# Development of a Platform for STEM Teaching and Learning Resource Materials in the field of Discrete Mathematics

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## Abstract

Past studies have found that there are constraints on teachers in developing teaching and learning (TnL) resources to implement STEM education in the classroom. Based on this issue, this research has developed a platform containing a variety of STEM TnL resource materials that focus on the field of Discrete Mathematics learning. This field of study is an area of learning in KSSM Mathematics for form four students. It encompasses three titles, namely Logical Reasoning, Operations on Sets, and Network in Graph Theory. Discrete Mathematics was the focus in the development of this platform as it is often considered difficult for students to understand. Additionally, as teachers find it challenging to find suitable learning materials to get students to be more interested. The wide range of TnL STEM source materials contained in this platform makes it easier for teachers to choose and apply them in TnL. The ADDIE model was used as the development model for this platform. This model is among the most systematic and effective development models, consisting of five phases, i.e. analysis, design, and development, implementation, and evaluation. The platform was developed using an interactive multimedia medium that makes learning fun for students.

**Keywords** Platform, TnL STEM Resource Materials, Discrete Mathematics, ADDIE Model, Interactive Multimedia

## INTRODUCTION

STEM education is an education system that integrates four subjects, which are Science, Technology, Engineering and Mathematics. Currently, STEM education implemented in a country is in accordance with its own education system [1]. In the context of Malaysia's education, there is a wide variety of initiatives taken by Education Ministry of Malaysia (KPM) to implement STEM education. One of the initiatives is the use of STEM TnL resource materials that can help teachers to implement STEM education in school. This will indirectly provide opportunities and exposures for students to facilitate the process of learning the topics covered by their teachers.

KPM always aspires to strengthen the concept of STEM, and this can be achieved by introducing the utilisation of Information and Communication Technology (ICT) [2]. Interactive multimedia medium is often used by researchers in the preparation of STEM resource materials for TnL such as modules [3, 4, 5, 6]. Multimedia is the combination of a myriad of communication methods, including audios, texts, videos, animation and pictures which function as presenting information. The word interactive refers to the way how users can interact with the multimedia. The usage of interactive multimedia can also be adjusted

according to the level of students' knowledge, skills and mindset [7].

Discrete Mathematics is one of the topics covered in Form 4 Mathematics' syllabus in Standard Secondary School Curriculum (KSSM). The syllabus includes three topics, namely Logical Reasoning and Operations on Sets as well as a newly added topic known as Network in Graph Theory. Discrete Mathematics is a series of mathematical knowledge that can train abstract thinking and logical thinking, training students to be capable of resolving problems critically and rationally [8,9]. However, students seem to be lacking of interest in this subject [8]. The use of STEM TnL resource materials that feature interactive multimedia is deemed to provide a fun experience and can attract students to learn. This is because the implementation of TnL STEM does enable in-depth learning in the real-world context [10]. Rusli et al. [11] claims that the use of interactive multimedia among teachers will not only arouse interest among students to stay active in the learning journey, this will also enable the students to stay focused on understanding the content of the subjects taught. Based on the past studies, the introduction of interactive multimedia to the world of learning can in fact improve students' achievements in academics, also creating a more innovative learning environment for them [12].

Hence, this study aims to develop a platform that collects sufficient STEM TnL resource materials, which focus on the KSSM syllabus of Form 4 Discrete Mathematics.

## PROBLEM STATEMENT

According to the study conducted by Sugiharni [8], it was found teachers encounter some issues in looking for TnL methods and resource materials that can gauge student understanding in Discrete Mathematics. Based on this statement, a study to analyse the needs for the platform development of STEM TnL resource materials in Form 4 Discrete Mathematics learning was conducted on 41 teachers who teach Form 4 mathematics. Based on the analysis of the questionnaire, the study findings are as follows:

### Platform Development Needs Analysis

Figure 1 shows the needs analysis data for the platform development of STEM TnL resource materials in the field of Discrete Mathematics learning. It was found that 90.2% teachers acknowledged that there is a need to develop this platform but the remaining 9.8% stated otherwise.
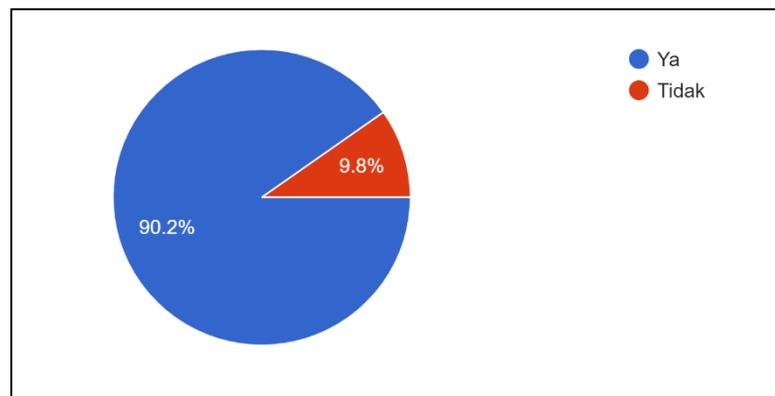


**Figure 1** Needs analysis data for the platform development of STEM TnL resource materials
in the field of Discrete Mathematics learning

### Topic Requirements

Figure 2 shows the data analysis of topic requirements in this platform. These three topics are covered under the field of Discrete Mathematics learning in the Form 4 Mathematics DSKP. It was found that 91.9% teachers opted for the Network in Graph Theory topic, 75.7% of the teachers chose the Logical Reasoning topic and there are 73% teachers who chose the topic of Set Operations. Based on the data, it is found that

there is a need for the platform development of STEM TnL resource materials that involve those three topics due to the high percentage values.
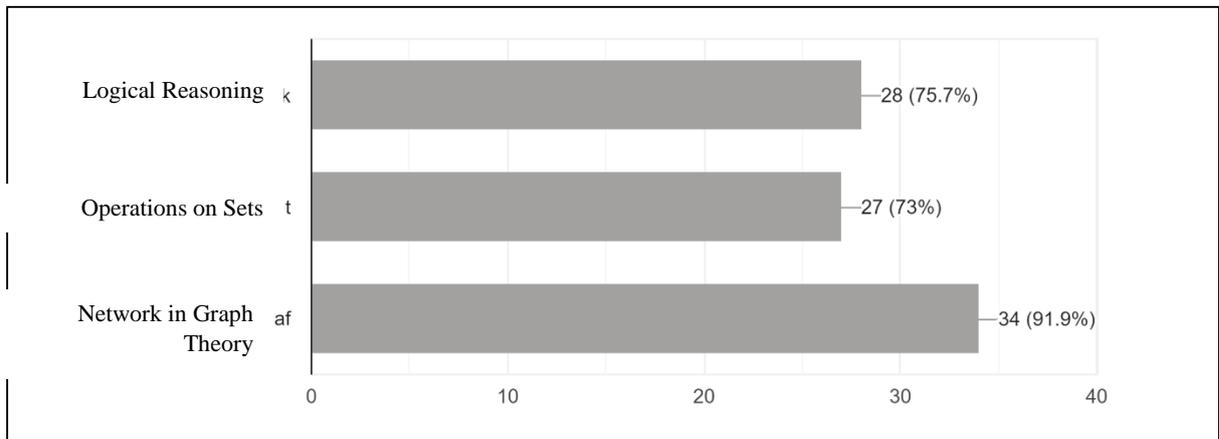


**Figure 2** Data analysis of topic requirements in the platform

## RESEARCH QUESTION

This study was conducted to address the following research questions:

What is the platform development design of the STEM TnL resource materials?

