

A conceptualization of Tactile Cathode Ray Oscilloscope in Learning Electronics via 3D Printing Approach

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ABSTRACT: Physics is a branch of STEM that deals with different properties of energy and matter. It is often difficult for students to grasp concepts as they cannot visualize the phenomena. Therefore, educators may need fun teaching aid to advocate teaching and learning process. Hence, 3D printing technology can be effective in providing better visualization and interaction with three - dimensional models that can ease the learning experience. The main objective of this research is to design model for teaching aid and consequently develop 3D printing-based learning. Therefore, a survey was conducted to obtain most difficult topic in physics to establish which object to be printed. It was found that Electronic is the most difficult topic and Cathode-ray Oscilloscope (CRO) and therefore CRO was used as the 3D model in the classroom. The CRO model then will be used as teaching aid in the classroom together with a module that was developed. This study is expected to greatly revolutionize educator-coordinated, student-oriented learning of physics. Designation of this teaching aid will enable students to self-develop into innovators and enhance the quality the teaching and learning of physics.

Keywords: *Gifted and Talented Education; Teaching aid, Visualization*

INTRODUCTION

Physics, as the component of STEM is a study of real world which make it one of the roots in science. The knowledge of physics needs to be through by understanding the conceptual not by memorize [1]. However, there are emerging concerns about Physics education due to the deteriorate affection in physics subject among the secondary school students. Previous study found out that pedagogical approaches showed that highest contribution to the decreasing interest in physics followed by the difficulty of the subject itself [2,3]. Therefore, an urgent action must be taken to develop and improve the performance of Physics educators in delivering the knowledge.

Meanwhile technological advancement through Industrial Revolution 4.0 has addressed 11 elements which including 3D printer as one of the main elements Education must also in a line with the Industrial Revolution 4.0 which bring the 3D printer technology in education [4].

Hence, the aim of this study is to integrate 3D

printer in Physics education as an alternative method to improve student's interest through fun learning activity with the addition of low-cost teaching aids.

METHODOLOGY

2.1 Development of questionnaire

A set of survey questions was developed consists of the physics chapters and topics based on National Curriculum of Malaysia and the difficulty level of each chapter.

2.2 Designing 3D printed CRO model

Analysis on survey conducted was carried out and it was found that the most difficult chapter in Physics is Electronics and Cathode Ray Oscilloscope (CRO). Therefore, a design model was develop using 2D sketch and converted into 3D design using TinkerCAD software. Consequently, the stereolithography (STL) file was generated for printing purposes and converted it in g-code form. The model was then 3D printed using Original Prusa MINI.

2.3 Implementation of CRO Model in Classroom

Implementation on 3D printed CRO was carried out by educators towards 35 students of Kolej GENIUS Insan. During the implementation process, theory and concept of the topic was delivered. Meanwhile, hands-on activity was conveyed, where students were divided into groups, and they were given a specific task to be completed. At the end of the program, survey was conducted again to obtain the level of understanding after learning from the 3D printed CRO.

3. RESULTS AND DISCUSSION

3.1 Development of questionnaire

Level of difficulty of Physics topics was summarize in Table 1 based on the survey performed. The easiest chapter in Physics is Chapter 1 while the highest percentage of respondents choose "Difficult" as their level of difficulty is shown by chapter Electromagnetism and Electronic. Hence, from the analysis in Table 1, selection was made between these two chapters and Electronic is chosen. In Electronic chapter, Cathode Ray Oscilloscope (CRO) was chosen as a tool to be used in explaining many concepts and applications in this chapter.

Table 1 Highest percentage of responses based on difficulty level

Chapter	Percentage (%)	Difficulty Level
1	42.29	Very Easy (VE)
2	33.49	Normal (N)
3	42.17	Easy (E)
4	35.53	Normal (N)
5	35.25	Normal (N)
6	32.04	Normal (N)
7	29.85	Normal (N)
8	30.77	Difficult (D)
9	27.66	Difficult (D)
10	33.33	Normal (N)

3.2 2D Sketching and 3D Modelling

Figure 1(a) shows the 2D sketch of the CRO developed. Designing the 3D model in graphical form is done by referring the designated 2D sketching and converted into g-code. This process is important because g-code is the form that read by the 3D printer after converted in .stl file that contains the information of the model [5]. Finally, the 3D model was converted into 3D printed model of CRO containing The 3D model of CRO consisting of few components including accelerating and focusing anode, cathode, case, control grid, x and y plate, connectors, pole (Figure 2).

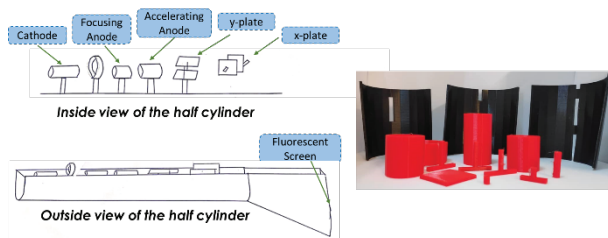


Figure 1 (a) 2D sketch of CRO and (b) 3D printed CRO components.

3.3 Implementation of 3D Printed CRO

Figure 3 shows the results on the percentage of response toward the efficiency of the 3D printed CRO model in delivering concept of Electronic in classroom. The result showed a positive response towards the employment of 3D printed CRO in classroom where 47.8% had chosen “Strongly Agree” and 43.7% choose “Agree” that the respondents were enjoyed the program, the model is useful in introducing the concept of Electronic, Besides, the respondents think that this teaching approach is beneficial to them. Hence, this finding demonstrated that the employment of teaching approach was successfully executed as a fun method towards increasing student’s interest in learning physics [6].

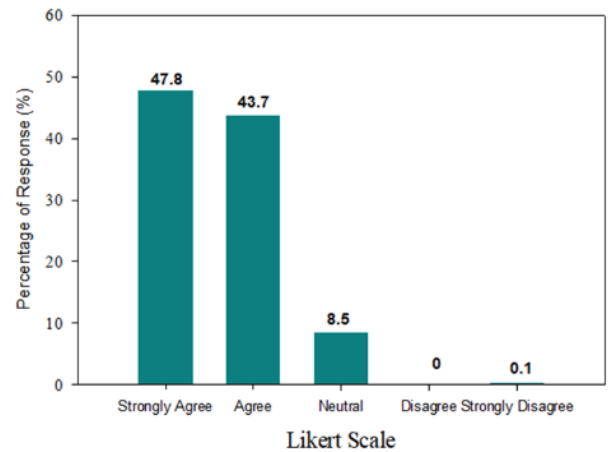


Figure 3 Response on the implementation of 3D printed CRO in classroom

4.0 CONCLUSION

3D printing has successfully incorporated into physics syllabus in secondary school level for a wide and variety applications. Educators can use 3D printer to fabricate their customized tools and equipment to be used as teaching aid. This research proved that teaching approach can be improved by using 3D printing model.

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