

The results presented in the table in *Appendix B3*, has demonstrated unanimous agreement and high mean values across all five items pertaining to the achievement of objectives of the module. These items assess whether teaching activities effectively contribute to achieving set objectives, align with the level of Form Four students, test students' comprehension of lesson content, foster the application of higher-order thinking skills (HOTS), and promote collaboration among students. The teaching activities embedded within the module are evidently well-aligned with educational goals, providing a structured pathway for students to meet the desired learning outcomes. The emphasis on higher-order thinking skills (HOTS) is particularly significant, as it ensures that students are not merely memorizing facts but are also developing critical thinking, problem-solving, and analytical skills. Amulla (2020) supports that the PjBL approach is an effective way to develop 21st-century capabilities, promoting critical thinking, problem-solving abilities, innovation, and creativity. This aligns with contemporary educational strategies that prioritize deeper cognitive engagement over rote learning.

The alignment with the research by Sary, Isnawati, and Asri (2023) further validates the module's design and implementation. Their findings highlight the importance of clear concept presentation and the use of reliable sources, which are integral to the MyBioProject module. This alignment with established research underscores the module's credibility and effectiveness in achieving its educational objectives. These findings also suggest that the module is well-equipped to enhance

student learning outcomes, making it a valuable resource for educators aiming to implement project-based learning in their classrooms.

Anggis, (2023) has stated that educators can develop effective learning plans tailored to students' needs and circumstances as a preparatory step before instruction, which serve to measure the quality of achievements in biology learning. Within the MyBioProject module, a detailed lesson plan accompanies each submodule which enables teachers to meticulously structure and organise lessons, thereby ensuring the effective attainment of learning objectives. The detailed lesson plans in the MyBioProject module allow educators to create a clear and coherent roadmap for each topic. This systematic approach ensures that all essential concepts are covered and that teaching methods are aligned with learning outcomes. By doing so, teachers can better track student progress and adjust their strategies to meet individual needs, enhancing the overall learning experience.

Nadir, Arthur and Daryati (2022) also suggests that modules can be aligned with suitable learning approaches and linked to scientific contexts and everyday problems, enabling students to grasp the relevance of the material to real-life situations. This alignment is evident in the MyBioProject module, where the incorporation of project-based learning (PjBL) facilitates the application of biology concepts to practical, real-world scenarios. By engaging in projects that mirror real-life problems, students can see the direct relevance of their studies, which enhances their motivation and understanding (Amulla, 2020). The structured lesson plans and real-life contextual learning activities together ensure that the module is both effective and meaningful,

ultimately promoting a deeper understanding of biology and equipping students with essential 21st-century skills.

In addition, the table in *Appendix B4*, has revealed unanimous agreement and high mean values across all five items concerning the feasibility of the teaching and learning process. These items evaluate the appropriateness of suggested teaching times, the effectiveness of provided lesson plans utilizing the project-based learning approach, the structure and clarity of learning activities, the use of handouts to enhance student interest, and the helpfulness of suggested answers for activities. As highlighted by Rini et al. (2020), the integration of PjBL in biology necessitates adherence to specific steps, encompassing learning outcomes, teaching materials, skill development, project themes, proposal execution, and presentation. The development of the lesson plan within the MyBioProject module meticulously incorporates these steps, ensuring the creation of an effective module with a robust and valid structure, along with clear learning activities. This engaging classroom environment ensures effective teaching and learning in biology education (Sulistyawati et al., 2019).

Pengestuti et al., (2023) highlights a drawback of the PjBL learning model, noting its comparatively longer duration compared to other learning models. Thus, in this module, each learning activity is designed with a shorter and more flexible time frame to address this concern. Additionally, a module's evaluation should ensure that the allocated time for its implementation is adequate (Sidek and Jamaludin, 2005) which has also attained unanimous agreement among teacher for the activities planned in this module.

Furthermore, in PjBL, teachers play a crucial role in guiding the learning process and fostering critical thinking levels, as noted by Vanhala (2018). This is achieved through the provision of appropriate handouts and suggested answers for all questions posed in each submodule. These elements support teachers in facilitating student learning and ensuring the effective implementation of the PjBL approach.

In summary, the findings indicate that the MyBioProject module effectively supports the teaching and learning process by ensuring clarity, structure, and practical application of biology concepts. Teachers universally agree that the module's objectives can be effectively attained through the implemented activities, and they find the module efficient and feasible for classroom use. This consensus underscores the module's potential to enhance the educational experience for both teachers and students, fostering a more interactive and engaging learning environment.

iii. Satisfaction construct

According to the table in *Appendix B5*, all six items received unanimous agreement and high mean values regarding the satisfaction construct of using the module. These items assess whether the module meets teachers' needs for implementing project-based learning and their enjoyment of using it. Furthermore, they evaluate whether the module saves teaching preparation time, its effectiveness in aiding students' understanding of biological concepts, its ability to engage student interest, and the desire for similar modules covering other topics. These findings are crucial as they reflect teachers' overall satisfaction with the module and its suitability for classroom use. The high levels of agreement and mean values indicate that the module effectively meets

teachers' needs and expectations, providing them with valuable resources to implement PjBL in their teaching practices.

Furthermore, the satisfaction reported by teachers suggests that the module enhances their teaching experience by saving preparation time and supporting students in understanding complex biological concepts. This will further motivate teachers to improve their teaching techniques and knowledge, resulting in more confident and effective classroom activities, particularly those related to PjBL (Guanggul et al., 2020). These findings collectively indicate that teachers universally agree that the module fulfils the requirements for conducting project-based learning lessons, is engaging, saves preparation time, and effectively supports students in learning biological concepts contributing to more confident and effective classroom activities.

6.4 Research Conclusion

In conclusion, this study aimed to develop a teaching module focusing on four specific Form Four KSSM biology topics, utilizing the project-based learning approach. The module's development process followed the systematic framework provided by the ADDIE model, while also drawing upon the constructivism theory to ensure alignment with effective pedagogical practices. Through meticulous planning and design, the MyBioProject module emerged as a robust educational resource, offering structured guidance for educators.

The evaluation of the module's validity and usability revealed promising results across key dimensions, including suitability, efficiency, and satisfaction. Each construct demonstrated consistently high mean values, indicative of the module's effectiveness in meeting educational objectives and catering to diverse learning needs. By providing clear instructions, relevant content, and engaging activities, the module offers educators a valuable tool to facilitate student learning in biology.

Overall, the MyBioProject module represents a significant contribution to biology education, offering a practical and engaging approach to teaching and learning. Its successful development underscores the importance of integrating innovative pedagogical strategies to enhance student outcomes and promote deeper understanding of biological concepts.

6.5 Research Implications

The implications derived from the discussion of research findings in the preceding chapter extend to Biology teachers, students, and educational institutions. The development of the teaching module based on the project-based learning (PjBL) approach demonstrates high validity and usability, indicating its suitability for both Biology teachers and Form Four students.

These findings offer valuable insights to teachers and schools regarding the integration of PjBL in Biology education for Form Four students, focusing on the four selected topics outlined in the KSSM syllabus. PjBL, being a student-centred approach,

fosters active student engagement in the learning process, thereby providing guidance for schools and educators to incorporate PjBL-based teaching and learning materials comprehensively at the Form Four level.

Moreover, the study highlights that the developed module is user-friendly and well-suited for implementation, which can serve as a compelling reason for biology teachers to adopt it in their instructional practices. Equipped with comprehensive lesson plans, implementation activities, and project-based evaluation methods, the module offers teachers valuable guidance and references, enabling them to implement PjBL-based teaching and learning more systematically and effectively.

Furthermore, the planned activities within the module are designed to capture students' interest in learning the selected topics and enhance their understanding of Biology concepts. Through activities fostering skills such as exploration, analysis, evaluation, problem-solving, and decision-making, students are exposed to higher-order thinking skills and improved communication abilities. Consequently, the module serves as an alternative pedagogical material for students to learn about topics like Movement of Substances across the Plasma Membrane, Nutrition and the Human Digestive System, Metabolism and Enzymes, and Cellular Respiration through the engaging and effective approach of PjBL.

6.6 Recommendations for Future Study

Based on the findings of this study, several research recommendations emerge, providing valuable directions for future investigations:

i. Testing the Effectiveness of the MyBioProject Module for all Four Selected Topics Using a Quasi-Experimental Method:

The developed module has thus far been assessed for usability only. Future researchers are urged to expand upon this by conducting quasi-experimental studies to assess the effectiveness of the module among Form Four biology students. This entails comparing student achievement between those who utilize the module and those who do not. Effectiveness can be inferred if significant differences in achievement are observed, indicating the module's impact on student learning outcomes.

ii. Development of Teaching and Learning Modules Based on the PjBL Approach for Other Topics:

While the current module focuses on four specific topics—Movement of Substances across the Plasma Membrane, Nutrition and the Human Digestive System, Metabolism and Enzymes, and Cellular Respiration—it is essential to broaden the scope of PjBL-based modules to encompass other topics within the Biology DSKP at the Form Four and even Form Five level. Given the identified need for such instructional aids, future researchers are encouraged to develop

PjBL modules for additional topics. This expansion will not only enrich teaching resources but also facilitate the implementation of PjBL in Biology education, ultimately enhancing student learning experiences and outcomes.

6.7 Conclusion

This study has effectively developed a module based on the Project-based Learning (PjBL) approach, following a systematic and structured process guided by the ADDIE Model. The resulting module serves as a valuable resource for biology teachers, offering comprehensive guidance and reference materials for the implementation of PjBL in the classroom. Central to this approach is its student-centred nature, encouraging active engagement and participation among students, with the teacher assuming the role of a facilitator.

The findings of data analysis demonstrate that the developed module exhibits high validity and usability, affirming its efficacy as an instructional tool. It is anticipated that the development of this MyBioProject module will serve as a foundation for the creation of future PjBL modules, with the potential for further enhancements and improvements. As educators continue to refine and expand upon this framework, the evolution of PjBL modules holds promise for enriching the teaching and learning experiences of students in biology education.