## RESEARCH METHODOLOGY

This study employs Design and Development Research (DDR) methodology by using the model of Analysis, Design, Development, Implementation, Evaluation or ADDIE as the development model. The ADDIE model has been widely used many past research to develop interactive multimedia for TnL materials [13, 14]. In this research, the design of ADDIE model that is used for developing DiskretSTEM Platform is shown in Figure 3.
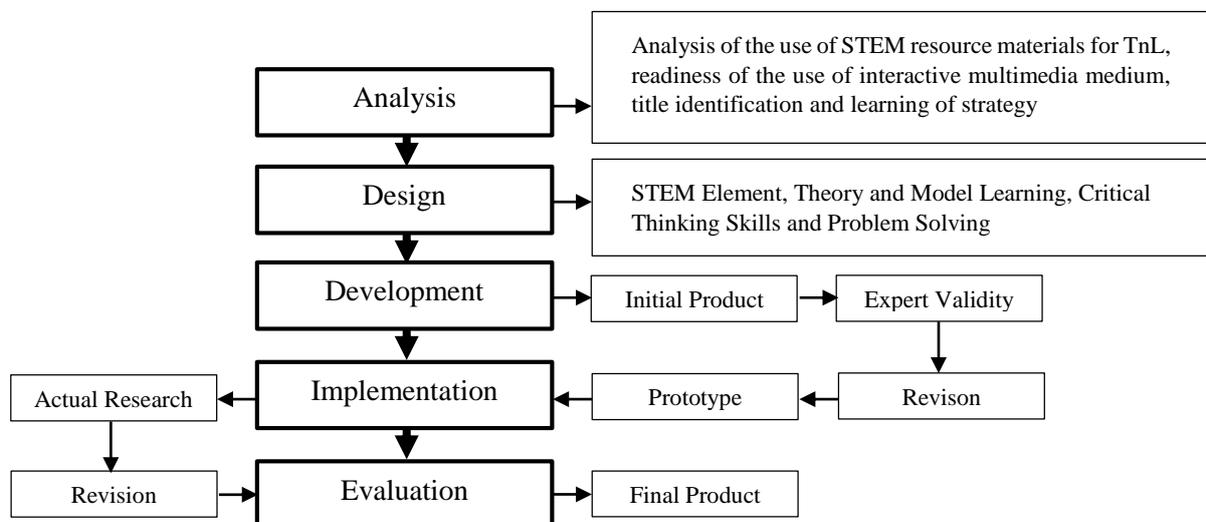


**Figure 3** ADDIE model
(Source: Abdurrahman et al. [40])

**Analysis**

The analysis phase gives an overview related to the platform that has been developed. According to [15], there are six things that must be determined in this phase, which are objective, users, content, methods, platform and software.

i. Objective

Form 4 students will understand the topics covered in Discrete Mathematics in the real-world context.

ii. User

The platform is targeted for Form 4 Mathematics teacher and Form 4 students.

iii. Content

Based on the problem statement, the survey regarding the need of platform development involves Form 4 Mathematics teachers. The analysis is conducted for the use of the existing STEM resource materials for TnL and also those prepared by the teachers themselves. The STEM materials for TnL available on the platform are developed based on the the topics from the syllabus of DiskretSTEM Mathematics that are chosen by teachers. These topics fulfill the requirement in accordance with the learning strategy listed in the questionnaire regarding the needs of introducing certain topics.

iv. Method

The possible methods used are tutorials, enforcement exercises, simulation, quiz and many more. The learning methods include inquiry approach, problem-based learning and project-based learning.
v. Platform

The platform uses interactive multimedia medium. The analysis about the readiness of teachers to use interactive multimedia medium is carried out. This platform is used online. Nevertheless, for those classes that have no internet access, the platform can also be stand-alone. Thus, it can be accessed using private computers, laptops and mobile devices.

vi. Software

The development of the platform utilises the software invented by iSpring Suite. Complementary to this, Adobe Photoshop software can be used to edit pictures or images, whereas Audacity software is used for recording and editing sound effects. Meanwhile, PowerDirector software can be used for editing videos.

**Design**

This phase is for sketching, including flowcharts, interfaces and storyboards.

