AN EFFECTIVENESS OF THE "FIST"-FORCE IN SIMPLE TRUSS AND APPS ENHANCEMENT FOR IMPROVING UNDERSTANDING AND VISUALIZATION SKILLS OF STUDENTS IN TRUSS ANALYSIS FOR ENGINEERING MECHANICS SUBJECT

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ABSTRACT: The objective of this paper is to improve the understanding of truss analysis among mechanical students through the implementation of interactive learning. In this study, a series of hands-on activities developed and integrated with the apps apply into the Engineering Mechanics classes to enhance students' comprehension of the behavior of trusses. The educational tools included the FIST, a 3-D model and an interactive apps experienced by students gives different learning environments. Through visualizing, this learning tool helps students see the differences between textbook solutions and in-class demonstrations hence experiencing 3-D model behaviors with apps in truss analysis. Additionally, students were given a more profound impression through the usage of the FIST in order to facilitate longer-term retention. To evaluate the implication of this learning approach, a quantitative survey technique is conducted through questionnaires among Engineering Mechanics student. Results show how this approach was able to increase students' skills and understanding as well as improvement of their motivation to learn truss analysis.

KEYWORDS: *3-D model, FIST, Engineering Mechanics, trusses analysis, interactive learning*

1.0 INTRODUCTION

The Engineering Mechanics is on core subject of mechanical program. These classes provide the knowledge of static and dynamics fundamental that include the trusses analysis. This subject delves into the foundational concepts of mechanics, such as Newton's laws of motion, equilibrium of forces, moments, analysis of structures and also analysis of dynamic motion include kinematic and kinetic of particles [1]. Through Engineering Mechanics, students develop critical problem-solving skills and learn to apply mathematical principles to analyze and predict the behavior of various mechanical systems, structures and also dynamics motions.

Based on the student achievement for each semester reported that the main affected reason on higher student failure rate due to the truss analysis in structure subtopics. In engineering a truss is a structure that consists of two–force members only, where the members are organized so that, the assemblage as a whole behaves like a single object [2]. The principle force in each element in a truss is axial tension or compression. The force in the bar of a truss structure is assumed as positive when corresponding to tension and they are considered as negative when representing to compression [3].

To analysis the force and corresponding condition of truss, tension or compression, two method which are method of joints and method of sections should students mastered. Students need to comprehend with several equations and complex mathematical solution. Traditionally, trusses analysis has always been related with traditional methods and hand calculations heavily relying on algebra, trigonometry, and geometry [4]. This method has created the unexciting learning process produced negative perception and loss of student interest. Figure 1 illustrated the percentage of student failure rate for Engineering Mechanics subject on three academic semester session.

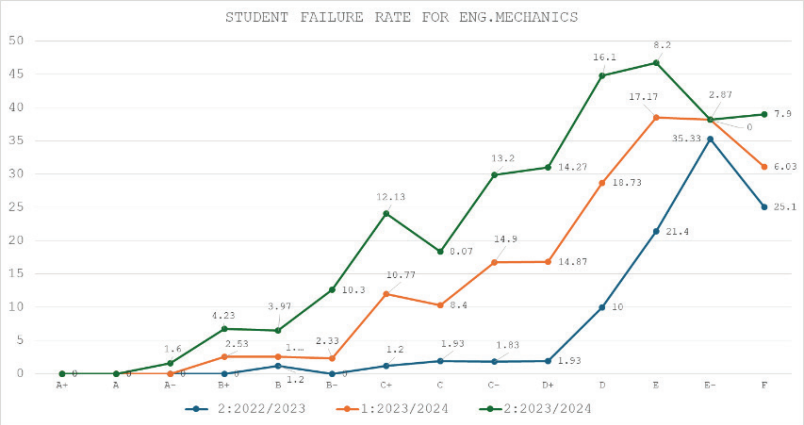

Figure 1: Percentage of student failure rate

Globally, interactive learning approaches have attracted a lot of interest as pedagogical approaches to improve polytechnic student learning outcome. These ways of teaching, in which students are actively involved in the process of learning, have been studied a lot and are used in many colleges and universities in the US, Europe, and other places [5]. Research has shown that interactive teaching methods positively impact student understanding and interest during learning process. Active learning approaches, including interactive methods, led to improved student performance in science, engineering, and mathematics courses [6].