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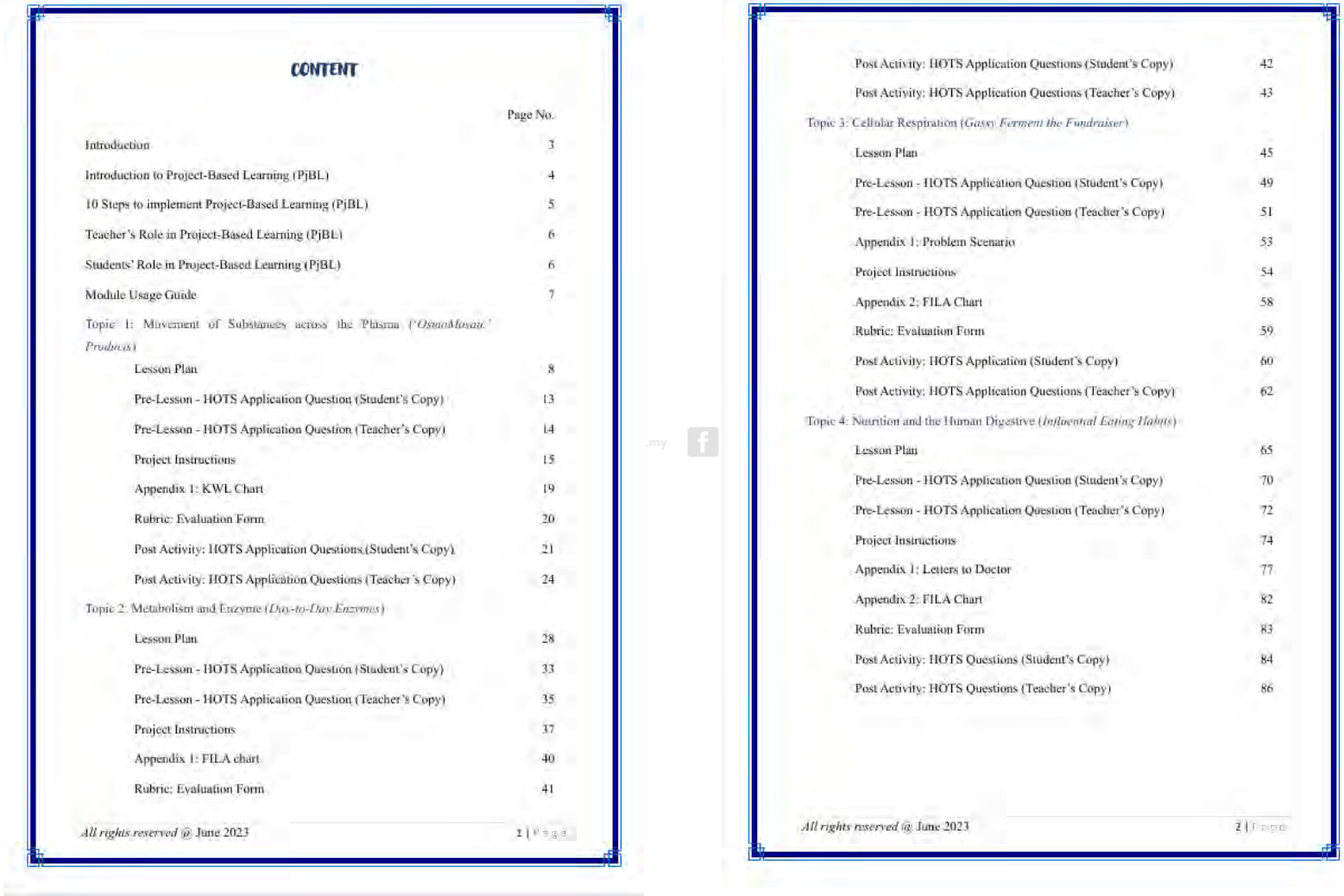
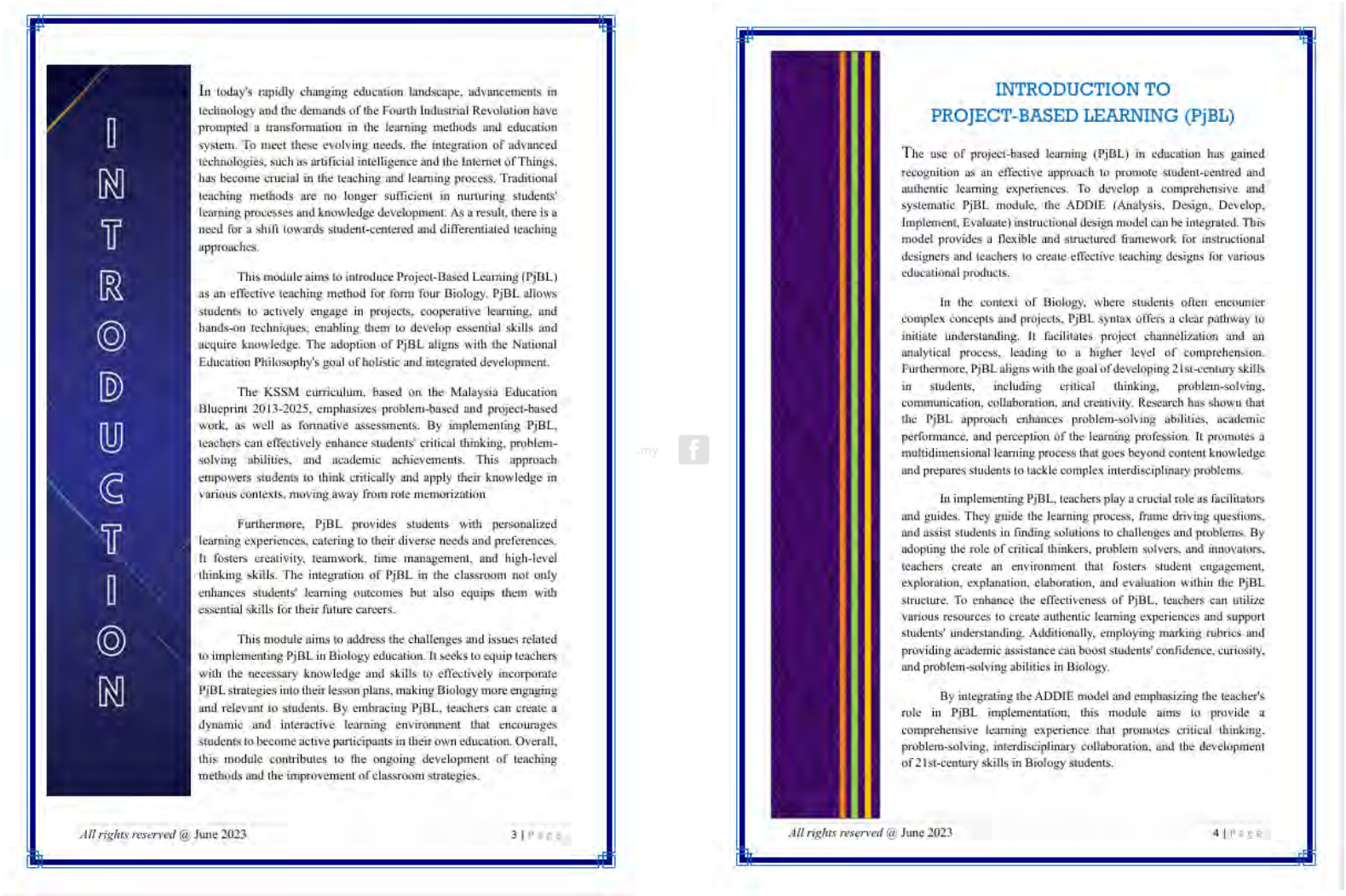
APPENDIX A1



CONTENT

Content pages of the module

APPENDIX A2



INTRODUCTION

In today's rapidly changing education landscape, advancements in technology and the demands of the Fourth Industrial Revolution have prompted a transformation in the learning methods and education system. To meet these evolving needs, the integration of advanced technologies, such as artificial intelligence and the Internet of Things, has become crucial in the teaching and learning process. Traditional teaching methods are no longer sufficient in nurturing students' learning processes and knowledge development. As a result, there is a need for a shift towards student-centered and differentiated teaching approaches.

This module aims to introduce Project-Based Learning (PjBL) as an effective teaching method for form four Biology. PjBL allows students to actively engage in projects, cooperative learning, and hands-on techniques, enabling them to develop essential skills and acquire knowledge. The adoption of PjBL aligns with the National Education Philosophy's goal of holistic and integrated development.

The KSSM curriculum, based on the Malaysia Education Blueprint 2013-2025, emphasizes problem-based and project-based work, as well as formative assessments. By implementing PjBL, teachers can effectively enhance students' critical thinking, problem-solving abilities, and academic achievements. This approach empowers students to think critically and apply their knowledge in various contexts, moving away from rote memorization.

Furthermore, PjBL provides students with personalized learning experiences, catering to their diverse needs and preferences. It fosters creativity, teamwork, time management, and high-level thinking skills. The integration of PjBL in the classroom not only enhances students' learning outcomes but also equips them with essential skills for their future careers.

This module aims to address the challenges and issues related to implementing PjBL in Biology education. It seeks to equip teachers with the necessary knowledge and skills to effectively incorporate PjBL strategies into their lesson plans, making Biology more engaging and relevant to students. By embracing PjBL, teachers can create a dynamic and interactive learning environment that encourages students to become active participants in their own education. Overall, this module contributes to the ongoing development of teaching methods and the improvement of classroom strategies.

INTRODUCTION TO PROJECT-BASED LEARNING (PjBL)

The use of project-based learning (PjBL) in education has gained recognition as an effective approach to promote student-centred and authentic learning experiences. To develop a comprehensive and systematic PjBL module, the ADDIE (Analysis, Design, Develop, Implement, Evaluate) instructional design model can be integrated. This model provides a flexible and structured framework for instructional designers and teachers to create effective teaching designs for various educational products.

