

Original Research Article

The Development and Perception of Trainee Teachers towards smartphone based Free Fall Measurement Kit using Arduino

ABSTRACT

The Free fall motion is one of the topics that are always considered difficult for Physics Students. The lack of teaching aids in this topic is also why students are less exposed to the free fall concept. Thus, this study aims to develop a Free Fall Kit as a teaching aid for the Physics Form Four under subtopic Free Fall Movement. This kit is developed using an Arduino microcontroller where the result of gravitational acceleration will be displayed on the smartphone using Bluetooth module. This study also aims to test trainee teachers perceptions majoring in physics at Universiti Pendidikan Sultan Idris towards the Free Fall Kit. The validity study was conducted on three experts among the physics lecturers at the Sultan Idris University of Education. These validity data were analyzed using Percentage of Consent. The validity value obtained showed a high value where the total percentage of validity agreement from the three experts was 98.3% for face validity and 93.3% for content validity. This study uses a descriptive method to assess the instrument reliability and respondents perceptions of the developed kits. The data obtained showed that Cronbach's Alpha value is 0.97, an average mean score is 3.82 and an average standard deviation value is 0.28 indicate that the level of reliability and perception is at a high level of agreement among the respondents. In conclusion, the Free Fall Kit has a good perception among trainee teachers of Universiti Pendidikan Sultan Idris and has achieved the objectives of this research. The implication is that the Free Fall Kit can be an alternative teaching aid for teachers to teach the subtopic of free fall motion to determine the value of gravitational acceleration.

Keywords: Free fall motion; teaching and learning aid; Arduino Kit

1. INTRODUCTION

The Education in Malaysia plays an important role in producing a balanced and harmonious current generation in terms of physical, emotional, spiritual, intellectual and social. Science Education in Malaysia is a field that encompasses knowledge, skills, scientific attitudes and values. Physics is one of the elective subjects for the science curriculum offered at the upper secondary level. The Physics curriculum plays a vital role in producing students who have knowledge and skills in technology and physics and are able to solve problems and make decisions in daily life based on scientific attitudes and values. The topic of force and motion is one of the topics covered in form four physics subjects in Malaysia. This topic is among the topics that are often considered difficult and require a high level of understanding to understand topic [1]. Among the subtopics covered in the topic of force and motion is free fall motion.

According to Nordin (2019), in his study of students' problems in learning physics to link the concept of physics with actual phenomena, students are confused and cannot imagine the physics phenomenon of acceleration that causes motion [2]. Only 35.48% of students answered correctly otherwise; 64.52% answered incorrectly. The alternative of using radical clocks is inaccurate for determining the value of gravitational acceleration, g [3]. One of the efforts in understanding the concept of physics requires the help of learning media such as teaching aids (TA) during teaching and learning sessions (TnL). TA can help students understand a concept of physics that is from abstract to concrete [4]. The use of traditional methods such as chalk and blackboard is no longer relevant to current educational developments. The dumping of

technology in education that provides multiple platforms to students should be the top choice of teachers [5]. Therefore, teachers need to implement the use of technology during their TnL sessions.

The use of teaching aids in the TnL process is a very important medium for a teacher to help speed up the process of student understanding and improve the quality of teacher teaching. Therefore, the Free Fall Kit was proposed to solve students difficulty in mastering the concept of free fall motion. This study was implemented to achieve the objective of the study which is to develop a Smartphone based Free Fall Measurement Kit using arduino as a teaching aids for the subtopic of free fall and test the perception of trainee teachers on this developed kit.

2. MATERIAL AND METHODS

2.1 Free Fall Measurement Kit

The Arduino Microcontroller has been used in this study, the primary purpose is to build a kit that is easy to carry and use. Figure 1(a) shows the block diagram of the kit where it consists of two infrared (IR) sensors, and the output will display on the android smartphone. Figure 1(b) shows the circuit diagram, where the IR sensors are connected to PIN 7 and 9. IR sensor emits the light to sense some object of the surroundings.

