THE DEVELOPMENT OF A TEACHER TRAINING MODULE FOR GAME-BASED LEARNING APPRAOCH IN TEACHING NEWTON'S LAWS OF MOTION

LOW JIE YING

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

THESIS PRESENTED TO QUALIFY FOR A DOCTOR OF PHILOSOPHY

FACULTY OF SCIENCE AND MATHEMATICS
SULTAN IDRIS EDUCATION UNIVERSITY

2024

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

UPSI/IPS-3/BO 32
Pind : 00 m/s: 1/1

UNIVERSITI PENDIDIKAN SULTAN IDRIS

Please tick (√)
Project Paper
Masters by Research
Master by Mixed Mode
PhD

√

INSTITUTE OF GRADUATE STUDIES

DECLARATION OF ORIGINAL WORK

This declaration is made on the 12 day of 9 20 24

i. Student's Declaration:

I, LOW JIE YING, P20201000638, FACULTY OF SCIENCE AND MATHEMATICS (PLEASE INDICATE STUDENT'S NAME, MATRIC NO. AND FACULTY) hereby declare that the work entitled THE DEVELOPMENT OF A TEACHER TRAINING MODULE FOR GAME-BASED LEARNING APPROACH IN TEACHING NEWTON'S LAWS OF MOTION is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

Signature of the student

ii. Supervisor's Declaration:

I ASSOC PROF DR. BALAMURALITHARA A/L BALAKRISHNAN (SUPERVISOR'S NAME) hereby certifies that the work entitled THE DEVELOPMENT OF A TEACHER TRAINING MODULE FOR GAME-BASED LEARNING APPROACH IN TEACHING NEWTON'S LAWS OF MOTION (TITLE) was prepared by the above named student, and was submitted to the Institute of Graduate Studies as a ~~*partial~~/full fulfillment for the conferment of DOCTOR OF PHILOSOPHY (PHYSICS EDUCATION) (PLEASE INDICATE THE DEGREE), and the aforementioned work, to the best of my knowledge, is the said student's work.

13.09.2024
Date

Signature of the Supervisor
DR. B. BALAMURALI THARA
UNIVERSITI PENDIDIKAN SULTAN IDRIS
35900, Tanjung Malim, Perak.

UPSI/IPS-3/BO 31
Pind.: 01 m/s:1/1

UNIVERSITI PENDIDIKAN SULTAN IDRIS

INSTITUT PENGAJIAN SISWAZAH /
INSTITUTE OF GRADUATE STUDIES

BORANG PENGESAHAN PENYERAHAN TESIS/DISERTASI/LAPORAN KERTAS PROJEK
DECLARATION OF THESIS/DISSERTATION/PROJECT PAPER FORM

Tajuk / *Title*: THE DEVELOPMENT OF A TEACHER TRAINING MODULE FOR GAME-BASED LEARNING APPROACH IN TEACHING NEWTON'S LAWS OF MOTION.

No. Matrik /*Matric's No.*: P20201000638

Saya / *I* : LOW JIE YING

(Nama pelajar / *Student's Name*)

mengaku membenarkan Tesis/Disertasi/Laporan Kertas Projek (Kedoktoran/Sarjana)* ini disimpan di Universiti Pendidikan Sultan Idris (Perpustakaan Tuanku Bainun) dengan syarat-syarat kegunaan seperti berikut:-
acknowledged that Universiti Pendidikan Sultan Idris (Tuanku Bainun Library) reserves the right as follows:-

1. Tesis/Disertasi/Laporan Kertas Projek ini adalah hak milik UPSI.
   The thesis is the property of Universiti Pendidikan Sultan Idris
2. Perpustakaan Tuanku Bainun dibenarkan membuat salinan untuk tujuan rujukan dan penyelidikan.
   Tuanku Bainun Library has the right to make copies for the purpose of reference and research.
3. Perpustakaan dibenarkan membuat salinan Tesis/Disertasi ini sebagai bahan pertukaran antara Institusi Pengajian Tinggi.
   The Library has the right to make copies of the thesis for academic exchange.
4. Sila tandakan (√) bagi pilihan kategori di bawah / *Please tick (√) for category below:-*

☐ **SULIT/*CONFIDENTIAL*** — Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub dalam Akta Rahsia Rasmi 1972. / *Contains confidential information under the Official Secret Act 1972*

☒ **TERHAD/*RESTRICTED*** — Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan ini dijalankan. / *Contains restricted information as specified by the organization where research was done.*

☐ **TIDAK TERHAD / *OPEN ACCESS***

(Tandatangan Pelajar/ Signature)

Tarikh: 11.11.2024

(Tandatangan Penyelia / *Signature of Supervisor*)
& (Nama & Cop Rasmi / *Name & Official Stamp*)
DR. B. BALAMURALI THARA
UNIVERSITI PENDIDIKAN SULTAN IDRIS
35900, Tanjung Malim, Perak.

Catatan: Jika Tesis/Disertasi ini **SULIT @ TERHAD**, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan ini perlu dikelaskan sebagai **SULIT** dan **TERHAD**.

Notes: If the thesis is CONFIDENTAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my respected supervisor, Associate Professor Dr. Balamuralithara A/L Balakrishnan, and co-supervisor, Dr. Mohd Ikhwan Hadi Yaacob, for the successful development of the teacher's training module on implementing a game-based learning approach in teaching Newton's laws of motion. This transformative experience would not have been possible without your unwavering support and guidance throughout the entire process.

Thank you to my parents and my youngest brother for their unwavering encouragement and support. Your constant motivation has been a driving force behind my commitment in enhancing the learning experience for students. Besides, I would also like to extend my sincere appreciation to my husband for being my pillar of strength and constant support during this journey.

Furthermore, I want to thank the Ministry of Education for providing the scholarship that allows me to pursue my PhD study. Last but not least, a sincere thank you to the state-level education officers for their instrumental role in organising and conducting the training workshops. Your support ensured that the program ran smoothly and effectively, leaving a lasting impact on the participating teachers and, ultimately, the education system.

A special note of gratitude goes out to the enthusiastic participants who willingly embraced the challenges of adopting a game-based learning approach. Your dedication, passion, and eagerness to learn have made this training module a dynamic and enriching experience for everyone involved.

In conclusion, the success of this training module is a testament to the collective effort, dedication, and collaboration of everyone involved. Together, we have taken a significant step towards creating a more engaging and effective learning environment for our students.

ABSTRACT

This study aimed to develop a teacher training module for game-based learning (GBL) approach in teaching Newton's laws of motion and to determine its usability and effects on teachers' perceptions of their game literacy capabilities. This study employed the Design and Developmental (DDR) research design. The module was developed using the ADDIE model. A need analysis was conducted using questionnaires involving 338 Physics teachers selected through a stratified sampling method. Descriptive statistics were used in the first phase. The nominal group technique (NGT) and fuzzy Delphi method (FDM) were used in the second phase to identify the main components of the module, obtained through the consensus of nine experts in NGT, with a percentage of agreement of more than 70%. The data collected through FDM involved another 15 experts. The suitability of the items in the module was assessed based on the threshold d value ≤ 0.2 and percentage of agreement $\geq 75\%$. Furthermore, a group of seven experts validated the content of the module. In the evaluation phase, a single-group pre-test and post-test design and a semi-structured interview were employed to evaluate the module's usability and effects on teachers' perceived game literacy. The data was analysed using descriptive statistics, Wilcoxon Signed-Rank Test and thematic analysis. The findings show that the module has high content validity. It positively impacts teachers' perceived game literacy capabilities, and it has a high level of usability (mean = 4.30, SD = 0.61). In conclusion, the module proves to be effective and user-friendly. Teachers' perceived game literacy capabilities improved after the intervention. This study implies that the module could encourage teachers to create educational games and adopt GBL in teaching Newton's laws of motion. Hence, teachers could offer a more engaging learning environment to the students, potentially enhancing students learning in Newton's laws of motion