i. Flow chart

Flowcharts are the brief descriptions of navigation or sequence of the activities [15]. The platform contains nine STEM activities of TnL that involve three topics in Discrete Mathematics, namely Logical Reasoning, Operations on Sets and Network in Graph Theory as well as another activity that covers these three topics. Figure 4 illustrates the navigation map of platform. There is also a sharing site for teachers to share TnL resources on the same topics.
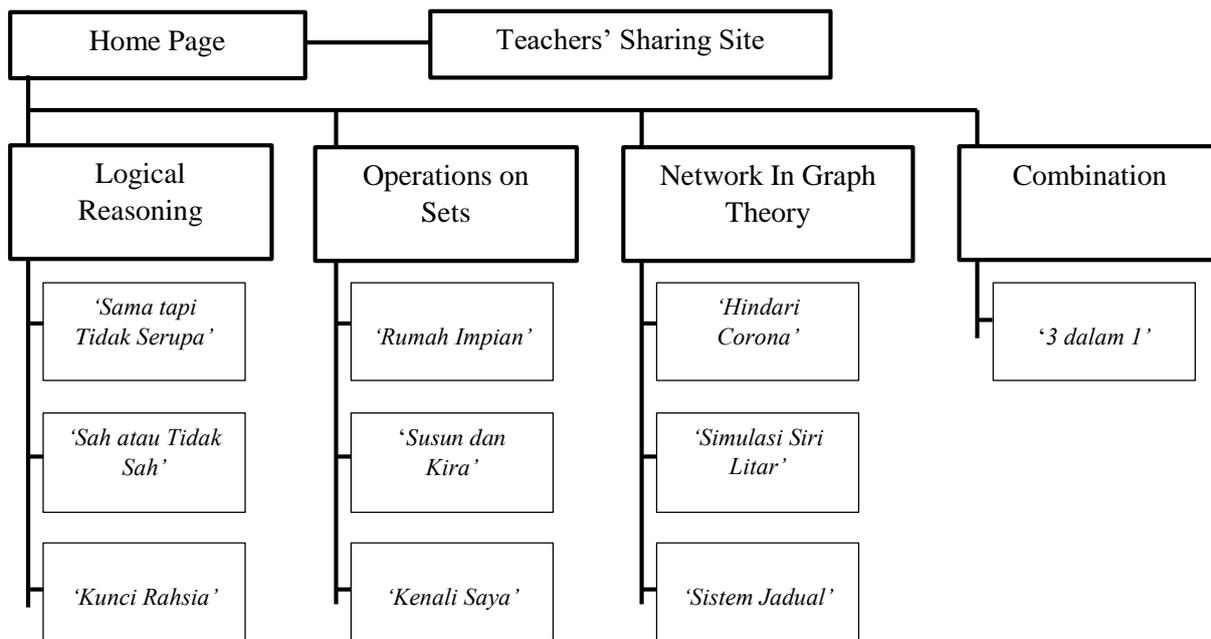
**Figure 4** Navigation map of platform

ii. Interface

Interface is appearance of the design on each screen display. Figure 5.1 and Figure 5.2 show the home page interface and teachers' sharing site on the platform which are both sketched using Stylus Pen that is found in Autodesk SketchBook application on smartphones.
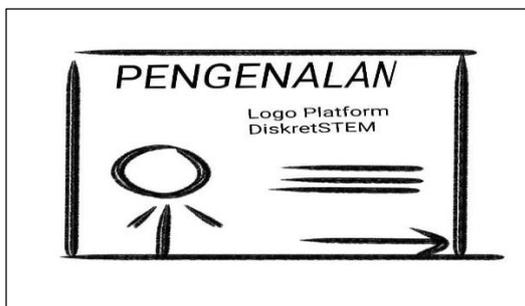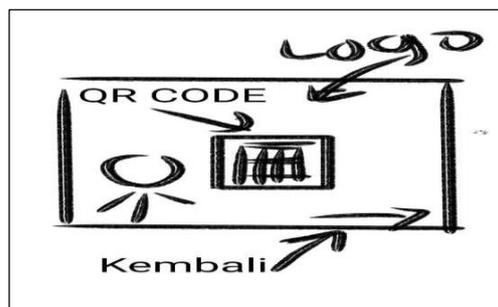


**Figure 5.1** Home page sketch



**Figure 5.2** Teachers' sharing site sketch

iii. Story board

Story board is provided to analyse the design and structure to illustrate a clear overview of the display of the platform based on the flowcharts constructed. Multimedia elements such as texts, graphics, animations, audios and videos in the activities are added, matching with the topics and STEM elements. This is to ensure that there are interactions between users and the platform built so as to achieve the intended usage of the platform.

**Development**

In this phase, the project on the platform is developed in accordance with the sketch of flow charts, interfaces and story board which have been planned in the design phase.

i. Platform Development

The storyboard completed is now ready to be launched in the form of interactive multimedia. Figure 6 shows that the actual display of the home page and teachers' sharing site on the platform.