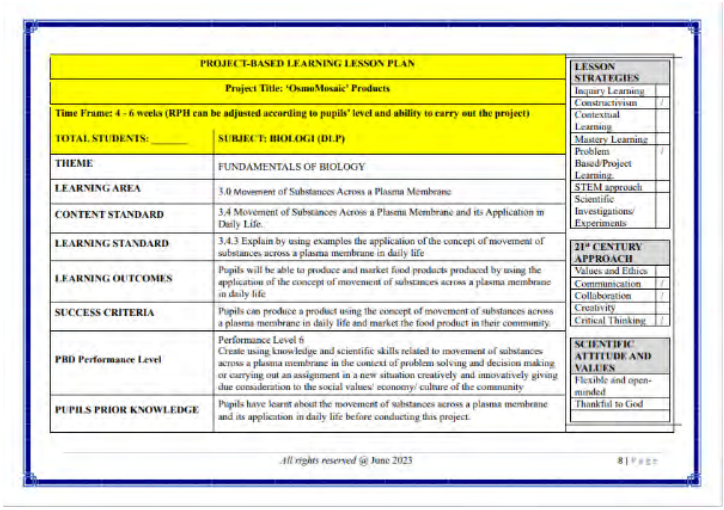
In the context of Biology, where students often encounter complex concepts and projects, PjBL syntax offers a clear pathway to initiate understanding. It facilitates project channelization and an analytical process, leading to a higher level of comprehension. Furthermore, PjBL aligns with the goal of developing 21st-century skills in students, including critical thinking, problem-solving, communication, collaboration, and creativity. Research has shown that the PjBL approach enhances problem-solving abilities, academic performance, and perception of the learning profession. It promotes a multidimensional learning process that goes beyond content knowledge and prepares students to tackle complex interdisciplinary problems.

In implementing PjBL, teachers play a crucial role as facilitators and guides. They guide the learning process, frame driving questions, and assist students in finding solutions to challenges and problems. By adopting the role of critical thinkers, problem solvers, and innovators, teachers create an environment that fosters student engagement, exploration, explanation, elaboration, and evaluation within the PjBL structure. To enhance the effectiveness of PjBL, teachers can utilize various resources to create authentic learning experiences and support students' understanding. Additionally, employing marking rubrics and providing academic assistance can boost students' confidence, curiosity, and problem-solving abilities in Biology.

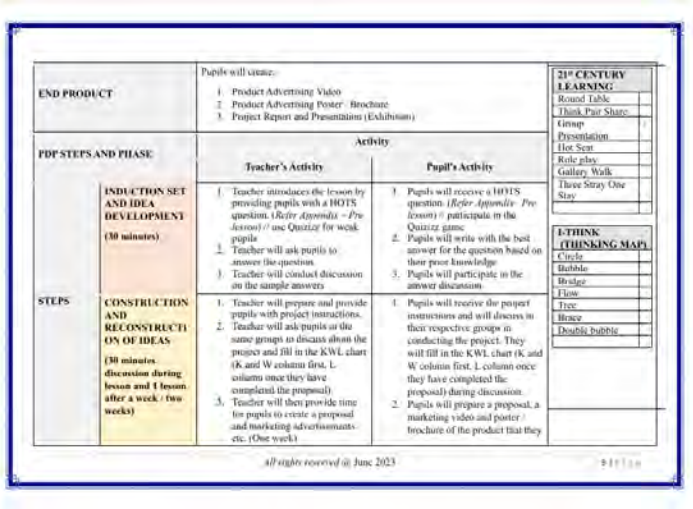
By integrating the ADDIE model and emphasizing the teacher's role in PjBL implementation, this module aims to provide a comprehensive learning experience that promotes critical thinking, problem-solving, interdisciplinary collaboration, and the development of 21st-century skills in Biology students.

Introduction to the module and an introduction to PjBL

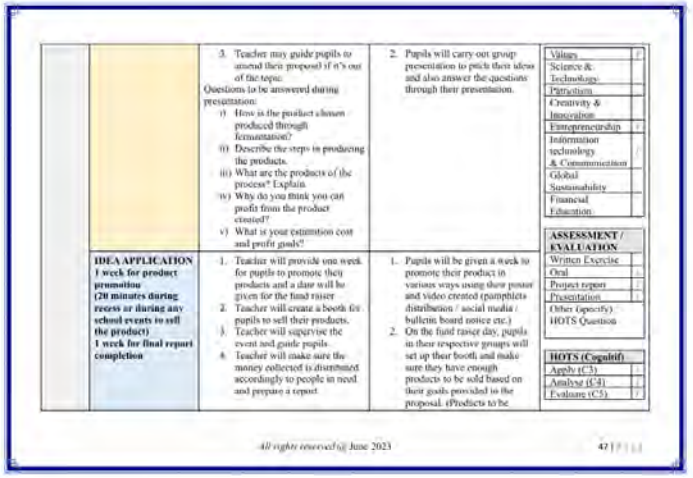
APPENDIX A3



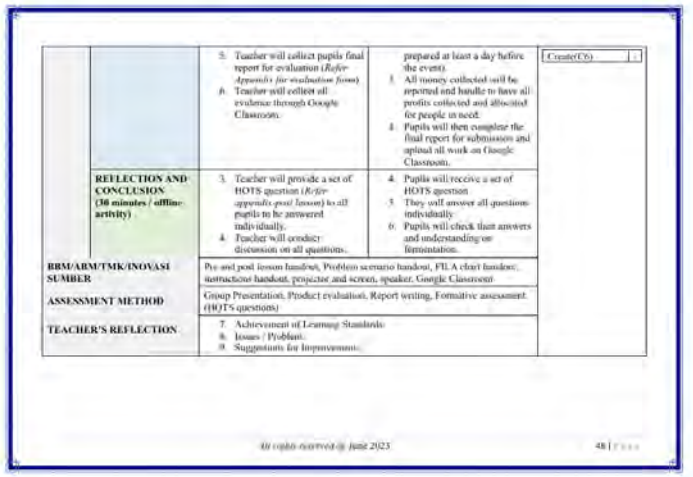
PROJECT-BASED LEARNING LESSON PLAN		LESSON STRATEGIES	
Project Title: 'OsmoMosaic' Products		Inquiry Learning	
Time Frame: 4 - 6 weeks (RPH can be adjusted according to pupils' level and ability to carry out the project)		Constructivism	/
TOTAL STUDENTS: _____	SUBJECT: BIOLOGI (DLP)	Contextual Learning	
THEME	FUNDAMENTALS OF BIOLOGY	Mastery Learning	
LEARNING AREA	3.0 Movement of Substances Across a Plasma Membrane	Problem Based/Project Learning	/
CONTENT STANDARD	3.4 Movement of Substances Across a Plasma Membrane and its Application in Daily Life.	STEM approach	
LEARNING STANDARD	3.4.3 Explain by using examples the application of the concept of movement of substances across a plasma membrane in daily life	Scientific Investigations/ Experiments	
LEARNING OUTCOMES	Pupils will be able to produce and market food products produced by using the application of the concept of movement of substances across a plasma membrane in daily life	21st CENTURY APPROACH	
SUCCESS CRITERIA	Pupils can produce a product using the concept of movement of substances across a plasma membrane in daily life and market the food product in their community.	Values and Ethics	
PBD Performance Level	Performance Level 6 Create using knowledge and scientific skills related to movement of substances across a plasma membrane in the context of problem solving and decision making or carrying out an assignment in a new situation creatively and innovatively giving due consideration to the social values/ economy/ culture of the community	Communication	/
PUPILS PRIOR KNOWLEDGE	Pupils have learnt about the movement of substances across a plasma membrane and its application in daily life before conducting this project.	Collaboration	/
		Creativity	
		Critical Thinking	/
		SCIENTIFIC ATTITUDE AND VALUES	
		Flexible and open-minded	
		Thankful to God	



		Pupils will create:		21st CENTURY LEARNING	
END PRODUCT		1. Product Advertising Video 2. Product Advertising Poster / Brochure 3. Project Report and Presentation (Exhibition)		Round Table	
PDP STEPS AND PHASE		Activity		Think Pair Share	
		Teacher's Activity	Pupil's Activity	Group Presentation	/
STEPS	INDUCTION SET AND IDEA DEVELOPMENT (30 minutes)	1. Teacher introduces the lesson by providing pupils with a HOTS question. (*Refer Appendix - Pre lesson*) // use *Quizizz* for weak pupils 2. Teacher will ask pupils to answer the question. 3. Teacher will conduct discussion on the sample answers	1. Pupils will receive a HOTS question. (*Refer Appendix - Pre lesson*) // participate in the Quizizz game 2. Pupils will write with the best answer for the question based on their prior knowledge. 3. Pupils will participate in the answer discussion.	Hot Seat	
				Role play	
				Gallary Walk	
				Three Stray One Stay	
	CONSTRUCTION AND RECONSTRUCTION OF IDEAS (30 minutes discussion during lesson and 1 lesson after a week / two weeks)	1. Teacher will prepare and provide pupils with project instructions. 2. Teacher will ask pupils in the same groups to discuss about the project and fill in the KWL chart (K and W column first, L column once they have completed the proposal). 3. Teacher will then provide time for pupils to create a proposed and marketing advertisements etc. (One week)	1. Pupils will receive the project instructions and will discuss in their respective groups in conducting the project. They will fill in the KWL chart (K and W column first, L column once they have completed the proposal) during discussion. 2. Pupils will prepare a proposal, a marketing video and poster / brochure of the product that they	I-THINK (THINKING MAP)	
				Circle	
				Bubble	
				Bridge	
				Flow	
				Tree	
				Brace	
				Double bubble	



