*Original Research Article*

# Development and Usability of Transistor Modul Using TinkercadAmong UPSI Physics Trainee Teacher


## ABSTRACT

This study was conducted to develop Transistor module using Tinkercad and to study the usability of Transistor modules using Tinkercad among trainee Physics teachers of Universiti Pendidikan Sultan Idris (UPSI). This study is a developmental design study using the ADDIE model and developed based on Constructivism theory. A total of 84 samples from UPSI Physics trainee teachers were taken as respondents through convenient sampling method to study the usability of the module. The research instruments involved were an expert validity assessment form and a usability questionnaire. The method used to analyze the validity using the expert consent percentage method. Statistical Package for the Social Sciences (SPSS) application was used to obtain the value of Cronbach's alpha reliability coefficient while the data for the usability questionnaire were analyzed using descriptive statistical analysis data to obtain the mean and standard deviation. As a result of the study, the value of expert agreement for modules and instruments is high with values of 94.5% and 92.7%. For the research instrument got a high reliability value of 0.93. The findings of the study also show that this module has good level of usability (M = 4.67, SP =0.46). Therefore, this module is suitable to be used as a study aid for the Transistors subtopic for Form Five Physics.



*Keywords: Transistor topic; teaching and learningaid; Learning module*


## 1. INTRODUCTION

In the post-development of Industry 4.0, the education system in Malaysia needs to be emphasized on the use of information and communication technology (ICT) to produce students who are able to meet the challenges of Industrial Revolution 4.0. According to a previous study, the young generation trained in the use of computer technology will be proficient with the development of educational technology tools at this time [1]. Therefore, learning methods are not only focused on the use of whiteboards and chalk but need to involve a variety of Teaching Aids (BBM), Teaching Tools (ABM), and Learning Materials (BBB) to create a more interactive learning environment and flexible.Tinkercad is an accessible web-based platform for designing digital circuits that allows teachers to create accounts and allows students to participate in class online and allows teachers to monitor student work [2]. Traditional learning methods require an electronic laboratory to test a component or in other words hands on activities but now with the presence of a platform like Tinkercad all experiments related to circuits can be carried out virtually.

Many student experience difficulties in understanding the function and operation of transistors during teaching and learning [3]. The reason for students' challenges in mastering the Transistor subtopic is the lack of interaction during teaching sessions and the complexity of understanding the theory and operating principles of transistors [4]. The Covid-19 pandemic has further exacerbated this situation, as it has limited interaction between students and teachers, resulting in restrictions on all laboratory activities. The impact of this epidemic has also affected students' access to physical libraries, workstations, and laboratories, as well as face-to-face consultations with supervisors, fieldwork opportunities, attendance at workshops or academic conferences, and participation in academic networks. Therefore, this study aims to develop a

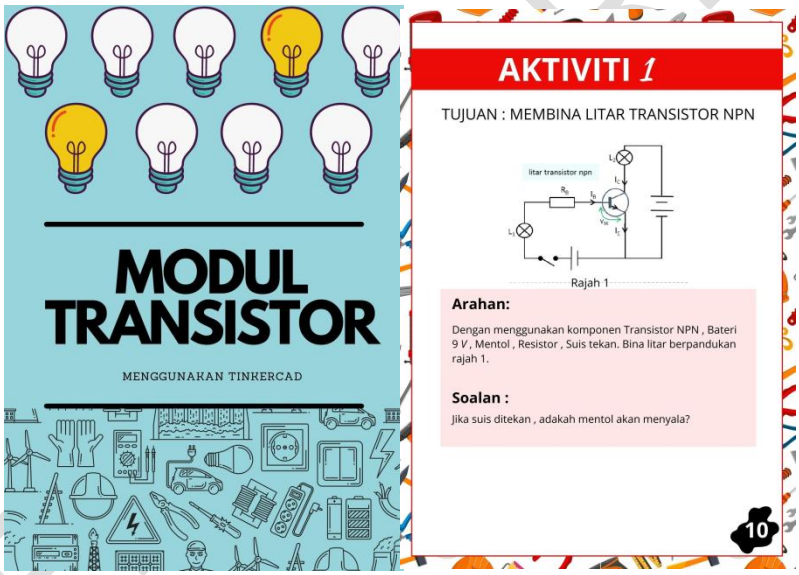

UNDER PEER REVIEW

Transistor module using Tinkercad. The objectives of this study include developing a Transistor module using Tinkercad for Electronics topics and assessing the usability of the Transistor module using Tinkercad among UPSI Physics trainee teachers.