Truss Analysis interactive learning through the FIST include student participant to conduct the model. The learning process exposed student to picture the real condition force in the truss members, while operate the FIST together with application of SW Truss apps. Principles for good practice in undergraduate education, including active engagement of students in learning through activities such as discussions, problem-solving, and technology-mediated learning [7].

In this era, the engagment and dependence student to the technology contributed to the usage of SW Truss apps as a toll to analyze and verify the truss problem. The complex mathematical solution can be compared and validate throught the apps for truss analysis problem during the learning with self confidence and satisfaction.

Therefore, an interactive approach of a 3-D model and apps in teaching and learning process to enriched student desire and understanding. A development of Force on Simple Truss FIST and the usage of SW Truss were useful in demonstrating how truss systems deform under forces. It helps students to improve their difficulty to visualize how forces are transferred through truss systems.

2.0 METHODOLOGY

This study consist of three methodology: (1) development of the FIST as a teaching and learning tool, (2) integration between TW Truss apps with The FIST in truss analysis and (3) quantitative survey conducted to Engineering Mechanics students to obtain an effectiveness of the FIST – Force in Simple Truss 3-D model.

2.1 Development of the FIST as a Teaching and Learning Tool

Brainstorming approach has been used in development of the 3-D model to help in subject Engineering Mechanics teaching and learning process. Brainstorming is a method for developing creative resolutions to problems. Brainstorming works by focusing on a problem, and then deliberately coming up with as many solutions as possible and by assertive the thoughts as far as possible [8].

This fabrication of the model with the dual mode function (vertical and horizontal axis) by using friendly and practical component that always been used in laboratory. Each orientation can be used in truss analysis and student can immediately visualize the mechanism of the member when load been applied to the model. It made the 3-D model became more interesting and very practical. Figure 2(a) and 2(b) shows the FIST for vertical and horizontal orientation.

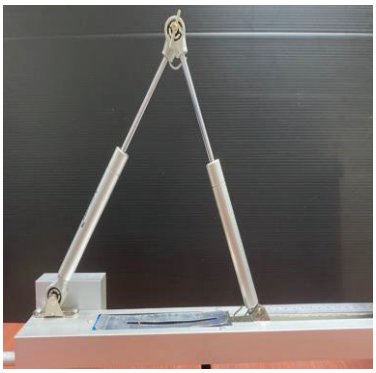

Figure 2(a): Horizontal orientation of the FIST

Figure 2(b): Vertical orientation of the FIST

2.2 Integration between SW Truss Apps with the FIST in Truss Analysis

The apps used in this study is SW Truss that used to determine the trusses force and the condition of truss member after load been applied. The apps is capable of calculating all the truss members based on the design that the user inputs. SW Truss utilized to integrate with the FIST to conduct an interactive teaching and learning approach while resolving truss analysis. Thus, this apps will validate the result taken from the FIST application. The construction of the truss diagram analyze in SW Truss apps as shown in figure 3(a) and 3(b).

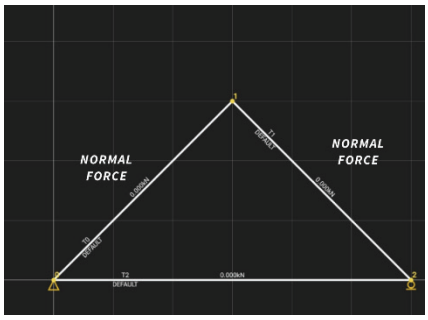

Figure 2(a): Horizontal truss diagram

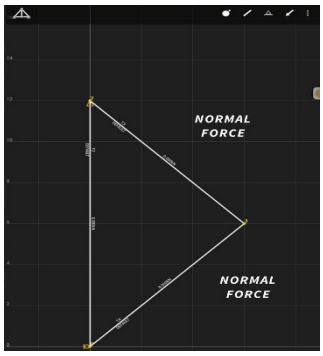

Figure 2(b): Vertical truss diagram

2.3 Quantitative survey conducted to Engineering Mechanics students to obtain an effectiveness of the FIST – Force in Simple Truss 3-D model

The research method for this study was survey design, which is commonly used to explore opinions of respondents that can represent a whole population. The survey design allowed for the collection of quantitative data through structured questionnaires [9]. The survey is appropriate in this study because it enables the researcher to formulate generalizations as it involves a large number of people.