		3. Teacher may guide pupils to amend their proposal if it's out of the topic. Questions to be answered during presentation: i) How is the product chosen produced through fermentation? ii) Describe the steps in producing the products. iii) What are the products of the process? Explain iv) Why do you think you can profit from the product created? v) What is your estimation cost and profit goals?	2. Pupils will carry out group presentation to pitch their ideas and also answer the questions through their presentation.	Values /
				Science & Technology /
				Patriotism
				Creativity & Innovation
				Entrepreneurship /
				Information technology & Communication /
				Global Sustainability
				Financial Education
	IDEA APPLICATION 1 week for product promotion (20 minutes during recess or during any school events to sell the product) 1 week for final report completion	1. Teacher will provide one week for pupils to promote their products and a date will be given for the fund raiser 2. Teacher will create a booth for pupils to sell their products. 3. Teacher will supervise the event and guide pupils. 4. Teacher will make sure the money collected is disseminated accordingly to people in need and prepare a report.	1. Pupils will be given a week to promote their product in various ways using show poster and video created (pamphlets distribution / social media / bulletin board notice etc.) 2. On the fund raiser day, pupils in their respective groups will set up their booth and make sure they have enough products to be sold based on their goals provided in the proposal. (Products to be	ASSESSMENT / EVALUATION
				Written Exercise
				Oral
				Project report /
				Presentation /
				Other (specify) : HOTS Question
				HOTS (Cognitif)
				Apply (C3) /
				Analyse (C4) /
				Evaluate (C5) /



		5. Teacher will collect pupils final report for evaluation (*Refer Appendix for evaluation form*) 6. Teacher will collect all evidence through Google Classroom.	prepared at least a day before the event). 3. All money collected will be reported and handle to have all profits collected and allocated for people in need. 4. Pupils will then complete the final report for submission and upload all work on Google Classroom.	Create(C6) /
	REFLECTION AND CONCLUSION (30 minutes / offline activity)	3. Teacher will provide a set of HOTS question (*Refer appendix post lesson*) to all pupils to be answered individually. 4. Teacher will conduct discussion on all questions.	4. Pupils will receive a set of HOTS question 5. They will answer all questions individually 6. Pupils will check their answers and understanding on fermentation.	
BBM/ABM/TMK/INOVASI SUMBER		Pre and post lesson handout, Problem scenario handout, FILA chart handout, instructions handout, projector and screen, speaker, Google Classroom		
ASSESSMENT METHOD		Group Presentation, Product evaluation, Report writing, Formative assessment (HOTS questions)		
TEACHER'S REFLECTION		7. Achievement of Learning Standards: 8. Issues / Problem: 9. Suggestions for Improvements:		

A complete lesson plan example from submodule 1 on the topic Movement of Substances across the Plasma Membrane

APPENDIX A4

APPENDIX

PRE-LESSON – HOTS APPLICATION QUESTION (STUDENT'S COPY)

Rajah 1 di bawah menunjukkan kaedah penyediaan kepingan pisang yang rangup.
Diagram 1 below shows the steps in preparing crispy banana chips.

Rajah 1 / *Diagram 1*

Menggunakan pengetahuan terkini anda dalam pembelajaran tentang pergerakan bahan merentasi membran plasma, terangkan kepentingan langkah-langkah yang diambil dalam menghasilkan kerepek pisang yang rangup.
Applying your recent knowledge in learning on the movement of substances across the plasma membrane, ***explain*** *the* ***importance of the steps taken*** *in producing banana chips that are crispy.*

PRE-LESSON – HOTS APPLICATION QUESTION (TEACHER'S COPY)

Rajah 1 di bawah menunjukkan kaedah penyediaan kepingan pisang yang rangup.
Diagram 1 below shows the steps in preparing crispy banana chips.

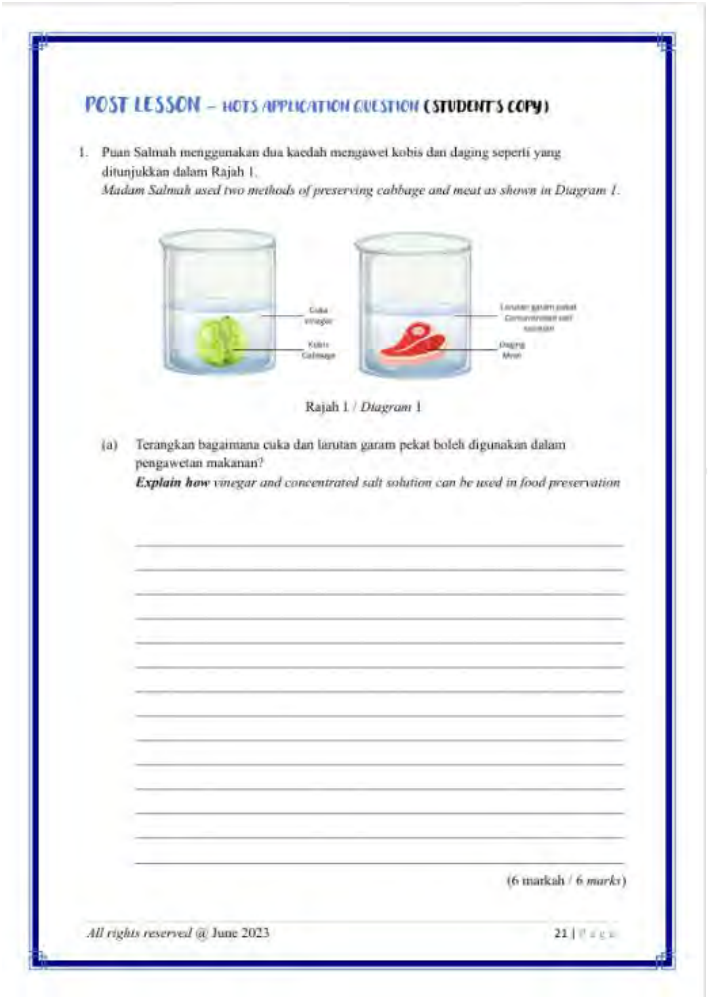
Rajah 1 / *Diagram 1*

Menggunakan pengetahuan terkini anda dalam pembelajaran tentang pergerakan bahan merentasi membran plasma, terangkan kepentingan langkah-langkah yang diambil dalam menghasilkan kerepek pisang yang rangup.
Applying your recent knowledge in learning on the movement of substances across the plasma membrane, ***explain*** *the* ***importance of the steps*** *taken in producing banana chips that are crispy.*

Peeling P1: To remove the (banana) skin Slicing P2: To increase the surface area P3: Increase rate of water diffuse out of the cell // fast removal of water out from the cell Soaking in salt solution P4: Salt solution is hypertonic to / has lower water potential than the banana cells / slices P5: Causing water diffuse out of the banana cells / tissue via osmosis	Dry the sliced banana P6: To remove (excess) more water from banana slices P7: By evaporation P8: Sliced potatoes do not stick together Frying P9: The temperature of hot oil is high P10: Water changed into water vapour / evaporation occurs P11: more water is removed

A pre-lesson activity from submodule 1 on the topic Movement of Substances across the Plasma Membrane with its answer scheme.

APPENDIX A5



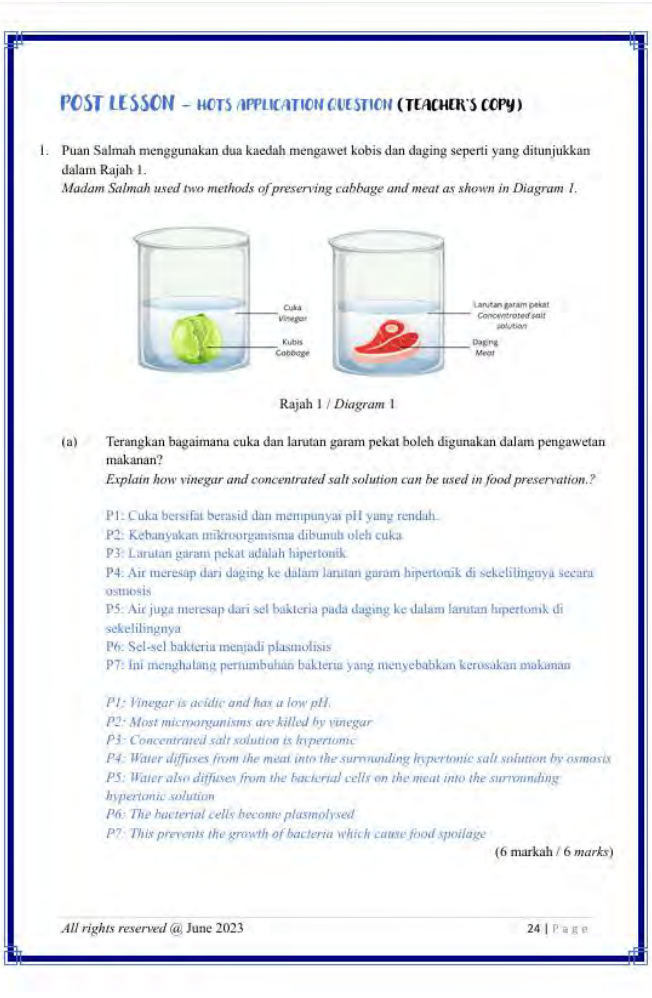
POST LESSON – HOTS APPLICATION QUESTION (STUDENT'S COPY)

1. Puan Salmah menggunakan dua kaedah mengawet kobis dan daging seperti yang ditunjukkan dalam Rajah 1.
Madam Salmah used two methods of preserving cabbage and meat as shown in Diagram 1.

Rajah 1 / *Diagram* 1

(a) Terangkan bagaimana cuka dan larutan garam pekat boleh digunakan dalam pengawetan makanan?
Explain how *vinegar and concentrated salt solution can be used in food preservation*

(6 markah / 6 *marks*)



POST LESSON – HOTS APPLICATION QUESTION (TEACHER'S COPY)

1. Puan Salmah menggunakan dua kaedah mengawet kobis dan daging seperti yang ditunjukkan dalam Rajah 1.
Madam Salmah used two methods of preserving cabbage and meat as shown in Diagram 1.

Rajah 1 / *Diagram* 1

(a) Terangkan bagaimana cuka dan larutan garam pekat boleh digunakan dalam pengawetan makanan?
Explain how vinegar and concentrated salt solution can be used in food preservation.?

