

The Effectiveness of Artificial Intelligence Multimedia in Subject Physics Mechanics for Diploma in Applied Science

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Abstract

Physics Mechanics is a fundamental subject that is encompassed in the applied science diploma program. Many students encounter difficulties in grasping the core concepts of mechanics. This may be attributed to conventional teaching methods, complex learning materials, limited exposure to practical experiments, or a lack of hands-on experience in conducting experiments. This study aims to increase the percentage of students' understanding of the subject by developing an Artificial Intelligence (AI) learning module. Sample of 90 students from the Diploma in Applied Science (DAU) students at UTHM Pagoh, consisting of first-year DAU (1DAU) batch 2023/2024, second-year batch DAU (2DAU) 2022/2023, and third-year batch DAU (3DAU) 2021/2020 students. A sample of 30 students from 2DAU as the Experimental Group (using the developed AI learning module) and 1DAU as the Control Group (using a conventional learning module), were involved in analyzing the understanding of Physics Mechanics (pre-post test). Three sets of questionnaires were used as research instruments: 1) A survey questionnaire Likert scale measurement analyzes the problems faced by students in terms of chapter assessment, course structure, teaching delivery, motivation, and quality learning. 2) Pre-test questionnaire aimed at measuring students' assessment before the treatment 3) Post-test questionnaire aimed at measuring students' assessment after the treatment. The pre- and Post-test are multiple-choice questions (MCQ) covering chapters 1 to 7 syllabus of Physics Mechanics. The t-test data for Experimental-Control Group: pre-test $t(58) = 0.824$ and post-test $t(58) = 0.906$. Results indicate there is a significant difference, with the experimental group scoring higher than the control group. The findings of the study indicated that there was an improvement in understanding those who used the AI learning module. This learning module has helped students enhance their understanding.

1. Introduction

Students of Diploma in Applied Science (DAU), Universiti Tun Hussein Onn Malaysia (UTHM) face difficulties in learning and excelling in Physics Mechanics because the reliance on lectures and standardized materials may not cater to the individual needs of visual learners or those who thrive in more hands-on or interactive learning

environment [1]. This needs to be emphasized due to its abstract nature, reliance on complex mathematical concepts, and the need for spatial visualization skills during Diploma studies, to strengthen the foundations of their courses. Reliance on lectures and standardized materials may not meet the individual needs of visual learners or those who thrive in more hands-on or interactive learning environments [1].

According to [2], for most college students, especially those who did not take physics classes in high school, basic physics courses might be difficult even basic classical physics notions, such as energy, power, or Newton's principles, can be counterintuitive and difficult to grasp. It is critical to address the difficulties DAU students encounter in learning Physics Mechanics to support their academic achievement, future employment opportunities, and the general growth of knowledge and innovation in related sectors. This research needs to be conducted to find the problems faced by DAU students according to learning course structure, teaching delivery, learning motivation, and learning quality while learning Physics Mechanics through a survey questionnaire. Thus, the purpose of this study is to develop a learning module for Artificial Intelligence (AI) multimedia in an Open Learning platform for Physics Mechanics using AI tools such as text, video, animation, graphics, and audio. AI technologies provide new tools and applications with the potential to revolutionize conventional teaching and learning approaches and AI has the potential to improve learning outcomes, productivity, and student engagement by providing new channels for tailored teaching, feedback, and support [3] [13].

To achieve the effectiveness of students after using an AI learning module, a pretest is conducted before any learning module is applied. It serves as a baseline measurement to understand the initial status or knowledge level of the participants. Based on the last research [4] titled "The Effect of an e-learning Module on Health Sciences Students' Venipuncture Skill Development" hypothesized that students will perform better in the study when an e-learning module is used in addition to in-class training. E-learning modules with the touch of AI tools can include multimedia materials such as movies and demonstrations that illustrate real-world applications, experiments, and phenomena, making the learning experience enjoyable and tangible.

2. Methodology

Creating an effective learning module is a significant endeavor that necessitates a methodical and iterative approach to ensure that it fits the needs of learners and accomplishes the intended educational results. The Successive Approximation paradigm (SAM) is a popular instructional design paradigm that offers a versatile and collaborative framework for developing high-quality learning modules.

Table 1 *The phase of the SAM method*

Phase	Description
Preparation	The first step in the development process is to plan and acquire information.
Iterative Design	Collaboration in design and prototyping allows for the rapid creation and testing of learning module components.
Iterative Development	Detailed module development, considering comments from iterative reviews and testing.
Implementation	Launching and deploying the finalized learning module to the intended audience.
Evaluation	Assessing the learning module's efficacy and making any necessary improvements.

Table 1 shows the explanation of the SAM method. This introduction covers the SAM technique and its application in constructing a learning module, highlighting the iterative design and development process that separates it from typical linear models. Appendix A shows the sequential processes of the study.

2.1 Population and Sample

This study is based on trials with a target population and sample. The target population is defined as all members who match the specific criteria established for a research study. Meanwhile, the sample can be defined as a group of relatively few persons selected from a population for inquiry purposes [5]. The target population of this study is DAU students from UTHM Campus Pagoh who are learning the subject of Physics Mechanics, comprising 147 students from the first-year batch (42 students), the second-year batch (58 students), and the third-year batch (47 students). To fulfill the first objective, which is to examine the problems faced when learning Physics Mechanics, only 90 out of 147 students (61%) were taken as the sample for this study.

Next, to achieve the second objective, which is the development of a learning module using AI tools, only 30 out of 58 students (51.7%), comprising second-year DAU students who form the experimental group, were taken as the sample for this study.