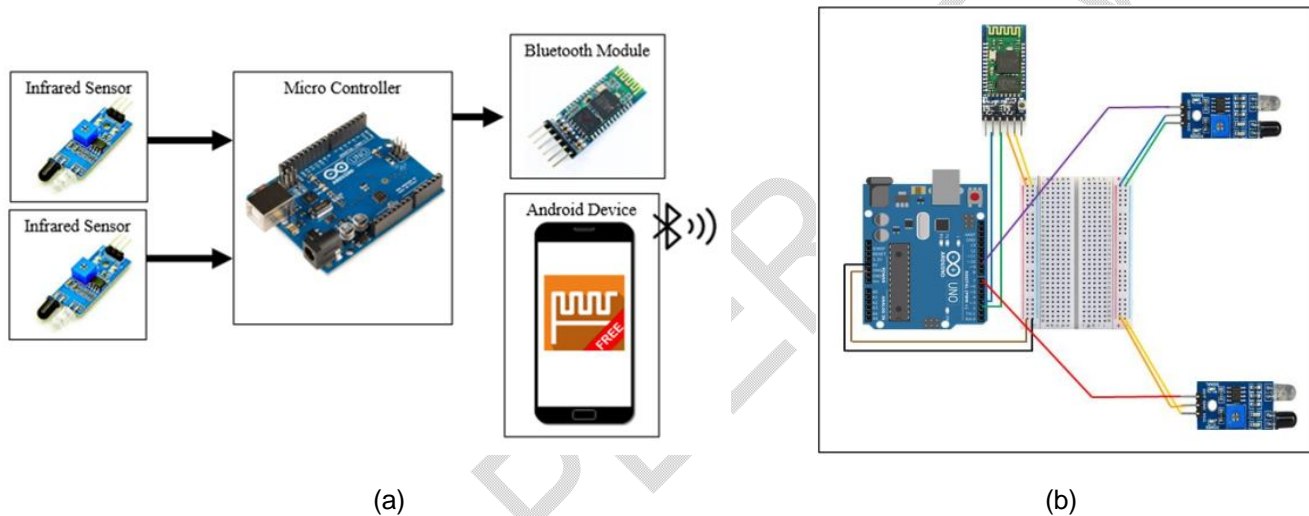


Figure 1. (a) The block diagram (b) circuit diagram of free fall kit

For the kit setup, two infrared sensors were placed on the top and bottom of a rod stick with a distance between the two infrared sensors is 120 cm as shown in Figure 2 (a-b). The IR sensor will detect the object released at starting point passing through IR 1 and then IR 2. Then, and time passing both the sensors will be measured, starting at point IR 1 and ending at point IR 2. The value of gravitational acceleration, g will be calculated based on the time value, t recorded by the arduino. Using the bluetooth module, the gravity acceleration value, g will be displayed on the smartphone screen via the RemoteXY application. Figure 2(c) shows the RemoteXY application used and the display value of g .

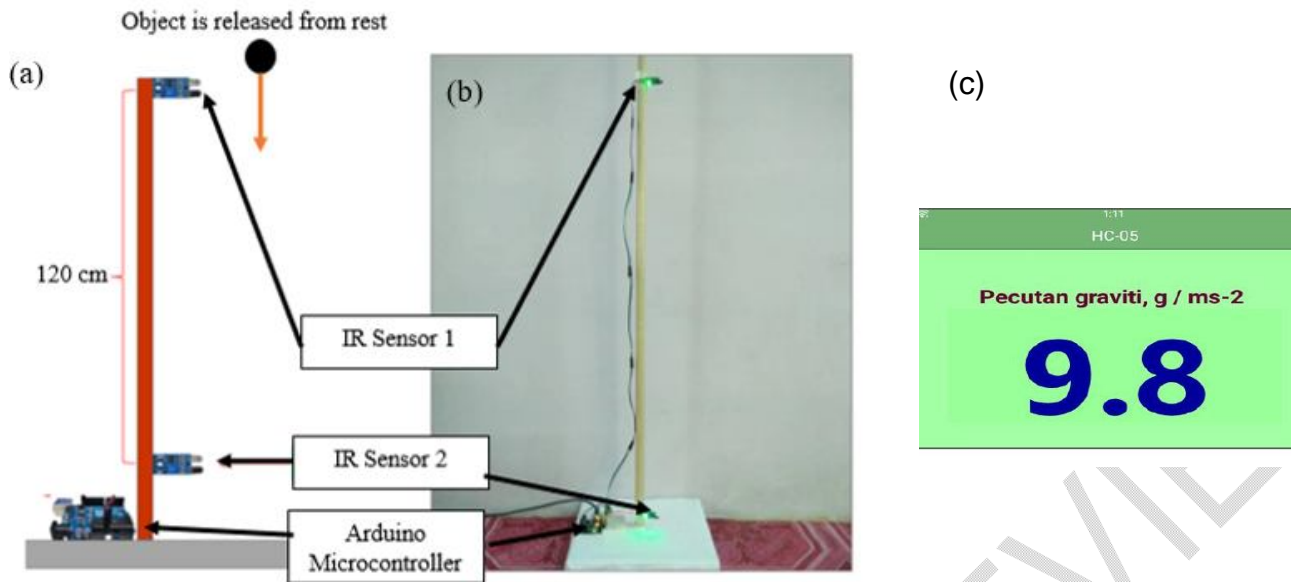


Figure 2 (a) The illustration of free fall measurement kit; (b) the developed free fall kit; (c) The real time data where the value of gravitational force display on the smartphone.