P1: Cuka bersifat berasid dan mempunyai pH yang rendah.
P2: Kebanyakan mikroorganisma dibunuh oleh cuka
P3: Larutan garam pekat adalah hipertonik
P4: Air meresap dari daging ke dalam larutan garam hipertonik di sekelilingnya secara osmosis
P5: Air juga meresap dari sel bakteria pada daging ke dalam larutan hipertonik di sekelilingnya
P6: Sel-sel bakteria menjadi plasmolisis
P7: Ini menghalang pertumbuhan bakteria yang menyebabkan kerosakan makanan

P1: Vinegar is acidic and has a low pH.
P2: Most microorganisms are killed by vinegar
P3: Concentrated salt solution is hypertonic
P4: Water diffuses from the meat into the surrounding hypertonic salt solution by osmosis
P5: Water also diffuses from the bacterial cells on the meat into the surrounding hypertonic solution
P6: The bacterial cells become plasmolysed
P7: This prevents the growth of bacteria which cause food spoilage

(6 markah / 6 *marks*)

Post lesson question with sample answer from submodule 1.

APPENDIX B1

Item Analysis on Module's Format

Item	Statement		4-Point Likert Scale			
			1	**2**	**3**	**4**
A1	The MyBioProject teaching module size is suitable and easy to carry	f %	0 (0%)	0 (0%)	40 (66.7%)	20 (33.3%)
		$\bar{x}$	3.33			
		σ	0.475			
A2	The order of the submodules is appropriate.	f %	0 (0%)	0 (0%)	42 (70%)	18 (30%)
		$\bar{x}$	3.30			
		σ	0.462			
A3	The instructions in the MyBioProject teaching module are clear.	f %	0 (0%)	0 (0%)	34 (56.7%)	26 (43.3%)
		$\bar{x}$	3.43			
		σ	0.500			
A4	The attachments in the MyBioProject teaching module are easy to refer to.	f %	0 (0%)	0 (0%)	37 (61.7%)	23 (38.3%)
		$\bar{x}$	3.38			
		σ	0.490			
A5	The activities provided are appropriate.	f %	0 (0%)	0 (0%)	41 (68.3%)	19 (31.7%)
		$\bar{x}$	3.32			
		σ	0.469			
	Overall average	**%**	**0%**	**0%**	**64.68%**	**35.32%**
	Overall Mean, $\bar{x}$		**3.35**			
	Overall SD, σ		**0.479**			

1=Strongly Disagree 2=Disagree 3=Agree 4=Strongly Agree, f = frequency, % = percentage, $\bar{x}$ = mean value, σ = standard deviation

APPENDIX B2

Item Analysis on Module's Content

Item	Statement		4-Point Likert Scale			
			1	**2**	**3**	**4**
A6	The content in each submodule is aligned with the DSKP.	f %	0 (0%)	0 (0%)	29 (48.3%)	31 (51.7%)
		$\bar{x}$	3.52			
		σ	0.504			
A7	The project guidelines in the MyBioProject teaching module are aligned with the concept.	f %	0 (0%)	0 (0%)	42 (70%)	18 (30%)
		$\bar{x}$	3.30			
		σ	0.462			
A8	The objectives of the MyBioProject teaching module are clearly understood.	f %	0 (0%)	0 (0%)	45 (75%)	15 (25%)
		$\bar{x}$	3.25			
		σ	0.437			
A9	The activities provided are in line with the project-based learning approach.	f %	0 (0%)	0 (0%)	42 (70%)	18 (30%)
		$\bar{x}$	3.30			
		σ	0.462			
A10	The term used in the MyBioProject teaching module are easy to understand.	f %	0 (0%)	0 (0%)	39 (65%)	21 (35%)
		$\bar{x}$	3.35			
		σ	0.481			
	Overall average	**%**	**0%**	**0%**	**65.66%**	**34.34%**
	Overall Mean, $\bar{x}$		**3.34**			
	Overall SD, σ		**0.469**			

1=Strongly Disagree 2=Disagree 3=Agree 4=Strongly Agree, f = frequency, % = percentage, $\bar{x}$ = mean value, σ = standard deviation

APPENDIX B3

Item Analysis on Module's Achievement of Objectives

Item	Statement		4-Point Likert Scale			
			1	**2**	**3**	**4**
B1	Teaching activities help achieve the objectives set.	f %	0 (0%)	0 (0%)	42 (70%)	18 (30%)
		$\bar{x}$	3.30			
		σ	0.462			
B2	Teaching activities are in accordance with the level of form four students.	f %	0 (0%)	0 (0%)	40 (66.7%)	20 (33.3%)
		$\bar{x}$	3.33			
		σ	0.475			
B3	The exercises given can test students' understanding of lesson content.	f %	0 (0%)	0 (0%)	44 (73.3%)	16 (26.7%)
		$\bar{x}$	3.27			
		σ	0.446			
B4	The module's learning activities can help students apply higher-order thinking skills (HOTS)	f %	0 (0%)	0 (0%)	29 (48.3%)	31 (51.7%)
		$\bar{x}$	3.52			
		σ	0.504			
B5	Learning activities encourage students to work together with group members.	f %	0 (0%)	0 (0%)	34 (56.7%)	26 (43.3%)
		$\bar{x}$	3.43			
		σ	0.500			
	Overall average	**%**	**0%**	**0%**	**63%**	**37%**
	Overall Mean, $\bar{x}$		**3.37**			
	Overall SD, σ		**0.477**			

1=Strongly Disagree 2=Disagree 3=Agree 4=Strongly Agree, f = frequency, % = percentage, $\bar{x}$ = mean value, σ = standard deviation

APPENDIX B4

Item Analysis on Module's Feasibility of Teaching and Learning Process

Item	Statement		4-Point Likert Scale			
			1	**2**	**3**	**4**
B6	Suggested time for teaching each subtopic is appropriate.	f	0	0	45	15
		%	(0%)	(0%)	(75%)	(25%)
		$\bar{x}$	3.25			
		σ	0.437			
B7	The provided lesson plan with the complete learning cycle phase helps to teach the four topics using the project-based learning approach	f	0	0	41	19
		%	(0%)	(0%)	(68.3%)	(31.7%)
		$\bar{x}$	3.32			
		σ	0.469			
B8	Learning activities are structured and easy to follow.	f	0	0	42	18
		%	(0%)	(0%)	(70%)	(30%)
		$\bar{x}$	3.30			
		σ	0.462			
B9	The use of handouts in activities increase students' interest.	f	0	0	31	29
		%	(0%)	(0%)	(51.7%)	(48.3%)
		$\bar{x}$	3.48			
		σ	0.504			
B10	Suggested answers for activities can help the teacher.	f	0	0	27	33
		%	(0%)	(0%)	(45%)	(55%)
		$\bar{x}$	3.55			
		σ	0.502			
	Overall average	**%**	**0%**	**0%**	**62%**	**38%**
	Overall Mean, $\bar{x}$		**3.38**			
	Overall SD, σ		**0.475**			

1=Strongly Disagree 2=Disagree 3=Agree 4=Strongly Agree, f = frequency, % = percentage, $\bar{x}$ = mean value, σ = standard deviation

APPENDIX B5

Item Analysis on Module's Satisfaction Construct

Item	Statement		4-Point Likert Scale			
			1	**2**	**3**	**4**
C1	This module fulfils my need as a teacher to implement project-based learning in the class	f %	0 (0%)	0 (0%)	44 (73.3%)	16 (26.7%)
		$\bar{x}$	3.27			
		σ	0.446			
C2	I enjoy using this module.	f %	0 (0%)	0 (0%)	47 (78.3%)	13 (21.7%)
		$\bar{x}$	3.22			
		σ	0.415			
C3	This MyBioProject teaching module can save teaching preparation time for me.	f %	0 (0%)	1 (1.7%)	42 (70%)	17 (28.3%)
		$\bar{x}$	3.27			
		σ	0.482			
C4	This MyBioProject teaching module helps students learn biological concepts more effectively.	f %	0 (0%)	0 (0%)	40 (66.7%)	20 (33.3%)
		$\bar{x}$	3.33			
		σ	0.475			
C5	The activities carried out can attract students' interest learn the topics.	f %	0 (0%)	0 (0%)	38 (63.3%)	22 (36.7%)
		$\bar{x}$	3.37			
		σ	0.486			
C6	I wish there were modules like this for other topics.	f %	0 (0%)	0 (0%)	36 (60%)	24 (40%)
		$\bar{x}$	3.40			
		σ	0.494			
	Overall average	**%**	**0%**	**0.3%**	**68.6%**	**31.1%**
	Overall Mean, $\bar{x}$		**3.31**			
	Overall SD, σ		**0.466**			

1=Strongly Disagree 2=Disagree 3=Agree 4=Strongly Agree, f = frequency, % = percentage, $\bar{x}$ = mean value, σ = standard deviation

APPENDIX C

FAKULTI SAINS DAN MATEMATIK
UNIVERSITI PENDIDIKAN SULTAN IDRIS
Tanjong Malim, Perak

EXPERT VALIDATION FORM FOR A PROJECT-BASED TEACHING MODULE MYBIOPROJECT

Prof/Associate Prof/Dr/Sir/Madam,

I am a postgraduate student from the Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris. I am conducting a study on developing a Project-Based Learning (PjBL) module called 'MyBioProject' and identifying its usability among teachers. This form aims to gather information regarding the developed 'MyBioProject' teaching module in terms of validity to ensure that the design and content of the module that has been constructed are aligned with the objectives of the study.

Prof/Associate Prof/Dr/Sir/Madam is required to answer all statements as instructed. All information provided is CONFIDENTIAL and for academic purpose only. This evaluation form contains 16 questions and there are 3 sections of content, namely:

Sections	Contents
A	Demographic
B	Face Validation
C	Content Validation

Prepared by: Natasha Kaur a/p Mindar Singh
Masters of Education (Biology)

SECTION A: DEMOGRAPHIC

This section requires experts to provide demographic information.

Prof./ Associate Professor/Dr./Sir/Madam is requested to tick (√) in the space provided.