## 2. MATERIAL AND METHODS

### 2.1 Transistor Module using Tinkercad

Tinkercad is an online computer-aided design (CAD) software application widely used by students and beginners who seek to learn on an online platform and gain a better understanding of theory. This module was developed based on this online software. The developed module comprises four elements: concise notes, exercises, simulation activities using Tinkercad, and a concept map. The module development was carried out using Canva.com online software. The design in terms of color, theme, and cover was created using this software. In the front content section of the module, there is a Tinkercad user manual along with important icons used in the Tinkercad platform. In addition to concise and engaging notes, the researcher has selected six simulation activities that require the use of Tinkercad, including building NPN transistor circuits, constructing PNP transistor circuits, exploring the use of transistors as current amplifiers, and creating three types of transistor circuits as automatic switches. Figure 1(a) displays the front page of the module, while Figure 1(b) illustrates the activity of building an NPN transistor circuit.




(a) (b)

Figure 1 Illustration of module in Bahasa Malaysia(a) Front page of the Module (b) Illustration of an activity for an NPN transistor circuit

### 2.2Research Design

The ADDIE model was chosen for the development of this module. During the analysis phase, the researcher conducted an analysis related to past studies on the research topic. At this stage, the main activity was to analyze the current issues in the Malaysian education system. Among the issues highlighted were the current circumstances where there is limited interaction between students and teachers during online learning, as well as issues related to the Transistor subtopic. Therefore, a module was developed as a learning aid to help alleviate these problems. In the design phase, the researcher shaped the study and selected research instruments. Tinkercad software was chosen, which is a platform that allows online simulation. In the development phase, the Transistor module was created using Tinkercad, and a survey form was developed. The developed Transistor module includes concept mapping, concise notes, Tinkercad simulation activities, and reinforcement exercises.

UNDER REVIEW

Furthermore, during the implementation phase of the Transistor module, both the module and the survey form went through expert validation. This was done to ensure that the research instruments developed achieved a good level of validity for the continuation of the pilot study. After calculating the expert agreement percentage and taking into account all comments and opinions from the experts regarding validity for the purpose of improving the Transistor module, the pilot study was conducted. The data obtained from the pilot study was then analyzed using the Cronbach's Alpha method with the SPSS software. Subsequently, the usability questionnaire was distributed to 84 respondents, who were physics trainee teachers from UPSI. The assessment phase was then continued by analyzing the data obtained from the 84 respondents. The actual research data was analyzed using descriptive statistical analysis methods with SPSS.

### 2.3Research Population and Sample

This study involved three categories of respondents, namely expert respondents from among physics lecturers and teachers to assess the validity of the module's appearance and content, as well as the usability questionnaire, and then two groups of Bachelor of Education in Physics students to assess the reliability and usability of the module. Three experts were selected through purposive sampling, while student respondents were selected through convenience sampling. The sample size taken was a total of 84 respondents according to Krejcie and Morgan (1970) [5]. Table 1 shows respondent information according to the objectives and numbers.

Table 1. Demographic information of respondents according to purpose and phase of involvement.

| No | Purpose of Sampling | Phase Involved | No. of Respondent |
|---|---|---|---|
| 1 | Expert validity | Implementation | 3 |
| 2 | Instrument reliability | Implementation | 15 |
| 3 | Module usability | Evaluation | 84 |

### 2.4Research Instrument

There are two instruments used in this study: the validity form and the usability questionnaire. The module and the usability questionnaire developed needed to undergo both face validity and content validity by experts first in order to measure the accuracy of a measurement used in research [6]. Therefore, the module and usability questionnaire needed to undergo validity assessment by three experienced experts in the field of Physics. Expert comments and opinions were considered for the purpose of improving the Transistor module.

Furthermore, the reliability questionnaire is the same as the usability questionnaire, which was adapted and modified from the 'Measuring usability with USE questionnaire by Lund, 2001 [7]. This reliability questionnaire consists of two parts: Part A includes questions related to respondent demographics, while Part B is used to determine the usability of the module, involving 3 constructs: usability, user satisfaction, and user-friendliness. Each construct consists of 5 items each. The Likert scale used is a five-point Likert scale [8].

### 2.5Data Analysis

For expert validity, it is assessed based on the percentage of expert agreement where a validity of 70% is considered to have reached a high level of accomplishment [9]. Furthermore, the reliability data from the pilot study and usability data from the actual study will be analyzed using the Statistical Package for Social Science (SPSS) application.

## 3. RESULTS AND DISCUSSION

### 3.1The Validity of Force Measurement Kit

Based on the findings of the expert validity agreement percentage, the Transistor module and the usability questionnaire have a high level of validity, exceeding 90%. This value indicates that the research instruments are good and can be

UNDER PEER REVIEW

proceeded to the pilot study and the actual study to assess the usability of the transistor module using Tinkercad. Table 2 shows the interpretation of the expert agreement percentage for the Transistor module and research instruments.