2.2 Research Design

The ADDIE model was used as the primary reference in the development of this kit. The ADDIE model consists of five phases: analysis, design, development, implementation, and evaluation. In the analysis phase, the researchers conducted a literature review to identify the problems in education. As stated in the study problem statement, students mastery for the concept of gravitational acceleration is at a low level where students are confused and unable to imagine the phenomena of acceleration physics [2]. During the design phase, the researchers sketched the Free Fall Kit. Later, the development phase of the researchers developed the Free Fall Kit as discussed in the previous section. Next, in the implementation phase, the researchers obtained validity from three experts while reliability and perception from the respondents among the trainee physics teachers involved. Finally, in the evaluation phase, the researchers analyzed the actual study data obtained to determine the level of trainee teachers perceptions of the developed kits.

2.3 Research Population and Sample

The population in this study consisted of trainee physics teachers at the Sultan Idris University of Education. The sampling method is done using the cluster random sampling method. Based on table 1, the study sample is divided into three groups, depending on the sampling purposes. The validity of experts involved 3 of experts, reliability of instrument that will be pilot test, will involved 15 of respondent. And lastly, the perception toward kit, 30 trainee physics teachers. According to Roscoe (1975), a total of 30 respondents is sufficient to perform most of the study if the study population consists of 30 to 500 people [6].

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	Trainee teachers perception	Evaluation	30

2.4 Research Instrument

This study uses two types of instruments, namely expert validity assessment form and perception questionnaire form. An expert validity assessment form was used to review the validity of the product while a perception questionnaire form was used to test the usability perception of the kits developed in this study. The perception questionnaire form was adapted and modified from the USE questionnaire form [7]. The questionnaire is divided into four parts: part A on the respondents information, part B on the usefulness, part C on the ease of use aspect, and part D on the product satisfaction aspect. Sections B, C, and D use a four-point Likert scale with one to four values.

2.5 Data Analysis

Validity data were analyzed using the Content Validity Index, CVI to study the validity of the instrument while the Percentage of Consent to study the validity of the kit. Reliability and perception data were analyzed using Statistical Package for Social Science (SPSS) to obtain Cronbach's Alpha value to determine the level of instrument reliability while mean score and standard deviation to determine the level of trainee teachers' perception of the Free Fall Kit developed..

3. RESULTS AND DISCUSSION

3.1 The Validity of Force Measurement Kit

A product validity evaluation form was used to obtain data on the validity of the Free Fall Kit developed in this study. The researcher has obtained validation from three experts consisting of physics lecturers at the Sultan Idris University of Education. There were 10 items on the face validity section and five items on the content validity section that used a four - point likert scale that had a value of one to four. Researchers determine the validity value of a product by analyzing the data obtained using the percentage of agreement.

The study results from the product validity evaluation form found that the average percentage of agreement for the three experts was 98.3% for face validity and 93.3% for content validity (Table 2). It has been explained that the achievement level of 70% is considered to have mastered or achieved a high level of achievement and suitable for use [8]. Therefore, validity with a value of 90% is considered to have reached a high level of achievement

Table 2. Average percentage of agreement for kit validity

	Face validity percentage (%)	Content Validity percentage (%)
Expert 1	100.0	80.0
Expert 2	100.0	100.0
Expert 3	95.0	100.0
Average	98.3	93.3

3.2 Reliability of Questionnaire Instrument

This study conducted a pilot testing process before the actual study was implemented to collect data. A pilot test can be referred to as a small test that needs to be conducted to assess feasibility, time, cost, reversal effects or adverse effects and the size of its effects in order to improve the study design before carrying out actual research [9]. The pilot test conducted in this study helps the researcher undergo the actual data analysis process to achieve the study objectives. In the pilot testing process, the reliability and feasibility of the questionnaire formed will be reviewed and improved based on the respondent's feedback. Questions that are unable to achieve the objectives of the study will be discarded.