1.	Gender	:	Female	☐
			Male	☐
2.	Teaching Experience	:	1-5 years	☐
			6-10 years	☐
			More than 10 years	☐
3.	Field of Expertise	:	_____	
4.	Institution	:	_____	
	School/University etc.		_____	
			_____	
			_____	

Instruction: Please to tick (√) your choice in the space provided for Section B and C

1 = Strongly disagree

2 = Disagree

3 = Agree

4 = Strongly agree

SECTION B: FACE VALIDITY

No	Content	Scale				Comments
		1	2	3	4	
1.	The font size used in MyBioProject teaching module is suitable and clear. *Saiz huruf yang digunakan dalam modul pengajaran MyBioProject adalah sesuai dan jelas.*					
2.	The writing style used in the MyBioProject teaching module is easy to understand. *Gaya penulisan yang digunakan dalam modul pengajaran MyBioProject mudah difahami.*					
3.	There is no spelling error in words used. *Tiada kesalahan ejaan dalam perkataan yang digunakan.*					
4.	The vocabularies used in the MyBioProject teaching module are appropriate. *Perbendaharaan kata yang digunakan dalam modul pengajaran MyBioProject adalah sesuai.*					
5.	The colour used in MyBioProject teaching module is suitable and attractive. *Warna yang digunakan dalam modul pengajaran MyBioProject adalah sesuai dan menarik.*					

6.	The teaching and learning instructions in the module are clear. *Arahan pengajaran dan pembelajaran dalam modul adalah jelas.*					
7.	The structure of the MyBioProject teaching module in terms of construction and well-thought-out format. *Struktur modul pengajaran MyBioProject dari segi pembinaan dan format yang difikirkan dengan baik.*					

SECTION B: CONTENT VALIDITY

No	Content	Scale				Comments
		1	2	3	4	
1.	The content of this module is aligned with learning standards in the Standard Document for Curriculum and Assessment (DSKP) for Biology Form 4. *Kandungan modul ini diselaraskan dengan standard pembelajaran dalam Dokumen Standard Kurikulum dan Pentaksiran (DSKP) Biologi Tingkatan 4.*					
2.	The content of this module is suitable for implementation in teaching and learning biology. *Kandungan modul ini sesuai untuk dilaksanakan dalam pengajaran dan pembelajaran biologi.*					

3.	The content of this module is relevant to the time allocated. *Kandungan modul ini adalah relevan dengan masa yang diperuntukkan.*					
4.	Module content encourages students' creativity and innovation. *Kandungan modul menggalakkan kreativiti dan inovasi pelajar.*					
5.	The content of the module applies elements of a scientific attitude and noble values. *Kandungan modul menerapkan unsur sikap saintifik dan nilai murni.*					

Comments / Suggestions:
Komen / Cadangan:

_____

_____

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_____

It is confirmed that I have reviewed the MyBioProject teaching module and its usability for form four Biology teachers on the Face and Content Validation for the process of the researcher.

Thank you.

Validated by:

_____

Name:

Designation:

Date:

APPENDIX D

FAKULTI SAINS DAN MATEMATIK
UNIVERSITI PENDIDIKAN SULTAN IDRIS
Tanjong Malim, Perak

USABILITY QUESTIONNAIRE OF MYBIOPROJECT TEACHING MODULE

Dr/Sir/Madam,

I am a postgraduate student from the Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris. I am conducting a study on developing a Project-Based Learning (PjBL) module called MyBioProject and identifying its usability among teachers. This questionnaire is distributed to Biology teachers to identify their perception of the usability of the MyBioProject teaching module. The module is developed to guide Biology teachers to carry out project-based learning (PjBL) more effectively among form four students.

Dr/Sir/Madam is required to answer all statements as instructed. All information provided is CONFIDENTIAL and for academic purpose only. This evaluation form contains 32 questions and there are 3 sections of content, namely:

Sections	Contents
A	Demographic
B	Questionnaire questions
C	Opinion and Suggestions

Prepared by: Natasha Kaur a/p Mindar Singh
natashakaur1489@gmail.com
016-6119348
Masters of Education (Biology)

SECTION A: DEMOGRAPHIC

This section requires experts to provide demographic information.

Dr/Sir/Madam is requested to tick (√) in the space provided.

1.	Gender	:	Female	☐
			Male	☐
2.	Teaching Experience	:	1-5 years	☐
			6-10 years	☐
			More than 10 years	☐
3.	Institution (School)	:	_____	

Instruction: Please to tick (√) your choice in the space provided for Section B and C

1 = Strongly disagree

2 = Disagree

3 = Agree

4 = Strongly agree

SECTION B: QUESTIONNAIRE QUESTIONS

NO	ITEM	SCALE / *SKALA*				COMMENT / *KOMEN*
		1	**2**	**3**	**4**	
FORMAT						
4.	The MyBioProject teaching module size is suitable and easy to carry. *Saiz modul pengajaran MyBioProject adalah sesuai dan mudah dibawa.*					
5.	The order of the submodules is appropriate. *Susunan submodul adalah sesuai.*					
6.	The instructions in the MyBioProject teaching module are clear. *Arahan dalam modul pengajaran MyBioProject adalah jelas.*					
7.	The attachments in the MyBioProject teaching module are easy to refer to. *Lampiran dalam modul pengajaran MyBioProject mudah untuk dirujuk.*					
8.	The activities provided are appropriate. *Aktiviti yang disediakan adalah bersesuaian.*					
CONTENT / *KANDUNGAN*						
9.	The content in each submodule is aligned with the DSKP. *Kandungan dalam setiap submodul adalah sejajar dengan DSKP.*					
10.	The project guidelines in the MyBioProject teaching					

	module are aligned with the concept. *Garis panduan projek dalam modul pengajaran MyBioProject adalah sejajar dengan konsep.*					
11.	The objectives of the MyBioProject teaching module are clearly understood. *Objektif modul pengajaran MyBioProject difahami dengan jelas.*					
12.	The activities provided are in line with the project-based learning approach. *Aktiviti yang disediakan adalah selaras dengan pendekatan pembelajaran berasaskan projek.*					
13.	The term used in the MyBioProject teaching module are easy to understand. *Istilah yang digunakan dalam modul pengajaran MyBioProject mudah difahami.*					
ACHIEVEMENT OF OBJECTIVES ***PENCAPAIAN OBJEKTIF***						
14.	Teaching activities help achieve the objectives set. *Aktiviti pengajaran membantu mencapai objektif yang ditetapkan.*					
15.	Teaching activities are in accordance with the level of form four students. *Aktiviti pengajaran adalah bersesuaian dengan tahap pelajar tingkatan empat.*					

16.	The exercises given can test students' understanding of lesson content. *Latihan yang diberikan dapat menguji kefahaman murid terhadap isi pelajaran.*					
17.	The module's learning activities can help students apply higher-order thinking skills (HOTS). *Aktiviti pembelajaran modul boleh membantu pelajar mengaplikasikan kemahiran berfikir aras tinggi (KBAT).*					
18.	Learning activities encourage students to work together with group members. *Aktiviti pembelajaran menggalakkan pelajar bekerjasama dengan ahli kumpulan.*					
FEASIBILITY OF THE TEACHING AND LEARNING PROCESS ***KEBOLEHLAKSANAAN PROSES PENGAJARAN DAN PEMBELAJARAN***						
19.	Suggested time for teaching each subtopic is appropriate. *Masa yang dicadangkan untuk mengajar setiap subtopik adalah sesuai.*					
20.	The provided lesson plan with the complete learning cycle phase helps to teach the four topics using the project-based learning approach. *Rancangan pengajaran yang disediakan dengan fasa kitaran pembelajaran yang lengkap membantu untuk mengajar empat topik menggunakan pendekatan pembelajaran berasaskan projek.*					

21.	Learning activities are structured and easy to follow. *Aktiviti pembelajaran tersusun dan mudah diikuti.*					
22.	The use of handouts in activities increases students' interest. *Penggunaan bahan edaran dalam aktiviti meningkatkan minat pelajar.*					
23	Suggested answers for activities can help the teacher. *Cadangan jawapan untuk aktiviti boleh membantu guru.*					
SATISFACTION / *KEPUASAN*						
24.	This module fulfils my need as a teacher to implement project-based learning in the class. *Modul ini memenuhi keperluan saya sebagai seorang guru untuk melaksanakan pembelajaran berasaskan projek di dalam kelas.*					
25.	I enjoy using this module. *Saya seronok menggunakan modul ini.*					
26.	This MyBioProject teaching module can save teaching preparation time for me. *Modul pengajaran MyBioProject ini dapat menjimatkan masa persediaan mengajar untuk saya.*					
27.	This MyBioProject teaching module helps students learn biological concepts more effectively.					

	Modul pengajaran MyBioProject ini membantu pelajar mempelajari konsep biologi dengan lebih berkesan.					
28.	The activities carried out can attract students' interest learn the topics. *Aktiviti yang dijalankan dapat menarik minat pelajar untuk mempelajari topik tersebut.*					
29.	I wish there were modules like this for other topics. *Saya harap ada modul seperti ini untuk topik lain.*					

SECTION C: OPINIONS AND SUGGESTIONS

Give your suggestions and opinions in the question section below.
Berikan cadangan dan pendapat anda dalam bahagian soalan di bawah.

30. State the special features of this module.
Nyatakan keistimewaan modul ini.

31. State the weakness / challenges of using this module.
Nyatakan kelemahan / cabaran penggunaan modul ini.

32. Specify suggestions for the improvement this module.
Nyatakan cadangan penambahbaikan modul ini.

It is confirmed that I have reviewed the MyBioProject teaching module and its usability for form four Biology teachers for the process of the researcher.

Thank you.

Validated by:

_____

Name:

Designation:

Contact Number:

Date:

APPENDIX E

FAKULTI SAINS DAN MATEMATIK
UNIVERSITI PENDIDIKAN SULTAN IDRIS
Tanjong Malim, Perak

EXPERT VALIDATION FORM FOR USABILITY QUESTIONNAIRE

Prof/Associate Prof/Dr/Sir/Madam,

I am a postgraduate student from the Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris. I am conducting a study on developing a Project-Based Learning (PjBL) module called 'MyBioProject' and identifying its usability among teachers. This form aims to evaluate the reliability of the instrument (usability questionnaire) that will be employed in the study.