PEMBANGUNAN MODUL LATIHAN GURU UNTUK PENDEKATAN PEMBELAJARAN BERASASKAN PERMAINAN DALAM PENGAJARAN HUKUM GERAKAN NEWTON

ABSTRAK

Kajian ini bertujuan untuk membangunkan modul latihan guru untuk mengintegrasikan pendekatan pembelajaran berasaskan permainan (GBL) dalam pengajaran Hukum Gerakan Newton dan menentukan kebolehgunaan modul serta kesannya terhadap persepsi guru atas keupayaan literasi permainan mereka. Kajian ini menggunakan reka bentuk penyelidikan Reka Bentuk dan Pembangunan (DDR). Modul ini dibangunkan dengan menggunakan model ADDIE. Analisis keperluan dilakukan dengan menggunakan soal selidik melibatkan 338 guru Fizik yang terpilih melalui kaedah persampelan berstrata. Statistik deskriptif digunakan dalam fasa pertama. Teknik kumpulan nominal (NGT) dan kaedah Delphi kabur (FDM) digunakan dalam fasa kedua untuk mengenal pasti komponen utama modul, diperolehi melalui persetujuan sembilan pakar dalam NGT, dengan peratusan persetujuan melebihi 70%. Data yang dikumpul melalui FDM melibatkan 15 pakar yang lain. Kesesuaian item dalam modul dinilai berdasarkan nilai ambang $d \leq 0.2$ dan peratusan persetujuan $\geq 75\%$. Selain itu, sekumpulan pakar seramai tujuh orang telah mengesahkan kandungan modul tersebut. Dalam fasa penilaian, reka bentuk ujian praujian dan pascaujian kumpulan tunggal dan temu bual separa berstruktur digunakan untuk menilai kebolehgunaan modul dan kesannya terhadap keupayaan literasi permainan tanggapan guru. Data dianalisis dengan menggunakan statistik deskriptif, ujian-pangkat Wilcoxon dan analisis tematik. Dapatan kajian menunjukkan bahawa modul mempunyai kandungan kebolehpercayaan yang tinggi. Ia memberi impak positif terhadap persepsi guru atas keupayaan literasi permainan, dan ia mempunyai tahap kebolehgunaan yang tinggi (min = 4.30, SD = 0.61). Kesimpulannya, modul ini terbukti berkesan dan mesra pengguna. Keupayaan literasi permainan dalam tanggapan guru meningkat selepas intervensi. Kajian ini memberi implikasi bahawa modul ini dapat menggalakkan guru untuk mencipta permainan pendidikan dan mengamalkan GBL dalam pengajaran Hukum Gerakan Newton. Oleh sebab itu, guru dapat menawarkan persekitaran pembelajaran yang lebih menarik kepada pelajar, yang berpotensi meningkatkan pembelajaran pelajar mengenai Hukum Gerakan Newton.

CONTENTS

CHAPTER 6 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

4-D Framework	Four-Dimensional Framework
ADDIE	Analysis, Design, Development, Implementation and Evaluation Model
A	Assessment
ASSURE	Analyse, State, Select, Utilise, Require, Evaluate
AT	Attitude
BI	Behavioural Intention
C	Context Evaluation
CIPP	Context, Input, Process and Product Model
COTS	Commercial-Off-The-Shelf
COVID-19	Coronavirus disease 2019
CVI	Content Validity Index
d	Threshold value
DDE	Design, Dynamics and Experience
DDR	Design and Development Research
DG	Digital Game
DPE	Design, Play and Experience
E	Equipment
EV	Evaluation of GBL
FDM	Fuzzy Delphi Method
GBL	Game-Based Learning

GD	Game Design
GE	Game Elements
GL	Game Literacy
GLTP	Game Literacy in Teaching Practice
IN	Input Evaluation
I-CVI	Individual Item Content Validity Index
ID	Instructional Design
LP	Learning Parameters
MDA	Mechanics, Dynamics, Aesthetic
NDG	Non-Digital Game
NGT	Nominal Group Technique
O	Objectives
OM	Organisation and Management of GBL
P	Process Evaluation
PE	Perceive Ease of Use
PU	Perceived Usefulness
S-CVI	Overall Scale Content Validity Index
SGPP	Single-Group Pre-Test and Post-Test
TAM	Technology Acceptance Model

APPENDIX LIST

CHAPTER 1

INTRODUCTION

1.1 Introduction

Physics is widely recognised as the foundational science because it investigates the natural phenomena occurring in our surrounding environment (Badruldin & Alias, 2022). However, Physics garners less student interest than other natural sciences, such as Chemistry and Biology (Chala, Kedir & Wami, 2020) because students commented that Physics demands solid mathematical abilities, presents challenging problem-solving tasks, and involves many formulas and laws to memorise (Ibrahim et al., 2019).

According to Halim, M. Meerah and Haron (2002), the topic of Forces and Motion in the upper secondary Physics syllabus in Malaysia is challenging as there are many subtopics (Curriculum Development Centre, 2018). At the same time,

Aykutlu, Bezen, and Bayrak (2015) highlighted that many teachers consider the topic of Forces and Motion within classical mechanics to be the most challenging because students struggle with comprehending formulas, interpreting definitions (Atasoy & Ergin, 2017; Tomara, Tselfes & Gouscos, 2017), and solving related problems (Supeno, Subiki & Rohma, 2018). As a result, students often fail to attain the desired learning outcomes.

Numerous upper secondary school students in Malaysia encounter challenges when trying to understand and master the concepts of Force and Motion (Alias & Ibrahim, 2015; Badruldin & Alias, 2022; Ibrahim et al., 2019; Ismail & Ayop, 2016; Mohd Yusof, Dalim, & Ibrahim., 2013). Alias and Ibrahim (2017) and Badruldin and Alias (2022) discovered that Malaysian students could not apply abstract concepts of Force and Motion. They encounter challenges in understanding and learning these concepts. In this study, the concepts of Force and Motion that are being focused on are Newton's laws of motion (NLM).

Game-based learning (GBL) offers a potential solution to these challenges. GBL is an instructional approach where games or game mechanics are integrated into an educational context, providing students with immersive learning experiences where they acquire knowledge and skills (Pan et al., 2021). By applying GBL approaches, teachers aim to leverage the usage of games or gamification strategies to foster active participation, knowledge acquisition, and skill development among their students within the classroom context. The games used in the GBL settings are educational games that are specifically designed to facilitate learning (Ahmad, Rahim & Arshad, 2015). The educational games encompass both physical and digital

formats. According to Pan et al. (2021), educational games can be traditional games, educational software, teaching aids, and toys that combine learning and entertaining elements.

The implementation of GBL in teaching Physics has been shown to improve student learning, according to several studies. For instance, Alias and Ibrahim (2017) developed "The World of Newton," a module that enhanced students' understanding of Newton's laws of motion through game activities based on real-life scenarios. Similarly, "Physics Playground" facilitated student learning and allowed teachers to evaluate students' comprehension via game activities (Shute, Rahimi & Smith 2019). Additionally, Thunyaniti and Wuttiprom (2019) found that card games could effectively enhance students' understanding of the concepts of motions. Learning Physics through the enjoyable GBL approach improved students' attitudes towards the subject.

Past studies demonstrated that GBL is an effective teaching approach that makes learning enjoyable, encourages active participation and fosters student learning for Physics (Alias & Ibrahim, 2017; Akbar et al., 2018; Cardinot & Fairfield, 2019; Dewantara et al. 2020; Setyaningrum, Pratama & Ali, 2018; Shute et al., 2019; Thunyaniti & Wuttiprom 2019). These studies generally reach a similar conclusion: GBL can lead to various educational benefits and can sometimes be more effective than non-game-based approaches in comparable situations.

Research indicated that teachers' involvement and guidance in a game-based classroom can create significant learning opportunities for students (Foster & Shah, 2020). However, the process of teaching using the GBL approach is demanding, requiring expertise that may not come naturally to all educators (Bell & Gresalfi, 2017; Eastwood & Sadler, 2013). The GBL approach demands specific skills to present academic content in a fun way that keeps students motivated and enhances their learning (North et al., 2021). Furthermore, Jääskä and Aaltonen (2022) asserted that to design and implement GBL practices successfully; teachers must integrate educational games seamlessly with the subject matter being taught. In short, teachers require GBL-specific skills, such as games literacy and technological competence, alongside their subject matter expertise and pedagogical abilities.

Shah (2019) found that there is a shortage of opportunities for teachers to develop proficiency in GBL, and there is a notable scarcity of comprehensive frameworks that support teachers in integrating educational games into their teaching. Furthermore, teachers often find they lack the time or resources to incorporate educational games into their teaching. Besides, finding an appropriate educational game can be challenging. Teachers frequently discover educational games by chance or through recommendations from colleagues who have already used them (Jääskä & Aaltonen, 2022). Teachers typically lack the time to actively search for suitable educational games. Due to these challenges and the general lack of professional development, teachers have found it difficult to adopt GBL.