The population for this study was consisted of Mechanical Engineering, Merlimau Polytechnics students who have seated for Engineering Mechanics subject from three programed which are DKM3, DTP3 and DEM3 for session 2:2023/2024. From each classes, a random of 50 sample of students from different gender and race was selected. The sample size was calculated based on the proposed degree of significance, effect size, and power, using relevant statistical methods [10].

Structured questionnaires were used to obtain data from the selected students. The questionnaire was prepared based on the research objectives. It will include items relating to students' demographic information, their perception of learning approach using FIST and apps methods, and their learning outcomes. The questionnaire was pilot-tested for validity and reliability with Cronbach Alpha value was 0.854. If Cronbach's value exceeds 0.8, this means the level of reliability of this item is high and uniform [11].

Then, data analysis was carried out using statistical apps such as SPSS. Percentages, means, and standard deviations were utilized to summarize demographic data and the efficiency of interactive teaching methods utilizing the FIST and SW Truss apps.

3.0 RESULT AND DISCUSSION

During the experimental of truss analysis on the FIST, the load applied for both vertical and horizontal orientation result were verify by using SW Truss apps. These approach have attract student attention in classroom. The psychomotor domain by using the FIST have improved their imaginary and creative thinking on resolving truss problems. The attachment of student in apps usage increased the retention period on solving the truss analysis due to the interactive learning process. Figure 4(a) and 4(b) shows the result of FIST analysis for both vertical and horizontal orientation using SW Truss apps.

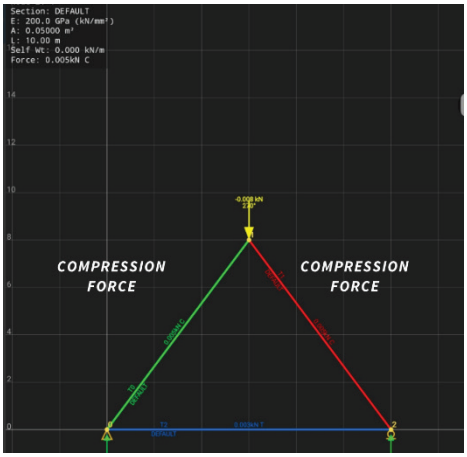

Figure 4(a): Horizontal FIST analysis result

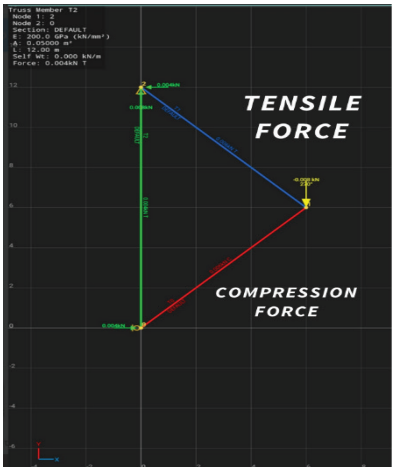

Figure 4(b): Vertical FIST analysis result

Figure 5 illustrated the percentage of student failure rate decreasing while Figure 6 shows the percentage of student passed rate for Engineering Mechanics subject for three semester session is increasing.