Prof/Associate Prof/Dr/Sir/Madam is required to answer all statements as instructed. All information provided is CONFIDENTIAL and for academic purpose only. This evaluation form contains 32 questions and there are 3 sections of content, namely:

Sections	Contents
A	Demographic
B	Questionnaire questions
C	Opinion and Suggestions

Prepared by: Natasha Kaur a/p Mindar Singh
natashakaur1489@gmail.com
016-6119348
Masters of Education (Biology)

NO	ITEM	SCALE / *SKALA*		COMMENTS / *KOMEN*
		Agree **Setuju**	**Disagree** **Tidak setuju**	
Section A: Demographic				
1	Gender			
2	Teaching Experience			
3	Institution (School/University etc.)			
Section B: Questionnaire Questions				
FORMAT				
4.	The MyBioProject teaching module size is suitable and easy to carry. *Saiz modul pengajaran MyBioProject adalah sesuai dan mudah dibawa.*			
5.	The order of the submodules is appropriate. *Susunan submodul adalah sesuai.*			
6.	The instructions in the MyBioProject teaching module are clear. *Arahan dalam modul pengajaran MyBioProject adalah jelas.*			
7.	The attachments in the MyBioProject teaching module are easy to refer to. *Lampiran dalam modul pengajaran MyBioProject mudah untuk dirujuk.*			
8.	The activities provided are appropriate. *Aktiviti yang disediakan adalah bersesuaian.*			
CONTENT / *KANDUNGAN*				

9.	The content in each submodule is aligned with the DSKP. *Kandungan dalam setiap submodul adalah sejajar dengan DSKP.*			
10.	The project guidelines in the MyBioProject teaching module are aligned with the concept. *Garis panduan projek dalam modul pengajaran MyBioProject adalah sejajar dengan konsep.*			
11.	The objectives of the MyBioProject teaching module are clearly understood. *Objektif modul pengajaran MyBioProject difahami dengan jelas.*			
12.	The activities provided are in line with the project-based learning approach. *Aktiviti yang disediakan adalah selaras dengan pendekatan pembelajaran berasaskan projek.*			
13.	The term used in the MyBioProject teaching module are easy to understand. *Istilah yang digunakan dalam modul pengajaran MyBioProject mudah difahami.*			
ACHIEVEMENT OF OBJECTIVES ***PENCAPAIAN OBJEKTIF***				
14.	Teaching activities help achieve the objectives set. *Aktiviti pengajaran membantu mencapai objektif yang ditetapkan.*			

15.	Teaching activities are in accordance with the level of form four students. *Aktiviti pengajaran adalah bersesuaian dengan tahap pelajar tingkatan empat.*			
16.	The exercises given can test students' understanding of lesson content. *Latihan yang diberikan dapat menguji kefahaman murid terhadap isi pelajaran.*			
17.	The module's learning activities can help students apply higher-order thinking skills (HOTS). *Aktiviti pembelajaran modul boleh membantu pelajar mengaplikasikan kemahiran berfikir aras tinggi (KBAT).*			
18.	Learning activities encourage students to work together with group members. *Aktiviti pembelajaran menggalakkan pelajar bekerjasama dengan ahli kumpulan.*			
FEASIBILITY OF THE TEACHING AND LEARNING PROCESS ***KEBOLEHLAKSANAAN PROSES PENGAJARAN DAN PEMBELAJARAN***				
19.	Suggested time for teaching each subtopic is appropriate. *Masa yang dicadangkan untuk mengajar setiap subtopik adalah sesuai.*			
20.	The provided lesson plan with the complete learning cycle phase helps to teach the four topics using the project-based learning approach. *Rancangan pengajaran yang disediakan dengan fasa kitaran pembelajaran yang lengkap membantu untuk mengajar empat topik*			

	menggunakan pendekatan pembelajaran berasaskan projek.			
21.	Learning activities are structured and easy to follow. *Aktiviti pembelajaran tersusun dan mudah diikuti.*			
22.	The use of handouts in activities increases students' interest. *Penggunaan bahan edaran dalam aktiviti meningkatkan minat pelajar.*			
23	Suggested answers for activities can help the teacher. *Cadangan jawapan untuk aktiviti boleh membantu guru.*			
SATISFACTION / *KEPUASAN*				
24.	This module fulfils my need as a teacher to implement project-based learning in the class. *Modul ini memenuhi keperluan saya sebagai seorang guru untuk melaksanakan pembelajaran berasaskan projek di dalam kelas.*			
25.	I enjoy using this module. *Saya seronok menggunakan modul ini.*			
26.	This MyBioProject teaching module can save teaching preparation time for me. *Modul pengajaran MyBioProject ini dapat menjimatkan masa persediaan mengajar untuk saya.*			
27.	This MyBioProject teaching module helps students learn			

	biological concepts more effectively. *Modul pengajaran MyBioProject ini membantu pelajar mempelajari konsep biologi dengan lebih berkesan.*			
28.	The activities carried out can attract students' interest learn the topics. *Aktiviti yang dijalankan dapat menarik minat pelajar untuk mempelajari topik tersebut.*			
29.	I wish there were modules like this for other topics. *Saya harap ada modul seperti ini untuk topik lain.*			
Section C: Opinions and Suggestions				
1.	State the special features of this module. *Nyatakan keistimewaan modul ini*.			
2.	State the weakness of this module. *Nyatakan kelemahan modul ini.*			
3.	Specify suggestions for the improvement this module. *Nyatakan cadangan penambahbaikan modul ini.*			

Comments / Suggestions:
Komen / Cadangan:

_____

_____

_____

_____

_____

It is confirmed that I have reviewed the research instrument on the usability for form four Biology teachers of the MyBioProject teaching module for the process of the researcher.

Thank you.

Validated by:

_____

Name:
Designation:
Date:

APPENDIX F

SOAL SELIDIK ANALISIS KEPERLUAN PEMBANGUNAN MODUL PEMBELAJARAN BERASASKAN PROJEK

Selamat sejahtera,

Saudara/saudari,
Kajian ini bertujuan untuk mendapatkan maklum balas mengenai keperluan Pembinaan Modul Pembelajaran Berasaskan Projek (Dwibahasa) dalam Sukatan Pelajaran Biologi Tingkatan Empat. Maklum balas anda akan membantu saya dalam membuat perancangan untuk membina modul yang berkesan dalam Pembelajaran Biologi KSSM.

Sila berikan maklum balas dengan jujur dan ikhlas.
Semua maklumat yang anda berikan adalah sulit dan akan digunakan untuk kajian ini sahaja. Laporan kajian tidak akan menunjukkan identiti mana-mana individu.
Kerjasama saudara/saudari dalam menjayakan kajian ini amatlah dihargai dan ribuan terima kasih saya ucapkan.

Soal selidik ini mengandungi empat bahagian:

(1) Bahagian A
Demografi sekolah dan guru

(2) Bahagian B
Topik pilihan untuk Pembelajaran Berasaskan Projek

(3) Bahagian C
Keperluan Membangunkan

Modul Pembelajaran Berasaskan Projek

Disediakan oleh :

Natasha Kaur a/p Mindar Singh
Fakulti Sains dan Matematik
Universiti Pendidikan Sultan Idris
natashakaur1489@gmail.com

* Indicates required question

1. Email *

Bahagian A

Demografi

2. Nama *

3. Jantina *

Mark only one oval.

- Lelaki
- Perempuan

4. Lokasi Sekolah

Mark only one oval.

- Bandar
- Luar Bandar
- Pedalaman

5. Jawatan *

- Pengetua
- Penolong Kanan
- GKMP
- Ketua Panitia
- Guru Cemerlang
- Guru Akademik

6. Kelulusan Akademik Tertinggi *

Mark only one oval.

- SPM
- STPM
- Diploma
- Ijazah Sarjana Muda
- Sarjana
- Doktor Falsafah

7. Pengkhususan Akademik *

- Kimia
- Fizik
- Biologi
- Sains
- Matematik
- Lain-lain

8. Pengalaman mengajar Biologi *

Mark only one oval.

- Kurang daripada 1 tahun
- 1 - 3 tahun
- 4 - 6 tahun
- 7 - 9 tahun
- 10 tahun ke atas

Bahagian B

Sila berikan pendapat tuan/puan tentang bidang pembelajaran dalam Sukatan Pelajaran Biologi KSSM Tingkatan Empat yang perlu disertakan di dalam modul

Pembelajaran Berasaskan Projek

9. Topik-topik pilihan dalam Modul Pembelajaran Berasaskan Projek Tingkatan 4 (Boleh pilih lebih dari satu) *

- Pengenalan kepada Biologi dan Peraturan
- Biologi Sel dan Organisasi Sel
- Pergerakan Bahan Merentasi Membran Plasma
- Komposisi Kimia dalam Sel
- Metabolisme dan Enzim
- Pembahagian Sel
- Respirasi Sel
- Sistem Respirasi dalam Manusia dan Haiwan
- Nutrisi dan Sistem Pencernaan Manusia
- Pengangkutan dalam Manusia dan Haiwan
- Keimunan Manusia
- Koordinasi dan Gerak Balas dalam Manusia
- Homeostasis dan Sistem Urinari Manusia
- Sokongan dan Pergerakan dalam Manusia dan Haiwan
- Pembiakan Seks, Perkembangan dan Pertumbuhan

10. Berdasarkan topik-topik yang dipilih di atas, yang manakah adalah topik yang **paling sukar** dalam silibus KSSM Biologi Tingkatan 4? (Satu pilihan sahaja) *

Mark only one oval.