Even though teachers face challenges in adopting the GBL approach, surveys indicated that both in-service and pre-service teachers are increasingly open to the integration of GBL in classrooms (Takeuchi & Vaala 2014). Hence, it is essential to offer teachers substantial professional development opportunities and resources to prepare them to effectively use educational games to achieve learning objectives and to implement GBL effectively in classrooms, especially in teaching Newton's laws of motion.

Therefore, the researcher designed and developed a teacher training module to facilitate teachers in creating their educational games and integrating GBL into teaching Newton's laws of motion, thereby enhancing students' learning. Professional development of GBL could be offered to secondary school Physics teachers through the use of the developed teacher training module. Besides, teachers' intentions to use educational games in teaching Newton's laws of motion and their perception of their game literacy capabilities are equally important. Hence, this study aims to investigate the effects of the teacher training module and its usability. The details of the research objectives will be discussed further in sub-section 1.3.

1.2 Research Background

The Ministry of Education Malaysia consistently works to advance the national education system through numerous initiatives and efforts. Notable changes to the secondary school education system include the gradual implementation of the Standard Curriculum for Secondary Schools (KSSM), which began with Form 1 students in 2017. The KSSM was introduced to align with the new policy objectives outlined in the Malaysia Education Blueprint (PPPM) 2013-2025, ensuring that the quality of the secondary school curriculum meets international standards.

Furthermore, the KSSM was established to make the national curriculum more comprehensive and relevant to the demands of the 21st century, which requires human capital to be critical, creative, and innovative to benefit the nation. As a result, students who follow the KSSM will develop essential skills such as critical thinking, effective communication, teamwork, adaptive leadership, self-motivation, information and communication technology proficiency, entrepreneurship, lifelong learning, and adaptability.

Physics is a branch of the Science curriculum in secondary schools, encompassing both pure and technical science streams. Malaysian students between 16 and 17 years old are introduced to the subject of Physics. In Form 4, the subject is divided into themes, including Elementary Physics, Newtonian Mechanics, Heat, Waves, Light and Optics. The topics covered under Form 4 KSSM Physics are Measurement, Force and Motion I, Gravitation, Heat, Waves, and Light and Optics. Meanwhile, in Form 5, Physics is categorised under the themes of Newtonian

Mechanics, Electricity and Electromagnetism, and Applied Physics, covering topics such as Force and Motion II, Pressure, Electricity, Electromagnetism, Electronics, Nuclear Physics, and Quantum Physics.

According to Tomara et al. (2017), classical mechanics or Newton's laws of motion are fundamental to all the other Physics domains. One must master the concepts of forces and motion and Newton's laws of motion before one can proceed to the different learning areas, such as electricity or waves. In Form 4 and Form 5 Physics KSSM syllabus, students are introduced to kinematics and dynamics as a branch of Physics related to motion in the topic of Force and Motion I (Form 4) and Force and Motion II (Form 5).

In the topic of Force and Motion I, students learn Newton's first law of motion, Newton's second law of motion, and Newton's third law of motion when they are in Form 4. When they progress to Form 5, in the topic of Force and Motion II, they learn how to solve problems related to all three of Newton's laws of motion. Regarding Newton's first law, students learn that an object will remain at rest or continue to move at a constant velocity in a straight line unless acted upon by an external force. This introduces the concept of inertia, which is the tendency of objects to resist changes in their state of motion.

Next, students learn that the acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass. This law is expressed mathematically as F = ma, where F is the net force, m is the mass of the object, and a is the acceleration. This is associated with Newton's second law.

Meanwhile, in Newton's third law, students learn the concept that for every action, there is an equal and opposite reaction. They comprehend that when one object exerts a force on a second object, the second object exerts a force of equal magnitude but in the opposite direction on the first object.

To achieve the goals set forth in the PPPM 2013-2025, the Ministry of Education has recommended that teachers adopt innovative pedagogical approaches to increase student engagement in school. One of the innovative teaching approaches is GBL (Farihah, Mohd Norawi & Nur Jahan, 2021). GBL has been proven to be effective in enhancing students' learning, motivation and 21st-century skills (Dewantara et al., 2020; Cardinot & Fairfield, 2019; Shute et al., 2019; Thunyaniti & Wuttiprom, 2019; Akbar et al., 2018; Setyaningrum et al., 2018; Alias & Ibrahim, 2017). Hence, Alias and Ibrahim (2016) suggested that educators could employ GBL and create educational games that prioritise conceptual understanding and problem-solving skills to foster students learning of Newton's laws of motion.

Proper professional development training is crucial for teachers to feel confident and well-prepared to integrate GBL into their teaching. Inadequate training can lead to fear, concerns, and anxiety, which may prevent teachers from adopting GBL. For instance, North et al. (2021) developed a platform named GATE: VET under the Erasmus+ project to help vocational education and training (VET) teachers find, create, and share GBL teaching resources. The results indicate that the platform has effectively helped VET teachers grasp both the theoretical and practical elements of GBL. Teachers reported improved abilities in creating and executing GBL activities, demonstrating that the platform has supported a more efficient

incorporation of GBL into their teaching. The blend of resources and collaborative tools offered by the platform has been beneficial in advancing innovative teaching strategies within vocational education.

Kennedy-Clark and colleagues (2013) conducted a two-hour workshop for 18 pre-service teachers, focusing on integrating GBL into inquiry-based education using the Technological Pedagogical and Content Knowledge (TPACK) framework. The results from pre- and post-tests showed that participants felt more confident in using educational games in the classroom. Similarly, Sardone and Devlin-Scherer (2016) offered a course on GBL where 25 pre-service teachers documented game characteristics such as playability, feedback mechanisms, alignment with content standards, 21st-century skills, and motivational aspects. The study found that these pre-service teachers could identify specific 21st-century skills in games, connect them to their subject areas, and envision how they might use these games in their teaching.

Meanwhile, An (2018) conducted a semester-long online professional development course for twenty-five participants, mostly K-12 teachers. This course aimed to develop skills in engaging educators and parents about the educational potential of games, selecting and evaluating relevant games, incorporating games into their teaching, and facilitating game design activities with their students. In another study, Hsu and colleagues (2015) divided 49 in-service teachers into two groups: one focused on pedagogy and the other on technology. The researchers evaluated the impact of these courses on teachers' technological pedagogical content knowledge for games (TPACK-G) and their acceptance of GBL. This quasi-experimental study found that teachers in the technology-oriented group, who first learned about the

game's objectives and functions, were better able to integrate the game with content and pedagogy when designing lesson plans (Hsu et al., 2015).

Based on the aforementioned studies, it is evident that providing teachers with resources and professional development opportunities significantly enhances their abilities to create and implement GBL activities. These findings highlight the critical need for tailored professional development programs to support teachers in leveraging GBL for more innovative and effective teaching. Given that teachers may not have received explicit training and lack the necessary resources to utilise GBL for teaching Physics, this study proposes the development of a teacher training module to facilitate them in creating educational games and adopting the GBL approach in teaching Newton's laws of motion. This teacher training module is designed based on the Design and Developmental (DDR) approach that takes teachers' needs and experts' consensus into account. It has the potential to leverage teachers' knowledge and skills in GBL by providing various educational games for teaching Newton's laws of motion, as well as the necessary steps to develop their educational games.

1.3 Problem Statement

Physics is essential to comprehend contemporary advancements and technological progress (Baran, 2016). However, despite its significance, Physics remains the least favoured scientific discipline among students (Erinosho, 2013). According to the Report on Analysis of the Malaysian Certificate of Education (SPM) Examination Results by the Malaysian Examination Board, there has been a consistent decline in the number of students taking the Physics examination over the years. In 2017, the number of candidates was 111,141, which decreased to 102,189 in 2018. This downward trend continued with 97,759 candidates in 2019, 93,728 in 2020, and 90,583 in 2021 (Malaysian Examination Board, 2017; 2018; 2019; 2020; 2021). This trend suggests a growing disinterest or decreased enrollment in Physics among Malaysian students from 2017 to 2021. This persistent decline may reflect underlying issues such as diminished student engagement or perceived difficulty. This observation is consistent with Wangchuk, Wangdi, Tshomo, and Zangmo's (2023) assertion that students frequently regard Physics as an abstract and challenging subject.