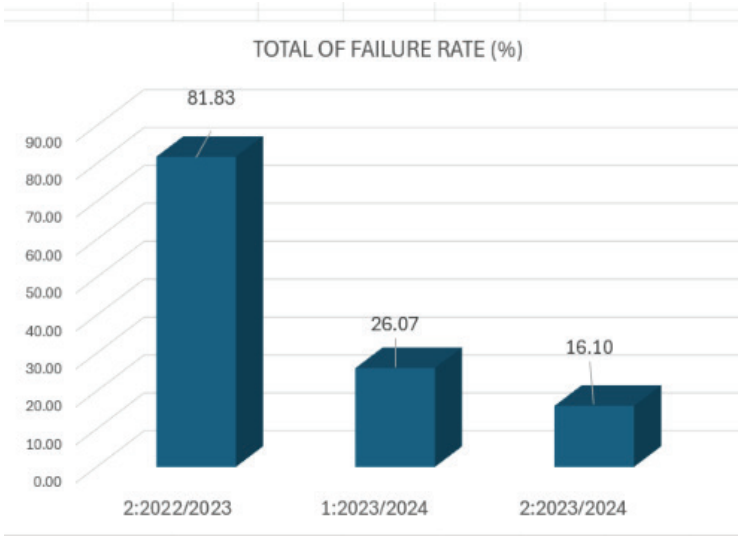

Figure 5: Percentage of student failure rate

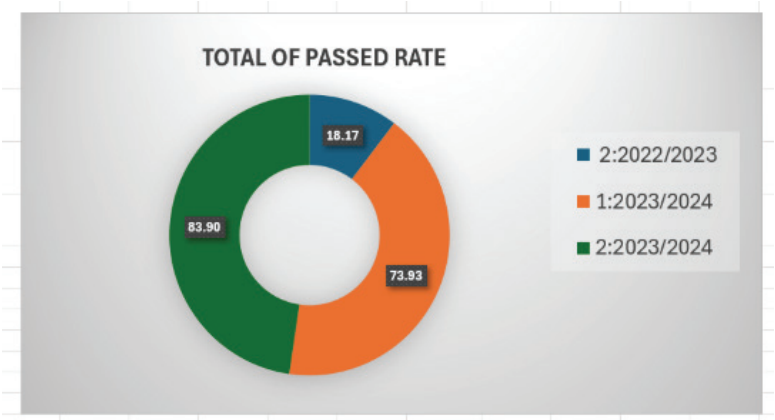

Figure 6: Percentage of student passed rate

To evaluate an effectiveness of the FIST and SW Truss apps teaching and learning approach to improve their understanding and visualization skills, a quantitative method has been applied through survey that has been distributed to 50 students from three programmed in Merlimau Polytechnics. The spider web shows in figure 7 is the result gather after analysis data conducted using SPSS.

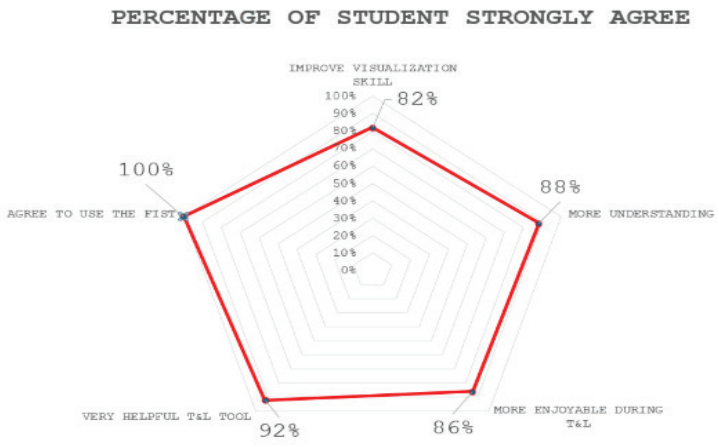

Figure 7: Survey result analysis data

4.0 CONCLUSION

This paper emphasizes the beneficial influence of the learning approach taken through the FIST and SW Truss apps in improving student understanding and visualization skill of student in truss analysis for subject Engineering Mechanics. Besides 3-D model hands-on activity, the attachment of student in apps usage increased the retention period on solving the truss analysis due to the interactive learning process in this 21st century. Therefore, the integration of technology-mediated learning, group projects, and active involvement in class are all essential components of the truss analysis learning strategy in the Engineering Mechanics subject.

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