Table 2. Expert agreement percentage for the Transistor module

| | Face validity percentage (%) | Content Validity percentage (%) |
|---|---|---|
| Expert 1 | 93.9 | 94.4 |
| Expert 2 | 95.0 | 91.0 |
| Expert 3 | 94.5 | 92.7 |
| Average | 98.3 | 93.3 |

### 3.2Reliability of Questionnaire Instrument

A pilot study was then conducted to measure the reliability of the developed instruments. The pilot study was carried out and involved 15 trainee physics teachers from semester 6. A Cronbach's Alpha value exceeding 0.8 indicates a high level of reliability [10]. Therefore, a Cronbach's Alpha value of 0.93 is at a high level for this reliability test. This indicates that the usability questionnaire is of good quality, consistent, and reliable for use in obtaining usability data in the actual study. Thus, this questionnaire can be used in the actual research due to its high reliability value and high level of consistency [11]. Table 3 shows the Cronbach's Alpha values obtained from this study.

Table 3. Instrument Reliability Based on Constructs

| Construct | Number of items | Cronbach Alpha |
|---|---|---|
| Usefulness | 5 | 0.89 |
| Easy to use | 5 | 0.95 |
| Satisfaction | 5 | 0.97 |
| Average | | 0.93 |

### 3.3Usability of the Transistor Module Using Tinkercad

"Questionnaires were employed to collect data from trainee teachers who used the Transistor Module Using Tinkercad. A total of 84 respondents, consisting of prospective physics teachers at Universiti Pendidikan Sultan Idris, completed the questionnaires. The study findings were analyzed by calculating mean scores and standard deviation values to assess the level of agreement among the respondents, as presented in Table 4. The results of the analysis indicate a high level of agreement among the respondents for each aspect of the Transistor Module evaluated in the questionnaire, including its usefulness, ease of use, and satisfaction. Furthermore, all items have a standard deviation of less than one, signifying a strong consensus among the respondents[12]. This suggests that there is a high level of agreement among the respondents. They believe that the Transistor module can be used as a teaching and learning module, increasing student engagement and improving understanding of the Transistor subtopic. This finding is supported by research by Ali, Abdullah and Rahman (2020), which indicates that student interest, attitudes, motivation, and achievement can be enhanced through the use of modules in learning [13]. Overall, this usability construct has a high interpretation (M=4.70, SD=0.43). Therefore, the module has a high level of usability among UPSI physics trainee teachers in terms of usability.

The module also has a high level of usability among UPSI physics trainee teachers in terms of user-friendliness (M=4.60, SD=0.5). They believe that the module is easy to use, can be used at any time, and is user-friendly. This is because, a good module should have good and user-friendly content [14]. In addition, the use of technology-integrated learning aids

UNDER PEER REVIEW

allows students to learn independently or with a teacher and explore modules at their own pace [15].The last construct is user satisfaction. The module also has a high level of usability among UPSI physics trainee teachers in terms of user satisfaction (M=4.7 , SD=0.46). They find the module interesting and satisfying. This is because user satisfaction is characterized as the user's assessment of a product, whether it meets user needs and expectations [16]. Thus, all respondents agree that this module has good satisfaction and a high level of agreement among respondents. Values exceeding 3.67 indicate a high and acceptable minimum value [17]. This shows that the Transistor module using Tinkercad has a high level of usability and good user satisfaction, as well as a high level of agreement among respondents (M=4.67, SD=0.46). Refer to Table 4 for usability analysis for each construct.

Table 4. Average mean scores and average standard deviation value for each aspect

| Items Category | Mean Score | Standard Deviation |
|---|---|---|
| Usefulness | 4.70 | 0.43 |
| Easy to use | 4.60 | 0.50 |
| Satisfaction | 4.70 | 0.46 |
| Average | 4.67 | 0.46 |

## 4. CONCLUSION

The Transistor module using Tinkercad has been successfully developed in this study. Overall, this study has successfully achieved its research objectives, which are to develop the Transistor module using Tinkercad for the Electronics topic among UPSI Physics Trainee Teachers and to assess the usability level of the Transistor module using Tinkercad among UPSI Physics Trainee Teachers. The research findings indicate that this module has an average expert validation rate for the module and research instruments of 94.5% and 92.7%, respectively. The usability questionnaire has also undergone a pilot study and has a high reliability score of 0.93. The minimum values for the usability construct are 4.70 (SD=0.43), for the user-friendliness construct are 4.60 (SD=0.5), and for the user satisfaction construct are 4.70 (SD=0.46). On average, this module has a high level of usability (M=4.67, SD=0.46). However, this study only focused on the usability level of the Transistor module using Tinkercad among trainee teachers. Therefore, further research is needed to determine the effectiveness of this module as a teaching aid for the Transistor subtopic.

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UNDER PEER REVIEW

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UNDER PEER REVIEW