An analysis of the answers to Papers 2 and 3 of the SPM Physics exams in 2013 and 2014 revealed that students' responses were generally of moderate quality (Malaysian Examination Board, 2013; 2014). Many students from these years showed a lack of understanding of Physics terms and concepts. They were categorised into two groups: moderate and low. The moderate group had an incomplete mastery of Physics terminology and found conceptual questions challenging. The low group struggled to comprehend the questions' requirements, demonstrating a weak grasp of

concepts, facts, formulas, units, physical quantities, and principles of Physics, particularly in conceptual and problem-solving questions (Malaysian Examination Board, 2013; 2014).

The topic of Force and Motion is widely recognised as one of the most challenging topics not only in Malaysia but abroad as well (Alias & Ibrahim, 2017). It is often seen as complex and demands a deep level of understanding to comprehend and master. For example, the analysis of the responses to Paper 2 of the 2014 SPM Physics examination revealed that the candidates' answers to structure questions related to Force and Motion were inaccurate. Candidates failed to correlate the concept of balanced force with constant velocity to determine the value of the frictional force. Additionally, their answers were incorrect due to the wrong substitution of the formula. They also did not explain the effect of the forces on the motion of the car (Malaysian Examination Board, 2014).

Furthermore, Mohd Yusof et al. (2013) conducted a study to investigate the level of understanding of the concept of Force and Motion among students in Johor Bahru. The findings indicated that students generally failed to understand the Force and Motion concepts, with an average comprehension rate of 19.23% and a standard deviation of 11.09. Additionally, 60.4% of the students were unable to understand the concepts. Similarly, Mohtar (2019) investigated the performance of Form 4 students at a school in Johor and found that their achievement on the topic of Force and Motion was moderate.

According to Alias and Ibrahim (2016), the decline in students' overall Physics performance is due to weaknesses in their conceptual understanding and problem-solving skills regarding Force and Motion. Their study of 189 Form 4 students in Kuala Kangsar revealed a significant lack of understanding of terminology and the application of Newton's Laws, such as inertia, momentum, conservation of momentum, and equilibrium of forces. Subsequently, Ismail and Ayop (2019) discovered that students' understanding of the topic of Force and Motion varies. No students demonstrated a high or very high understanding of Force and Motion. These findings collectively suggest that students continue to struggle with comprehending Force and Motion concepts. Hence, it will potentially lead to decreased confidence when answering related questions, thus affecting their overall Physics performance. As a result, this study recommends revising the teaching approach for Force and Motion to enhance students' understanding, particularly in Newton's laws of motion.

Additionally, utilising conventional teaching techniques to learn Physics causes to various unfavourable emotions among students, including finding it uninteresting, struggling to grasp the concepts, and perceiving it as disconnected from real-life scenarios (Mohd Najib, Md-Ali & Yaacob, 2022; Yunzal & Casinillo, 2020). Thus, shifting from traditional teaching and learning methods to alternative approaches to infuse more excitement into learning Physics, especially Newton's laws of motion, would enhance students' learning and potentially cultivate a positive attitude towards Physics. This could be done by utilising educational games that could support teachers in varying their teaching and learning methods, ultimately enhancing students' comprehension and engagement with the topic of forces and motion.

However, in the Malaysian education system, teachers must cover the syllabus based on the examination calendar set by upper management (Alias & Ibrahim, 2015). This emphasis on examinations is a prominent aspect of the education system in Malaysia. Despite recent changes in the Malaysian education system, transitioning from a teacher-centred methodology to a student-centred one, some educators have not fully embraced this shift. Their main emphasis remains on ensuring timely curriculum completion and adequately preparing students for their final exams (Jing & Saleh, 2020). This instructional approach has significantly impacted students' attitudes toward learning.

Moreover, Reeves, Greiffenhagen, and Laurier (2017) reported that many educational games have been developed with unclear standards and guidelines. Educators struggle to judge whether the games created meet the learners' needs and expectations. Concurrently, Ahmad (2020) argued that there are numerous studies on educational game production but few on the methodologies to enhance the game design process.

Furthermore, Avdiu (2019) explained that integrating GBL in educational settings can pose difficulties for teachers, especially in integrating games effectively into the established curriculum. Past studies on GBL have predominantly concentrated on attributes of the games themselves, learning results, and factors related to students. This has often led to a lack of attention toward the viewpoints and encounters of educators when it comes to educational game design.

Apart from that, Kamışlı (2019) highlighted that most educators are interested in adopting GBL. Still, they are incompetent in doing so as they lack the knowledge and training to assist them in incorporating GBL into the lessons. At the same time, there is limited research investigating teachers' experience in game design. Very little is known about studies regarding teachers' experience in game design or professional development of game design among teachers, especially in Malaysia.

Therefore, the researcher will design and develop a teacher training module to facilitate teachers in creating their educational games and integrating GBL into teaching Newton's laws of motion, thereby enhancing students' learning. Professional development of GBL could be offered to secondary school Physics teachers through the use of the developed teacher training module.

1.4 Research Objectives

The main objective of this study is to design and develop a teacher training module to guide teachers in creating Physics educational games and adopting the GBL approach in teaching Newton's laws of motion. At the same time, this study also evaluates the usability and effectiveness of the teacher training module in shifting teachers' perceived game literacy capabilities. The study's objectives are also built based on three main phases, namely (1) need analysis, (2) design and development, and (3) evaluation.

The research objectives are:

1. To identify the need for developing a teacher training module for the GBL approach in teaching Newton's laws of motion. (Phase 1)

2. To identify the main components and sub-elements to be included in the design and development of the teacher training module. (Phase 2)

3. To measure the content validity of the teacher training module. (Phase 2)

4. To assess the effects of the teacher training module on teachers' perceptions of their game literacy capabilities. (Phase 3)

5. To evaluate the usability of the teacher training module. (Phase 3)

1.5 Research Questions

The following shows the research questions of this study according to phases.

Objective 1: (Phase 1)

(i) What challenges do teachers face while teaching Newton’s Laws of motion?

(ii) What are students' difficulties in learning Newton's laws of motion?

(iii) What is the implementation level of the GBL approach in teaching Newton's Laws of motion?

(iv) What are teachers' attitudes towards using the GBL approach in teaching and learning Newton's Laws of motion?

(v) Is professional development needed for the GBL approach in teaching Newton's laws of motion?

(vi) What are the content requirements for the teacher training module?

(vii) What are the requirements for the teacher training module's design features?

Objective 2: (Phase 2)

(i) What are the main components to be included in the design of the teacher training module for the GBL approach in teaching Newton's laws of motion based on the experts' suggestions?

(ii) Based on the experts' consensus, what sub-elements are intended for inclusion in developing educational games in the teacher training module for the GBL approach in teaching Newton's laws of motion?

Objective 3: (Phase 2)

What is the content validity of the newly developed teacher training module for the GBL approach in teaching Newton's laws of motion?

Objective 4: (Phase 3)

To what extent does the usage of the teacher training module for the GBL approach in teaching Newton's laws of motion effect teachers' perceptions of their game literacy capabilities?

Objective 5: (Phase 3)

What is the usability level of the teacher training module for the GBL approach in teaching Newton's laws of motion among secondary school Physics teachers?

1.6 Research Framework

A research framework is a systematic and organised structure delineating a research study's essential elements, concepts, variables, and relationships. It offers a systematic approach in designing and conducting the research, assisting the researcher in crafting research questions, formulating hypotheses, choosing methodologies, and interpreting the results. A research framework comprises a theoretical framework and a conceptual framework.

According to Kivunja (2018), a theoretical framework incorporates established theories articulated by experts in the research field that serve as a theoretical scaffold for analysing and interpreting the data and results obtained. It encapsulates key concepts and theories derived from established and published knowledge that has been tested before. This synthesis of existing knowledge provides a theoretical background that could be utilised to conduct data analysis and interpret the significance or meaning embedded in the research data. In essence, the theoretical framework acts as a guide, drawn from prior research, to help make sense of and analyse the data in a new research study.

On the other hand, a conceptual framework encompasses the comprehensive, logical orientation and connections within every aspect that shapes the fundamental thinking, structures, plans, and practices in the execution of the entire research project (Varpio, Paradis, Uijtdehaage & Young, 2020). In other words, it includes the considerations regarding the identification of the research topic, the problem under investigation, the formulation of questions, the literature to be reviewed, the application of theories, the chosen methodology, the methods, procedures, and instruments to be employed, as well as the data analysis, interpretation of findings, and the recommendations and conclusions intend to draw (Ravitch & Riggan, 2017). Therefore, a conceptual framework represents the systematic conceptualisation of the entire research endeavour. It serves as a metacognitive, reflective, and operational component of the research process as a whole.