**Figure 6** Actual display of home page and teachers' sharing site

Next, Figure 7 depicts the display of the activities that are comprised of the STEM TnL resource materials, namely Network in Graph Theory.
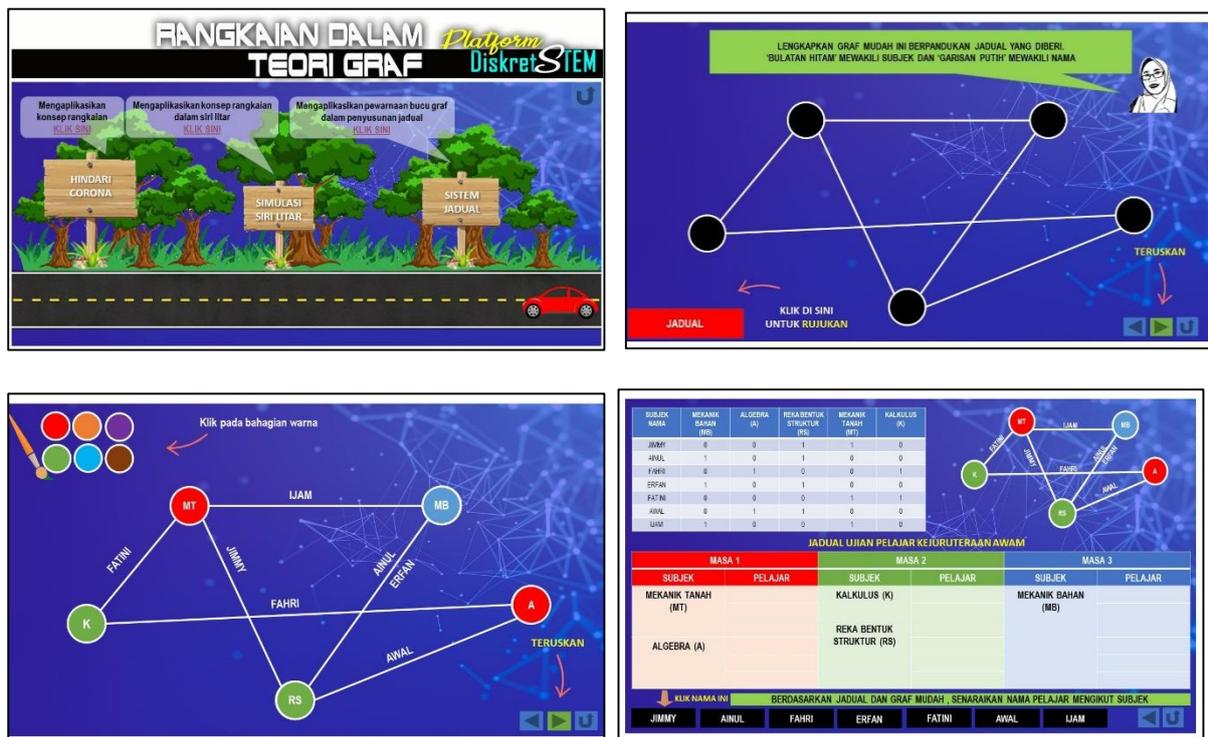


**Figure 7** Display of activities for the topic, Network in the Graph Theory

ii. Expert Validity

This phase also aims to have a closer look at the platform developed from various aspects, including how well it works, whether it is capable of attracting students' attraction and whether it meets the requirements including the use of TnL resource materials that consist of STEM elements, involving critical thinking and problem solving skills. Therefore, the validation of the platform's content is obtained according to the expert criteria. The experts involved are in the field of STEM, ICT and Mathematics. After this, improvements are

to be made on the platform after receiving the reply from the experts regarding the result of the evaluation for the content.

**Implementation**

This phase is crucial in ensuring the objective of the platform development can be achieved. In this phase, implementation of the platform is manipulated based on the perception of Form 4 Mathematics teachers and the interview with the Form 4 students.

**Evaluation**

The evaluation phase is the final phase in ADDIE model. In evaluation phase, the findings obtained from implementation phase are analysed. The result from this analysis then provides answer to the problems encountered during the research.

## CONCLUSION

A total of 14 experts consisting of DSKP drafters, senior lecturers in Mathematics who are involved in STEM, senior lecturers in ICT, and excellent teachers have been appointed to request for expert consensus in determining the validity of the platform content. From the evaluation outcomes, it was found that the platform fulfils the objectives and is tailored to the target group. Besides, the experts also acknowledged the use of learning models and STEM integration in this platform. Also, the use of interactive multimedia in this platform has received good validation from all the experts.