- Pengenalan kepada Biologi dan Peraturan
- Biologi Sel dan Organisasi Sel
- Pergerakan Bahan Merentasi Membran Plasma
- Komposisi Kimia dalam Sel
- Metabolisme dan Enzim
- Pembahagian Sel
- Respirasi Sel
- Sistem Respirasi dalam Manusia dan Haiwan
- Nutrisi dan Sistem Pencernaan Manusia
- Pengangkutan dalam Manusia dan Haiwan
- Keimunan Manusia
- Koordinasi dan Gerak Balas dalam Manusia
- Homeostasis dan Sistem Urinari Manusia
- Sokongan dan Pergerakan dalam Manusia dan Haiwan
- Pembiakan Seks, Perkembangan dan Pertumbuhan

11. Berdasarkan soalan di atas, mengapakah sub-topik ini dikenal pasti sebagai paling sukar? * (Nota: Jika pilihan anda adalah pilihan lain untuk soalan ini, sila nyatakan sebabnya)

- Pelajar sukar memahami konsep
- Pelajar tidak dapat menghafal fakta
- Pelajar tidak dapat membayangkan konsep
- Pelajar tidak dapat menjawab soalan-soalan KBAT
- Lain-lain - Sila nyatakan di bawah
- Other: _____

Bahagian C : Kepentingan Membangunkan Modul Project Based Learning

12. Saya sangat memerlukan Modul Pembelajaran Berasaskan Projek bagi meningkatkan kompetensi kemahiran pengajaran dan pembelajaran berasaskan projek *

1 2 3 4 5

San ○ ○ ○ ○ ○ Sangat Setuju

13. Saya dapat menerapkan pelbagai kemahiran dengan menggunakan Modul Pembelajaran Berasaskan Projek *

1 2 3 4 5

San ○ ○ ○ ○ ○ Sangat Setuju

14. Modul Pembelajaran Berasaskan Projek boleh membantu saya melaksanakan pengajaran dan pembelajaran dengan lebih berkesan *

1 2 3 4 5

San ○ ○ ○ ○ ○ Sangat Setuju

15. Saya suka menggunakan Modul Pembelajaran Berasaskan Projek jika dibekalkan. *

1 2 3 4 5

San ○ ○ ○ ○ ○ Sangat Setuju

16. Saya jarang menggunakan Pembelajaran Berasaskan Projek di dalam proses pengajaran dan pembelajaran saya *

1 2 3 4 5

San ○ ○ ○ ○ ○ Sangat Setuju

17. Saya yakin panduan di dalam Modul Pembelajaran Berasaskan Projek dapat membantu saya memberi pengalaman menyeronokkan kepada pelajar. *

1 2 3 4 5

San ○ ○ ○ ○ ○ Sangat Setuju

18. Saya berhasrat untuk menggunakan Modul Pembelajaran Berasaskan Projek untuk pengajaran dan * pembelajaran Biologi

1 2 3 4 5

San Sangat Setuju

19. Saya bercita-cita untuk memperkenalkan Modul Pembelajaran Berasaskan Projek kepada rakan- * rakan lain

1 2 3 4 5

San Sangat Setuju

20. Saya berpendapat pembangunan Modul Pembelajaran Berasaskan Projek adalah penting. *

1 2 3 4 5

San Sangat Setuju

21. Saya yakin Modul Pembelajaran Berasaskan Projek mampu menarik minat pelajar khususnya Biologi *

1 2 3 4 5

San Sangat Setuju

Terima kasih atas kerjasama anda

APPENDIX G

KEMENTERIAN PENDIDIKAN MALAYSIA
BAHAGIAN PERANCANGAN DAN PENYELIDIKAN DASAR PENDIDIKAN
ARAS 1-4, BLOK E8
KOMPLEKS KERAJAAN PARCEL E
PUSAT PENTADBIRAN KERAJAAN PERSEKUTUAN
62604 PUTRAJAYA

TEL : 0388846581
FAKS : 0388846579

Ruj. Kami : KPM.600-3/2/3-eras(16682)
Tarikh : 15 Jun 2023

NATASHA KAUR A/P MINDAR SINGH
NO. KP : 891224086248

NO.62, JALAN 2/7, TAMAN SERI MAWAR 2, KAMPUNG CINA
32000 SITIAWAN
PERAK

Tuan,

KELULUSAN BERSYARAT UNTUK MENJALANKAN KAJIAN :
THE DEVELOPMENT OF ' MYBIOPROJECT' TEACHING MODULE FOR SELECTED TOPICS IN FORM FOUR BIOLOGY

Perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan bahawa permohonan tuan untuk menjalankan kajian seperti di bawah telah diluluskan dengan syarat :

" KELULUSAN DAN PENGUTIPAN DATA TERMASUK SECARA DALAM TALIAN (CONTOH: GOOGLE FORM) PERLU MENDAPATKAN KEBENARAN PENGARAH JPN DAN PERTIMBANGAN PENTADBIR SEKOLAH. "

3. Kelulusan adalah berdasarkan kepada kertas cadangan penyelidikan dan instrumen kajian yang dikemukakan oleh tuan kepada bahagian ini. Walau bagaimanapun kelulusan ini bergantung kepada kebenaran Jabatan Pendidikan Negeri dan Pengetua / Guru Besar yang berkenaan.

4. Surat kelulusan ini sah digunakan bermula dari **14 Jun 2023** hingga **3 Disember 2023**

5. Tuan dikehendaki menyerahkan senaskhah laporan akhir kajian dalam bentuk *hardcopy* bersama salinan *softcopy* berformat pdf dalam CD kepada Bahagian ini.Tuan juga diingatkan supaya mendapat kebenaran terlebih dahulu daripada Bahagian ini sekiranya sebahagian atau sepenuhnya dapatan kajian tersebut hendak diterbitkan di mana-mana forum, seminar atau diumumkan kepada media massa.

Sekian untuk makluman dan tindakan tuan selanjutnya. Terima kasih

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Ketua Penolong Pengarah Kanan
Sektor Penyelidikan dan Penilaian Dasar
b.p. Pengarah
Bahagian Perancangan dan Penyelidikan Dasar Pendidikan
Kementerian Pendidikan Malaysia

salinan kepada:-

JABATAN PENDIDIKAN PERAK

" SURAT INI DIJANA OLEH KOMPUTER DAN TIADA TANDATANGAN DIPERLUKAN "

APPENDIX H

KEMENTERIAN PENDIDIKAN MALAYSIA
Jabatan Pendidikan Negeri Perak
Jalan Tun Abdul Razak
30640 Ipoh, Perak Darul Ridzuan

Tel : 605 501 5000
Faks : 605 527 7273
Laman Web : http://jpnperak.moe.gov.my

"PENDIDIKAN BERKUALITI, SEKOLAH UNGGUL, MURID HOLISTIK"

Ruj. Kami : JPNPk.SPS.USJK.600-1/Jld.10(16)
Tarikh : 20 Jun 2023

Natasha Kaur a/p Mindar Singh
No.62, Jalan 2/7
Taman Seri Mawar 2, Kampung Cina
32000 Sitiawan, Perak

Tuan,

KELULUSAN UNTUK MENJALANKAN KAJIAN DI SEKOLAH-SEKOLAH NEGERI PERAK DI BAWAH JABATAN PENDIDIKAN NEGERI PERAK

Dengan segala hormatnya, perkara di atas adalah dirujuk dan surat tuan yang diterima pada 20 Jun 2023 adalah berkaitan.

2. Sehubungan dengan itu, dimaklumkan bahawa Jabatan Pendidikan Negeri Perak tiada halangan untuk membenarkan pihak tuan menjalankan kajian yang bertajuk **"*THE DEVELOPMENT OF 'MYBIOPROJECT' TEACHING MODULE FOR SELECTED TOPICS IN FORM FOUR BIOLOGY*"** seperti dinyatakan dalam surat tuan dengan syarat-syarat berikut:

2.1 Pihak tuan perlu mendapatkan kebenaran terlebih dahulu daripada Pegawai Pendidikan Daerah dan Pengetua / Guru Besar sekolah berkenaan untuk menggunakan sampel kajian;

2.2 Kajian yang dijalankan hendaklah tidak mengganggu proses pengajaran dan pembelajaran yang telah ditetapkan oleh pihak sekolah;

2.3 Pihak tuan bertanggungjawab menjaga keselamatan dan kebajikan murid dan guru yang terlibat dalam kajian ini;

2.4 Murid, guru dan warga sekolah tidak boleh dipaksa terlibat dalam kajian ini;

2.5 Pihak tuan hendaklah bertanggungjawab menanggung semua kos kajian;

2.6 Pihak tuan dipohon agar menghantar satu (1) salinan laporan kajian dalam tempoh 30 hari ke jabatan ini selepas kajian tersebut dilaksanakan;

2.7 Tiada sebarang implikasi kewangan kepada Jabatan Pendidikan Negeri Perak, Pejabat Pendidikan Daerah dan pihak sekolah;

../2-

KELULUSAN UNTUK MENJALANKAN KAJIAN DI SEKOLAH-SEKOLAH NEGERI PERAK DI BAWAH JABATAN PENDIDIKAN NEGERI PERAK

Ruj. Kami : JPNPk.SPS.USJK.600-1 Jld.10(16) Tarikh: 20 Jun 2023

3. Sukacita juga diingatkan, sekiranya sebahagian atau sepenuhnya dapatan kajian tersebut hendak dibentangkan di mana-mana forum atau seminar atau diumumkan kepada media massa, pihak tuan perlu mendapatkan kebenaran terlebih dahulu daripada Bahagian Perancangan dan Penyelidikan Dasar Pendidikan, Kementerian Pendidikan Malaysia dan satu (1) salinan kepada Jabatan Pendidikan Negeri Perak.

4. Kebenaran ini adalah untuk tujuan yang dipohon dan melibatkan sekolah dalam daerah yang dinyatakan sahaja dan luput **selepas tarikh 3 DISEMBER 2023.**

Sekian, terima kasih.

"MALAYSIA MADANI"

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

(SABARINA BINTI JAMALUDDIN)
Timbalan Pengarah Pendidikan
Sektor Pengurusan Sekolah
b.p Pengarah Pendidikan Negeri Perak

s.k 1. Pengarah Pendidikan Negeri Perak
2. Pegawai Pendidikan Daerah Negeri Perak

"PERAK SEJAHTERA 2030"