1.6.1 Theoretical Framework

Since this is a teacher training module designed especially for teachers, it is essential to incorporate learning theory that is associated with adult learners to facilitate their learning and adoption of the GBL in teaching Newton's laws of motion. Besides, to effectively design and develop comprehensive Physics educational games that bolster students' understanding, motivation, and 21st-century skills, it is imperative to corporate relevant learning theories and GBL frameworks. Concurrently, the Technology Acceptance Model (TAM) serves as the foundational model for assessing the usability of the teacher training module. Meanwhile, the Context, Input, Process, and Product (CIPP) evaluation model was employed to evaluate the teacher training module and its impact on teachers' perceptions of their game literacy capabilities.

1.6.1.1 Andragogy

According to Haq and Karunakaran (2013), adult education or adult learning is addressed with a technical term named 'Andragogy', where adults learn differently than children as they learn through sharing their ideas and experiences with educators. Meanwhile, adult education fosters lifelong learning, wherein adults engage in continuous learning to enhance their abilities and skills, expand their knowledge, and improve their professional qualifications, values, and attitudes (Prakash, Sharma & Advani, 2019).

Andragogy was embedded in the theoretical framework because it acknowledges adult learners' unique needs, motivations, and experiences, ensuring that the teacher training module is tailored to their specific characteristics and requirements. Furthermore, principles of andragogy promote self-directed learning and learner autonomy, empowering teachers to take ownership of their professional development and actively engage in designing educational games that meet their teaching objectives and students' needs. Additionally, it facilitates the design of the teacher training module that emphasises practical application and real-world problem-solving, ensuring that the learning experiences provided are relevant, engaging, and directly applicable to teachers' classroom practices.

1.6.1.2 Constructivism

According to Sharma and Bansal (2017), when constructivism was introduced in the education world, it caused a change in the teaching and learning process where initially students act as passive receivers, and now students construct knowledge based on experience and interactions with artefacts (Gaeta et al., 2019) as well as through discovery learning.

In the GBL approach, students need to explore the game world, and during the exploration process, students encounter new information and different types of game tasks or activities. Throughout the task completion process, students learned to organise and structure their prior knowledge and construct knowledge based on their experiences gained through the gameplay, from interacting with their peers, and the resources

provided in the game world (Rieber, 2001). As a result, students become active learners, and their problem-solving, critical thinking, and creative thinking skills are developed.

Apart from that, by incorporating constructivist principles into the design process, the teacher training module can prioritise hands-on, experiential learning activities that encourage teachers to engage actively with educational game design concepts and principles. This approach fosters deeper understanding and retention of knowledge as teachers engage with real-world challenges and actively apply theoretical concepts in practical contexts.

Thus, constructivism learning theory must be embedded in the design and development of the teacher training module to guide teachers in producing educational games that can improve students' understanding and problem-solving skills and help teachers understand the concept of GBL and game design better.

1.6.1.3 GBL Frameworks

Two GBL frameworks are integrated as the core of the design and development of the teacher training module, namely: (i) the Van Staalduinen and De Freitas Framework (Van Staalduinen & De Freitas, 2011), as shown in Figure 1.1 and (ii) the Integrated Design Framework of Playful Learning (Plass, Homer, & Kinzer, 2015), as shown in Figure 1.2.

The Van Staalduinen and De Freitas framework divided the game-designing process into three phases: (i) the learning phase, (ii) the instructions phase, and (iii) the assessment phase. In each phase, there are selected aspects that need to be aware of, whereas, during the learning phase, educators need to select the desired learning objectives and goals as well as learning content.

After that, during the instruction phase, educators select the game elements based on the four dimensions: context, learner specifics, pedagogy and representation. Lastly, during the assessment phase, educators choose the types of feedback to be provided to the students in the game environment. This framework was selected as it can help educators decide the types of games that should be used in the lessons. Besides, it allows educators to choose suitable game elements from the four dimensions to design educational games that suit the learning contents and meet the student's needs.

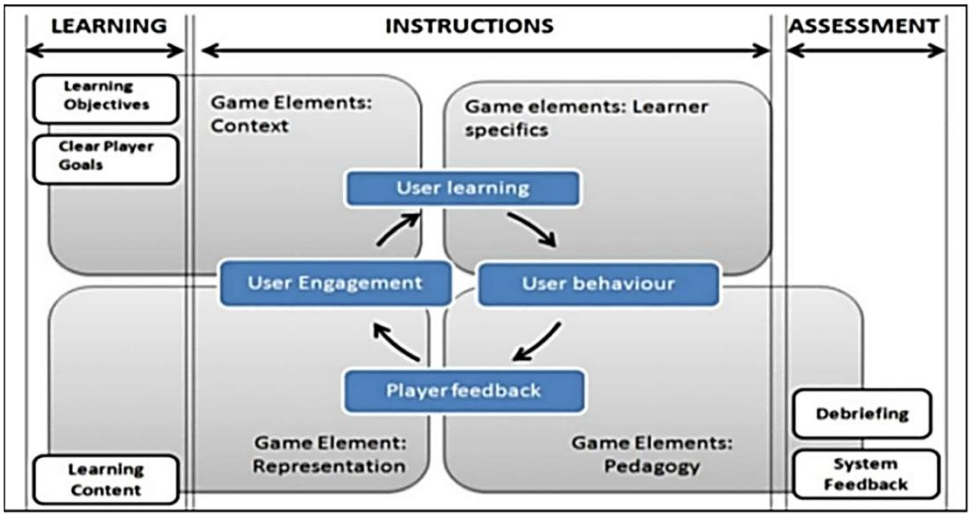

Figure 1.1. Then Van Staalduinen and De Freitas Framework (Van Staalduinen & De Freitas, 2011)

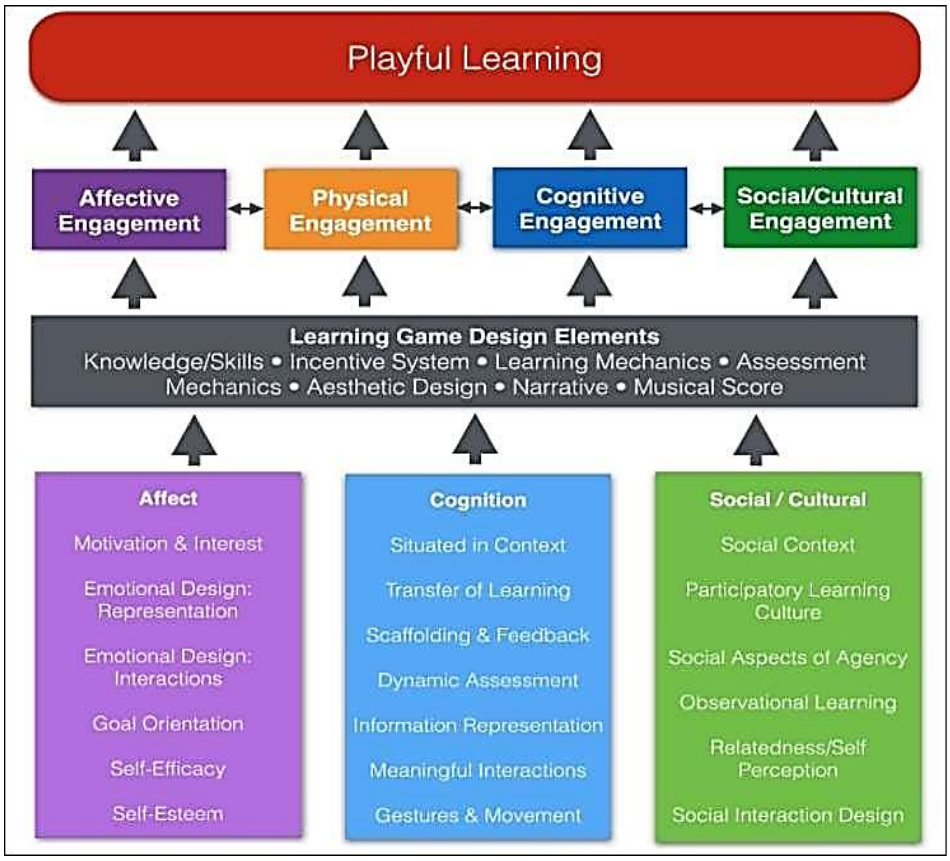

Figure 1.2. Integrated Design Framework of Playful Learning (Plass, Homer, & Kinzer, 2015)

On the other hand, the Integrated Design Framework of Playful Learning is developed based on three main foundations: (i) cognitive, (ii) affective, and (iii) social/ cultural, as shown in Figure 1.2. This framework covers four factors that keep the students engaged in the game, which leads to playful learning: affective engagement, physical engagement, cognitive engagement and social or cultural engagement.