The development of this platform is expected to solve the issues among teachers in looking for TnL methods and resource materials to teach some topics in the field of Discrete Mathematics learning. The integration of STEM in the content and the use of interactive multimedia are expected to provide understanding and generate interest to study the topics in this field.

## ACKNOWLEDGEMENTS

## REFERENCES

[1]     Jerki, A., & Han, C. G. K. (2020). Influence of teaching experience in knowledge, motivation and implementation of STEM teaching and learning. Jurnal Pendidikan Sains Dan Matematik Malaysia, 10(2), 45–56.

[2]     Shanmugam, K., & Balakrishnan, B. (2018). Kerangka Panduan Efektif Pengajaran Dan Pemudahcaraan (PdPc) Sains Menggunakan Information Communication Technology (ICT) di Sekolah Jenis Kebangsaan Tamil (SJK)(TAML). Sains Humanika, 10(1).

[3]     Pramuji, L., Permanasari, A., & Ardianto, D. (2018). Multimedia Interaktif Berbasis STEM Pada Konsep Pencemaran Lingkungan Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa.

[4]     Hidayatul Illah A.S, R. Adawiah A. (2020). Persepsi guru terhadap pendidikan STEM di peringkat pra universiti. Journal of Educational Research Ang Indigeneous Studies, 1(1).

[5]     Hidayati, N., & Irmawati, F. (2019). Developing digital multimedia of human anatomy and physiology material based on STEM education. JPBI (Jurnal Pendidikan Biologi Indonesia), 5(3), 497-510.

[6]     Saefullah, A., Suherman, A., Utami, R. T., Antarnusa, G., & Ayu, D. (2021). Implementation of PjBL-STEM to Improve Students' Creative Thinking Skills On Static Fluid Topic. JIPF (Jurnal Ilmu Pendidikan Fisika), 6(2), 149–157.

[7]     Zakaria, Z. A. & E. (2019). Penggunaan Multimedia Interaktif dalam Pengajaran dan Pembelajaran Matematik. Amalan Baik Dalam Penambahbaikan Sistem Pendidikan. Pengajaran Dan Penyelidikan, 321–334.

[8] Sugiharni, G. A. D. (2018). Pengembangan Modul Matematika Diskrit Berbentuk Digital Dengan Pola Pendistribusian Asynchronous Menggunakan Teknologi Open Source. Jurnal Nasional Pendidikan Teknik Informatika: JANAPATI, 7(1), 58–72.

[9] Oktaviana, D., & Susiaty, U. D. (2020). Pengembangan Bahan Ajar Matematika Diskrit dalam Meningkatkan Kemampuan Pemecahan Masalah Matemtis Mahasiswa IKIP PGRI Pontianak. SAP (Susunan Artikel Pendidikan), 4(3).

[10] Kementerian Pendidikan Malaysia. (2016). Panduan pelaksanaan sains, teknologi, kejuruteraan dan matematik (STEM) dalam pengajaran dan pembelajaran. Putrajaya: Kementerian Pendidikan Malaysia.

[11] Rusli, N. F. M., Ibrahim, N. F. S. C., Shaari, M. R., & Nallaluthan K. (2021). Persepsi Pelajar terhadap Aplikasi Multimedia Interaktif dalam Proses Pengajaran dan Pembelajaran Abad ke-21. Online Journal for TVET Practitioners, 6(1), 15–24.

[12] Ibrahim, N. H., Yusoff, M. F. M., & Ghazali, N. (2017). Multimedia interaktif mempertingkatkan pengajaran dan pembelajaran kursus bahasa Melayu pengurusan (SBLM 1053) dalam kalangan pelajar Universiti Utara Malaysia. Proceedings of the ICECRS, 1(1).

[13] R. N. Farah, F. N. Hanani, R. L. Zuraida (2019). Linprot: A Multimedia Courseware For Optimization Methods With Integration Of Augmented Reality. International Journal of Scientific and Technology Research, 8(10), 2558-2563

[14] R. N. Farah, R. N. Hanani (2019). LinProT: The Feasibility of a Multimedia Courseware for Optimization Methods Course, International Journal of Recent Technology and Engineering (IJRTE), 8(4), 4601-4606

[15] Ahmad Zamzuri M.A. (2019). Multimedia dan Perisian Pendidikan. Panduan Praktikal Reka Bentuk dan Penyelidikan, Penerbit Universiti Pendidikan Sultan Idris.