Cronbach's Alpha is a statistic that is generally used by researchers as a measure of reliability to ensure that the constructed questionnaire instruments are approved for research purposes in actual studies [10]. Reliability data were analyzed using a questionnaire form. The researcher has obtained the level of reliability through a questionnaire from 15 respondents consisting of prospective physics teachers in semester seven at Universiti Pendidikan Sultan Idris. The analysis of the study findings from the questionnaire found that the average value of Cronbach's Alpha is 0.975 (Table 3). The highest Cronbach's Alpha value is 0.977 for the satisfaction aspect followed by 0.975 for the usefulness aspect and finally 0.973 for the ease-of-use aspect. According to Taber (2018) a reliability value is accepted if the Cronbach's Alpha value exceeds 0.8. Therefore, the level of reliability of the questionnaire instrument is at a high level [10].

Table 3: Instrument Reliability Level

Items Category	Cronbach Alpha
Usefulness	0.975
Easy to use	0.973
Satisfaction	0.977
Average Cronbach Alpha	0.754

3.3 Trainee Teachers Perceptions of Free Fall Kits

Questionnaires were used to obtain data on trainee teachers perceptions of the Free Fall Kit developed. It was filled by 30 respondents consisting of prospective physics teachers in semester six and eight at Universiti Pendidikan Sultan Idris. The researcher has analyzed the study findings using mean scores and standard deviation values to determine the respondents' level of agreement. Based on Table 4, the results of the analysis of the study findings for each aspect of the Free Fall Kit developed in the questionnaire, namely the aspects of usefulness, ease of use, and satisfaction are at a high level of agreement. Physics trainee teachers had a high level of perception for aspects of usefulness (mean = 3.82, standard deviation = 0.308). Physics trainee teachers agree that the Free Fall Kit is helpful for teachers to teach the concept of gravitational acceleration. It can also be used to engage students, increase student understanding, and save students time while studying the topic of Gravity Acceleration and can be used to improve student performance for Physics subjects. This indicates that the majority of the respondents agreed in the aspect of the usefulness of the Free Fall Kit as a tool that can help in the TnL process. This is in line with research conducted by Hamdan & Jasmi (2014), stating that teaching aids can help teachers convey a topic taught better [11].

Furthermore, the physics trainee teachers also had a high level of perception for the easy -to -use aspect (mean = 3.78, standard deviation = 0.275). There are five items in the ease-of-use aspect. Trainee physics teachers agree that the Free Fall Kit is easy to use, can be used anytime and anywhere. Furthermore, the user manual contained in the Free Drop Kit is user -friendly. Finally, the trainee teachers felt that they could use the Free Fall Kit successfully at all times. This indicates that the majority of the respondents agreed in the easy -to -use aspect i.e. the Free Fall Kit is easy to use in the TnL process. This is in line with the research conducted by Boimau and Mellu (2019), conducting a study on the development of microcontroller-based TA [12]. The use of TA in the learning process can reduce difficulties, make the planning of TnL sessions run smoothly and information retrieval becomes easier.

Finally, physics trainee teachers also had a high level of perception for aspects of satisfaction (mean = 3.87, standard deviation = 0.264). There are five items in the aspect of satisfaction. Physics trainee teachers are satisfied, enjoy using the kit, feel the need to own the Free Fall Kit, intend to use the free fall kit when teaching Gravity Acceleration in the future, and recommend the Free Fall Kit to their other friends. This indicates that most of the respondents agreed in the satisfaction aspect of the Free Fall Kit developed as TA in the TnL process. Overall, the results of the analysis of the study findings from the questionnaire showed the average value of the mean score for all three aspects found (mean = 3.82). A mean score value between 3.00 to 4.00 is a good value because it is a high level of evaluation given by the respondents [13]. The mean value of the standard deviation for all three aspects was found (standard deviation = 0.282). Standard deviation values ranging from 0.00 to 0.75 indicate very high respondent agreement [14].

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

Items Category	Mean Score	Standard Deviation
Usefulness	3.82	0.308
Easy to use	3.78	0.275
Satisfaction	3.87	0.264
Average	3.82	0.282

4. CONCLUSION

This study has developed a Free Fall Kit that has a good perception among trainee teachers of Universiti Pendidikan Sultan Idris as a teaching aid in the subtopic of Form Four Free Fall Movement. The validity values obtained from the three experts showed a high value where the total percentage of validity agreement was 98.3% for face validity and 93.3% for content validity. The Cronbach's Alpha value obtained for the pilot study was 0.97 having a high level of reliability. Furthermore, for the actual study found that the average mean score value is 3.82 and the average standard deviation value is 0.282 indicating the level of perception is at a high level of agreement among the respondents involved. The implication is that the Free Fall Kit can be used as an alternative teaching aid for teachers to teach the subtopic of free fall motion to measure the value of gravitational acceleration.

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UNDER PEER REVIEW