The purpose of this framework is to provide educators with guidelines on what games have to offer for learning by combining the three main foundations and the design of games, which keep the students engaged with the learning goals within the game, unlike other frameworks which focus more on cognitive perspective without

taking the motivational and socio-cultural factors of the game into account.

This framework was chosen as it is a complete game design framework covering all three main foundations in learning and game elements needed to design an educational game. These two GBL frameworks were then integrated into one by combining all the related aspects and dimensions to facilitate the creation and development of educational games within the teacher training module.

1.6.1.4 Gagne's Nine Events of Instruction

In order to enhance cognitive processing and student engagement, it is essential to focus on instructional strategies that support active learning. According to Gagné, Briggs and Wager (1992), the learning process is shaped by a sequence of external stimuli or events. Table 1 shows Gagné's Nine Events of Instruction, proposed by Robert Gagné in 1985, that guide the design and delivery of instruction that stimulates the learning process.

Table 1.1

Gagne's Nine Events of Instruction (Northern Illinois University Center for Innovative Teaching and Learning, 2020)

No.	Instructional Event	Description
1.	Gain attention	Attracting students' attention or interest before a lesson starts with any stimulus is essential to ensure the students are ready to learn.
2.	Explain objectives	Clarifying the objectives and learning outcomes assists students in comprehending what they are supposed to learn by the end of the instruction. This helps students to be motivated to complete the tasks throughout the learning process.
3.	Stimulate recall of prior knowledge	This event aids students in understanding new information by relating it to their existing knowledge or personal experiences.
4.	Present content	New content or materials must be well-organised and presented to the students systematically through various media and strategies to promote learning.
5.	Provide guidance	Offering assistance and reinforcement could aid students' learning. This support can be conveyed through explanations, illustrations, and practical demonstrations, contributing to student's long-term memory.
6.	Elicit performance	In this phase, students practice and demonstrate what they have learned through tasks such as tests, quizzes or projects. This phase enables students to strengthen their newly acquired skills and knowledge.
7.	Provide feedback	Offering students personalised feedback regarding their performance in the previous phase is essential as it provides insights into the correctness and quality of their work. It helps to reinforce their understanding.

(continue)

Table 1.1 *(continue)*

No.	Instructional Event	Description
8.	Assess performance	It is necessary to perform a thorough evaluation to identify whether students have achieved their learning goals without additional coaching or clues. Assessments can encompass diverse formats, including quizzes, exams, projects, or presentations.
9.	Enhance retention	In the final phase, students are prompted to employ their acquired knowledge in real-world scenarios, either in their lives or work, strengthening their comprehension and fostering its applicability beyond the initial context.

According to Iqbal, Siddiqie and Mazid (2021), many educators worldwide have integrated Gagne's Nine Events of Instruction into their lesson planning because these steps take into account the unique qualities and characteristics of each learner, aligning the instructional approach with their cognitive abilities, readiness to learn, and motivation, resulting in a more tailored and effective learning experience. Hence, educators could refer to this framework as the guidelines for implementing the GBL approach in Physics classrooms to create an engaging learning environment that promotes active learning. Consequently, this framework was integrated in designing the teacher training module.

1.6.1.5 Technology Acceptance Model (TAM)

According to Surendran (2012), Davis developed TAM in 1989 to investigate an individual's acceptance behaviour on information technology or information systems. TAM consists of two major aspects: (i) perceived usefulness (PU) and perceived ease

of use (PE). Davis, Bagozzi & Warshaw (1989) defined PU as the degree to which one believes using a specific system would enhance one's performance. Meanwhile, PE is the degree to which one believes using a particular system would be effortless. Moreover, TAM is a widely used model in research on technology acceptance (Dumpit & Fernandez, 2017; Joo, Park & Lim, 2018; Scherer, Siddiq & Tondeur, 2019) to gauge their acceptance levels.

This study employed the TAM model proposed by Davis et al. (1989), as shown in Figure 1.3, which includes four main aspects: perceived ease of use (PE), perceived usefulness (PU), attitude (AT) and behavioural intention (BI) to investigate the usability of the teacher training module.

In the context of this study, PE is defined as the perception that using the teacher training module would require minimal effort. Meanwhile, PU refers to participants' perceptions regarding enhancing their game literacy capability through the teacher training module. Additionally, Weng, Yang, Ho and Su (2018) asserted that TAM could serve as the foundational model for exploring attitudes and intentions regarding using specific teaching materials. Consequently, in this study, participants' attitudes (AT) toward using the teacher training module and their behavioural intentions (BI) to utilise it are also being examined.

TAM originated from the Theory of Reasoned Action (TRA) by Ajzen and Fishbein in 1980, which focuses on psychological aspects such as attitude and behaviour (Fatmawati, 2015 & Teo, Luan & Sing, 2008), making it suitable to determine the usability of the teacher training module as it evaluates the users'

acceptance level. The TAM survey was adapted as the assessment tool to assess the usability of the teacher training module because of its robustness and simplicity.

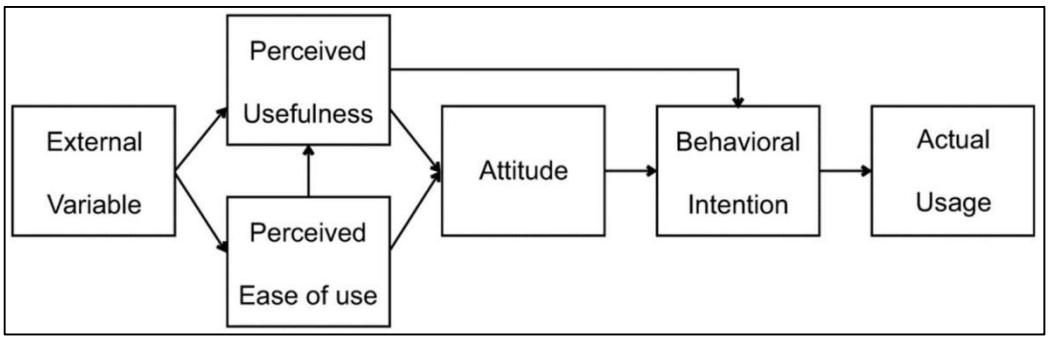

Figure 1.3. Technology Acceptance Model (TAM) (Davis, Bagozzi & Warshaw, 1989, p. 985)

1.6.1.6 Context, Input, Process and Product (CIPP) Model

The CIPP evaluation model consists of four core values, namely, Context, C; Input, I; Process, P; and Product, P (Stufflebeam, 2003) and when the CIPP Evaluation Model is associated with the evaluation of a program, its relationship is as shown in Figure 1.4.

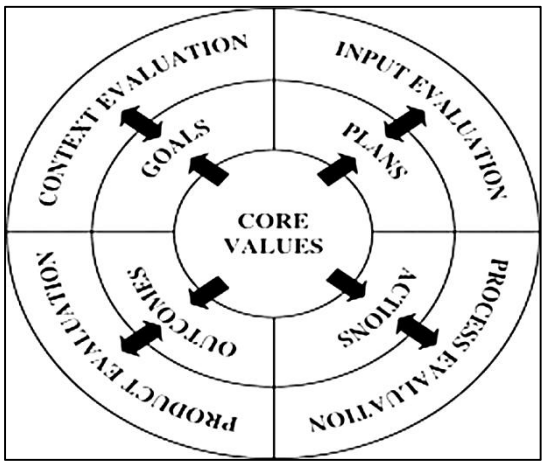

Figure 1.4. The Key Components of the CIPP Evaluation Model Associated with the Programs (Stufflebeam, 2003)

The CIPP evaluation model was developed in the 1960s by Daniel Stufflebeam, and this framework is commonly used to evaluate educational programs and projects (Stufflebeam, 2003). According to Aziz, Mahmood and Rehman (2018), the CIPP evaluation model is very useful in determining the quality of the programs, and Al-Khathami (2012) elaborated that the CIPP model provides component evaluations which could be used to evaluate each part of the programs separately. Thus, it is a powerful model for determining the strengths or weaknesses of a program. Therefore, the CIPP evaluation model is chosen to evaluate the teacher training module according to the components, as shown in Table 1.2, to explore teachers' perceptions about the usage of the teacher training module.

Table 1.2

The CIPP Model Applied to the Evaluation of the Teacher Training Module

Evaluation framework (CIPP model)			
Context	Input	Process	Product
Focus on gauging the teacher training module's achievement of objectives.	Measure the alignment of the teacher training module with teachers' needs.	Examine the clarity of instructions and the process of activities to facilitate understanding of GBL.	Evaluate the usability of the teacher training module via perceived ease of use (PE), perceived usefulness (PU), attitude (AT) and behavioural intention (BI).

1.6.2 Conceptual Framework

Several considerations must be taken into account when designing a practical training module to support teachers in adopting GBL to enhance students' learning and motivation in Physics. These factors involve incorporating various theories, instructional design models, and GBL models throughout the design and development process.

The conceptual framework for creating the teacher training module to improve teachers' GBL competency is illustrated in Figure 1.5. This framework is structured based on the Design and Development Research (DDR) approach proposed by Richey and Klein in 2007, encompassing three primary stages: Needs Analysis, Design and Development, and Evaluation. The DDR approach acts as the research design for this

study and the teacher training module was designed and developed based on the ADDIE model.

The ADDIE model is recommended for designing and developing the teacher training module. This model aids researchers in visualising the entire instructional design process. According to Alnajdi (2018), the ADDIE model incorporates a paradigm of input, process, and output within its design process, facilitating the creation of instructional materials with greater ease for designers.

Figure 1.5 shows the steps involved in producing the teacher training module, starting with needs identification through analysis. It progresses to define the structure, format, and objectives of educational materials, create materials to meet these goals during the design and development phase and conclude with implementation and assessment of effectiveness in the final stage.

The initial step in the ADDIE model involves conducting a need analysis. This phase entails gathering data to establish the foundational information necessary to produce a product that meets the users' requirements. It facilitates the examination of a specific phenomenon by identifying problems within the target population and anticipating potential solutions (Branch, 2009; Gagne, Wager, Golas & Keller, 2005; Reinbold, 2013). Consequently, need analysis often serves as the groundwork for educators to create impactful teaching resources, learning tasks, assessments, and program assessment methods.

The Discrepancy Model proposed by McKillip (1987) was chosen because it underscores the importance of recognising gaps between the current situation and the desired state. Moreover, this model is commonly employed in education to identify goals and determine actions by evaluating performance and identifying areas needing improvement.

Before developing the teacher training module, it is crucial to perform a need analysis to ascertain the necessity for creating the module and understand the challenges encountered during the teaching and learning process.

The phase after need analysis is the design and development, as illustrated in Figure 1.5. This phase is crucial in enabling researchers to generate pertinent final products and ensuring their beneficial impact on the intended users (Ven den Akker, Gravemeijer, McKenney & Nieveen, 2006).

In designing training modules, it is imperative to incorporate learning theories. They provide a robust foundation for producing modules that cater to users' needs, facilitate knowledge transfer, and offer impactful learning experiences. The adult learning model- andragogy, was integrated into the teacher training module's design to enhance teachers' educational game design skills and implement GBL. Andragogy, focusing on educating and training adults (Hag & Karunakaran, 2013), promotes lifelong learning in the workplace, aiding in skill development and knowledge enhancement (Prakash et al., 2019). Other learning theories, such as constructivism, are considered for integration into the teacher training module's design. Since this teacher training module guides teachers in educational game design, incorporating

constructivism aligns with the idea of creating meaningful contexts for applying knowledge during game design and developing educational games that foster students to become active learners.

The Van Staalduinen and De Freitas Framework and the Integrated Design Framework of Playful Learning, illustrated in Figure 1.1 and Figure 1.2, are the core for designing and developing the teacher training module. These GBL frameworks guide teachers in selecting appropriate games for lessons and considering factors essential for creating educational games that align with the curriculum and students' needs.

Gagne's Nine Events of Instruction was chosen to provide guidelines for educators to implement the GBL approach effectively in Physics classrooms. This systematic framework is action-oriented, enabling educators to enhance their teaching efficacy by organising classes and students' learning processes (McKivigan, 2019). Ultimately, it assists students in acquiring, retaining, and applying knowledge in real-world contexts, facilitating the achievement of learning objectives and outcomes.

Integrating these selected models and theories must align with the main objectives of teacher training module development. In this study's context, the primary goals are to enhance teachers' GBL competency, enabling them to successfully adopt GBL in Physics classrooms to enhance students' learning and motivation.

Once the theoretical groundwork for the teacher training module is established, the subsequent step involves pinpointing the essential elements to incorporate into the

module's design. The Nominal Group Technique (NGT) is a viable option, as it enables experts to contribute their insights and perspectives in identifying the main components of the teacher training module. NGT serves as a method for fostering group consensus and formulating action plans through structured face-to-face sessions dedicated to a specific topic (Ghazali, Siraj, Ali & Asra , 2021).

Once the design of the teacher training module has been established, the Fuzzy Delphi Method (FDM) can be applied during the development phase to attain a consensus among experts regarding the predetermined elements and sub-elements gathered through the NGT workshop and literature review.

Vasodavan, DeWitt, and Alias (2022) emphasised the effectiveness of FDM as a valuable decision-making tool, particularly for complex problems. It facilitates collective decision-making by incorporating fuzzy set logic and theory, allowing the integration of expert viewpoints through cumulative frequency and fuzzy scores rather than relying solely on individual perspectives. Therefore, FDM proves to be suitable for capturing the insights and consensus of experts, aiming to assess and validate the appropriate components and elements to be incorporated into the development of the teacher training module.

Assessing a newly developed product in the evaluation stage holds significant importance. Before the official launch of a product or program, a usability evaluation enables designers to observe and comprehend how users engage with and utilise the product (Rosenzweig, 2015). As Basaran, Dursun, Gur Dortok and Yilmaz(2021) outlined, obtaining feedback from users serves as a means to determine whether the

product has successfully achieved its goals. This process allows for collecting insights into users' behaviour and preferences, facilitating necessary improvements before introducing the product to a broader audience. Ultimately, this approach ensures the quality of the product and enhances user satisfaction.

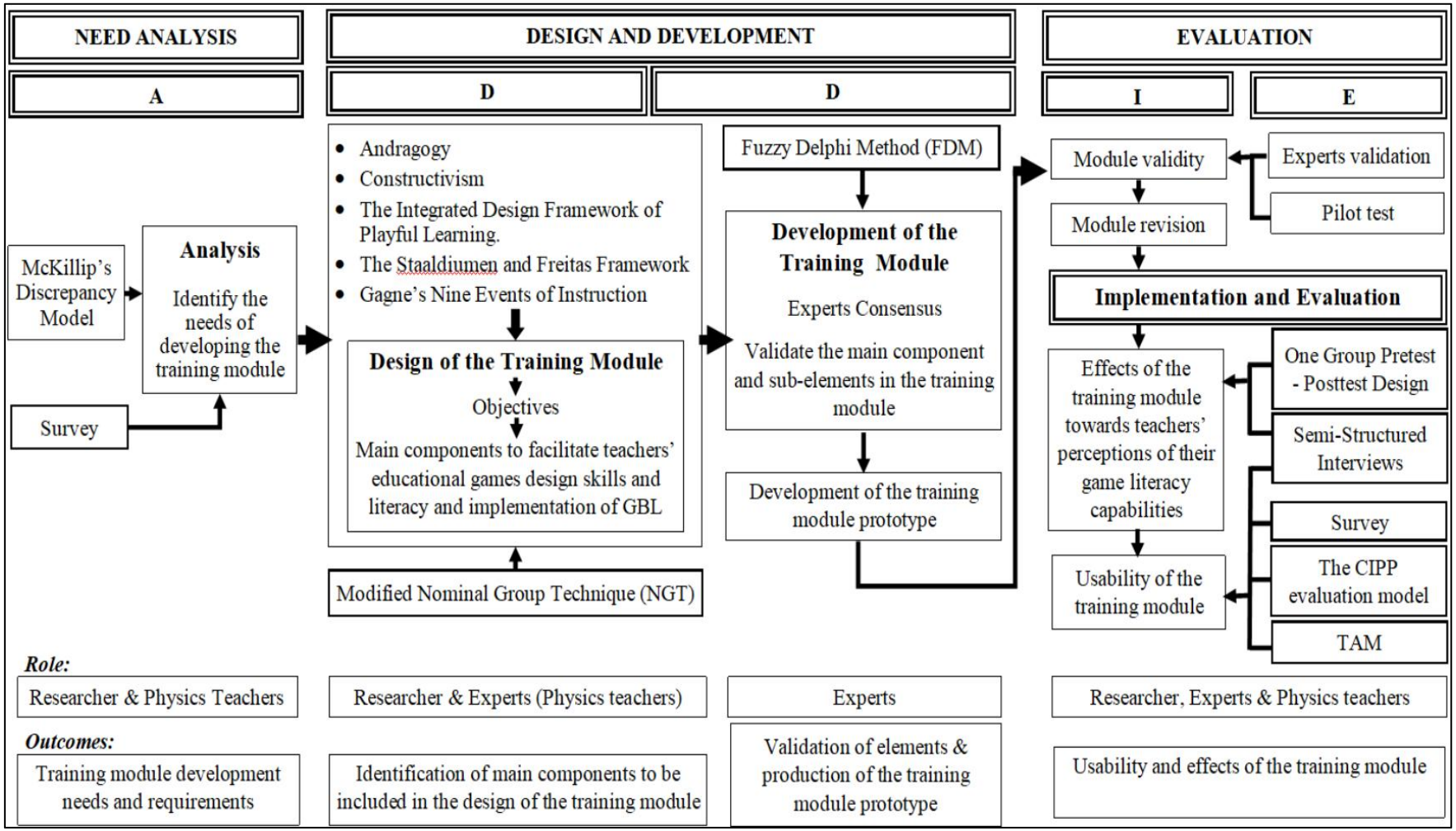

Figure 1.5. The Conceptual Framework for Designing and Developing the Teacher Training Module for the GBL Approach in Teaching Newton's Laws of Motion (Adaptation of the ADDIE model & Padzil, Abd Karim & Husnin, 2021)

1.7 Operational Definitions

Below are the operational definitions employed in this study.

1.7.1 Needs

As outlined by Bradshaw (1972), there are four distinct types of needs: normative need, felt need, expressed need, and comparative need. Felt need specifically pertains to the perceived requirements of the targeted population concerning the challenges they encounter. In this study, a need analysis was conducted to determine whether teachers perceived the need for a teacher training module to facilitate their development of educational games and implement the GBL approach to enhance students' learning of Newton's laws of motion. This evaluation was done using a need analysis questionnaire.

1.7.2 Validity of the Teacher Training Module

According to Sidek and Jamaludin (2005), the validity of a module generally refers to the accuracy of the concepts and contents of a module. In the context of this study, validity pertains to an assessment of the module contents' quality. The validity of the teacher training module was measured through a content validity survey proposed by Sidek and Jamaludin (2005) and the calculation of the content validity index (CVI) and individual item content validity index (I-CVI).

1.7.3 Usability of Teacher Training Module

According to Chung and Sahari (2015), usability is defined as the extent to which a product can be used by users in order to achieve the targeted goals effectively, efficiently and satisfactorily. Hence, in the context of this study, the usability of the teacher training module refers to teachers' perceptions towards the training module in terms of the perceived ease of use (PE), perceived usefulness (PU), attitude towards using (AT) and behavioural intention to use the module (BI). The usability of the module is measured using the product evaluation survey with a five-point Likert scale under the construct of product evaluation.

1.7.3.1 Perceived Ease of Use (PE)

Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). The perceived ease of use in this study referred to the degree of the participants' perceptions of simplicity and comprehensibility of utilising the teacher training module.

1.7.3.2 Perceived Usefulness (PU)

Perceived usefulness (PU) is denoted as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). In this study, PU examined teachers' perceptions regarding the extent to which

the teacher training module enhances their capabilities in game design and facilitates the implementation of the GBL approach in their lessons.

1.7.3.3 Attitudes (AT)

According to Teo et al. (2008), attitude refers to the users' positive or negative responses when utilising relevant technology. In this study, AT examines teachers' perceptions regarding the favourability of using the teacher training module and their attitudes toward the integration of self-designed educational games into their teaching practices.

1.7.3.4 Behavioural Intention (BI)

Behavioural intention (BI) signifies the likelihood or extent of an individual's intention to carry out a specific behaviour (Ajzen & Fishbein, 1980). This study examined the likelihood of teachers intending to utilise the teacher training module to design educational games and employ self-designed educational games to enhance students' learning of Newton's laws of motion.

1.7.4 Teachers' Perceptions of Their Game Literacy Capabilities

According to Zagal (2008), game literacy refers to the ability to play games, create games and understand games from the aspects of their contexts and components. In the context of this study, teachers' perceptions of their game literacy capabilities refer to teachers' perceived knowledge and capabilities about educational games, game elements, evaluating games, implementing games into teaching and designing games. Teachers' perceived game literacy capabilities were measured through the game literacy in teaching practice (GLTP) survey adapted from Chen, Zhang, Qi and Yang (2020).

1.7.5 Studied Participants

The studied participants in this research refer to secondary school Physics teachers in Malaysia. Therefore, they are categorised as adult learners who are employed as Physics educators in schools. They also attended professional development training workshops in this study and utilised the teacher training module to familiarise themselves with the game design process and adopt the GBL approach in teaching Newton's laws of motion.

1.7.6 Effectiveness

The effectiveness of the teacher training module involves examining the impact of the training module on teachers' change of perceptions of their game literacy capabilities after the intervention. This evaluation focused on detecting any changes in teachers' attitudes, beliefs, or self-assessments of their proficiency in game literacy following their engagement with the training content.

1.8 Significance of the Study

GBL has been well documented to be effective in fostering students' learning, motivation and 21st-century skills; however, teachers faced difficulties in implementing GBL as aforementioned. Thus, this teacher training module could be the stepping stone in helping teachers overcome the challenges they face. Besides, this teacher training module provides both in-service teachers and pre-service teachers with an opportunity to be updated with the current education trend by enhancing their planning and game design skills, hence gaining a sense of ownership of the teaching and learning process.

Moreover, this teacher training module can be a reference for teachers who are interested in developing Physics educational games as the guidelines proposed in this module will be able to help them in designing games in order to achieve the intended learning outcomes, especially during the COVID-19 pandemic where schools were closed and changed to online learning. At the same time, this teacher training module will help teachers prepare themselves for the new teaching and learning paradigm shift

if another pandemic strikes in the future. Furthermore, the educational games developed based on this teacher training module can complement face-to-face learning when schools were re-opened after the COVID-19 pandemic.

Apart from that, this teacher training module can be used to design both digital games and non-digital games where teachers or students from rural areas without advanced technological support and the internet also can make use of this teacher training module to produce board games, card games, outdoor games to help the students to be engaged and interested towards Physics and learning Newton's laws of motion. Hence, students' mastery level of Newton's laws of motion will be improved as teachers provide them with an engaging learning environment through GBL.

Besides, the findings of teachers' perceptions about the training module can be beneficial for schools, stakeholders, and the Ministry of Education in deciding whether or not to adopt digital or non-digital educational games in classrooms. Such decisions aim to enhance student's learning through a playful learning approach, which corresponds with the latest education trend. Apart from that, the applicability of this teacher training module extends beyond the realm of Physics, potentially benefiting educators from diverse subjects and countries in designing and developing educational games to facilitate student learning.

1.9 Limitations of the Study

As this study focused on developing a teacher training module aimed at addressing students' challenges in learning Newton's laws of motion, there is a limitation in the sample selection. Only secondary school teachers instructing Physics, along with their students who encounter difficulties in grasping Newton's laws of motion, would be included in this study.

Simultaneously, it is worth noting that during the need analysis survey conducted in the first phase of the research, the sincerity of the respondents in completing the survey could impact the study's findings.

Additionally, the study centred on exploring shifts in teachers' perceptions of their game literacy capabilities, particularly examining how their perceived proficiency in game literacy might change with the implementation of the teacher training module. Essentially, it analysed teachers' self-assessment of their competence in game literacy rather than directly assessing their tangible game literacy skills.

Besides, the tendency for social desirability bias could have impacted how respondents perceived the usability and usefulness of the teacher training module, possibly resulting in exaggerated or biased responses.

1.10 Summary

This chapter provides an overview of the topic under investigation, discussing the problems faced within the teaching and learning of Newton's laws of motion. It outlines the research objectives, expected contributions, operational definitions, and overall structure of the study based on the arguments presented. The primary goal of this study was to develop a teacher training module to support educators in creating educational games and integrating the GBL approach into the teaching of Newton's laws of motion. This was accomplished through three phases: need analysis, design and development, and evaluation. The subsequent chapter delves into a comprehensive review of existing literature, offering detailed explanations of the underlying theories and issues related to GBL and professional development.