Lastly, to achieve the third objective, which is to measure the student's level of understanding, the sample was divided into two groups: the control group and the experimental group. For the control group, only 30 out of 42

students (71.4%) from the first-year DAU were taken as the sample. Meanwhile, for the experimental group, only 30 out of 58 students (51.7%) from the second-year DAU were taken as the sample for this study. Third-year students were not involved in this sample division.

2.2 Survey Questionnaire

The process of questionnaire development involved several meticulous steps to ensure the reliability and validity of the instrument [6]. Initially, the surveys were innovatively designed to achieve specific objectives, such as identifying the problems faced by DAU students in learning Physics Mechanics and assessing their knowledge levels. For the first questionnaire, a checklist consisting of 10 items was developed. This checklist focused on critical aspects such as course design, learning delivery, learning motivation, and the level of Physics Mechanics instruction. Each item in the checklist was carefully crafted to gather comprehensive data that would inform effective solutions. The responses were measured using a five-point Likert Scale, ranging from 1 (strongly disagree) to 5 (strongly agree), allowing for nuanced feedback from the respondents.

The second questionnaire was designed to assess the knowledge level of individual respondents. It comprised 30 multiple-choice questions covering chapters 1 through 7 of the Physics Mechanics curriculums. These questions were divided into two parts: 1) Pre-test questions and 2) Post-test questions, ensuring a thorough assessment of the respondents' knowledge before and after the instructional period. To ensure the effectiveness and accuracy of the questionnaire, a pilot test was conducted with the survey achieving a high response rate of 90%, with 27 out of 30 participants completing it. The average completion time is 40 minutes. This involved administering the questionnaires to a small, representative group of students to identify any potential issues with the questions, such as ambiguity or difficulty level. Following the creation of the survey, a pilot study may be conducted to ascertain the necessary sample size for the main survey and to enhance the questionnaire by identifying any limitations and inaccuracies before the main survey is conducted. The methods suggested for the primary study are replicated in a pilot study [7].

Validation processes were then carried out to ensure that the questionnaires accurately measured what they were intended to measure. Content validation involved reviewing the questions to ensure they covered all relevant topics comprehensively. Construct validation ensured that the questions accurately reflected the theoretical constructions they were designed to measure. Expert reviews played a crucial role in this phase, with specialists in education and mechanical physics examining the items for relevance, clarity, and comprehensiveness. Reliability testing was also conducted to ensure that the questionnaires produced consistent results over time. This involved methods such as posttest and pretest reliability, where the same questionnaire was administered to the same group of respondents at different points in time, and internal consistency reliability, which measured the consistency of responses across items within the questionnaire. The Cronbach Alpha coefficient is the internal consistency metric that is most frequently employed. It is thought to be the most suitable reliability metric when using the Likert scales [8].

After completing the validation and reliability testing processes, the questionnaires were finalized and administered to the target population of DAU students. The data collected from these questionnaires were then analyzed to achieve the study's objectives. By following these meticulous steps, the researchers ensured that the questionnaires were reliable and valid instruments for collecting the necessary data to identify the problems faced by students and assess their knowledge levels in Physics Mechanics.

Table 2 *The items in the survey questionnaire*

No.	Item
1	Chapter Assessment
2	Course Structure (RPP)
3	Problem: Teaching Delivery
4	Problem: Motivation
5	Problem: Quality Learning

Table 2 shows that the item is included in the survey questionnaire. There are five items in the survey questionnaire: Chapter Assessment covering seven chapters in the course. The purpose of this section in a survey might be to assess the effectiveness of each chapter or topic in terms of content delivery, understanding, and relevance. Course structure (RPP) is related to the overall structure and planning of the course. The survey questions in this section are likely designed to evaluate the effectiveness of the course planning, the clarity of information provided, the achievement of course goals, and the ease of understanding the material. The problem in teaching delivery would likely focus on assessing issues related to how the course material is delivered by the instructor. The survey questions might address various aspects of teaching delivery, such as clarity, engagement,

and effectiveness. The problem in motivation would likely address issues related to student motivation within the course. The survey questions might focus on factors that affect student interest and enthusiasm for the subject. Lastly, the problem in quality learning would likely focus on the overall quality of the learning experience. The survey questions might address various factors that contribute to a high-quality learning environment, including resources, support, and student outcomes.

2.3 The Preparation Stage in the Successive Approximation Model (SAM)

The preparation phase is a quick process used to gather background information on learners [9]. It involves looking at their strengths and weaknesses, understanding what they already know, and setting the main goals for the project. This phase ends with something called the SAVY start [10]. The SAVY start is a meeting where all the key people come together to brainstorm ideas for the training design. During this session, the team quickly shares and rotates design ideas. From these ideas, they create rough prototypes, basic sketches, and storyboards that serve as a foundation for further design work. Whether the SAVY start takes one day or a week, it involves brainstorming, creating quick prototypes, and refining them.

Surveys were distributed to students taking courses in Physics Mechanics. Through survey questionnaires, targeted questionnaires were used to identify issues DAU students faced with their Physics Mechanics coursework. Survey (on issues related to understanding, motivation, and quality of teaching and learning). Formulas and theories are used as examples of understanding. An additional source of motivation is the desire to understand challenging concepts. The issue with the tutorial is that the writing is not very interesting, and the graphics are not that great. A final issue with the quality of learning is that students struggle with memorization, among other things. Surveys are used to identify issues by creating new scenarios and prototypes. For application, the project begins with extensive research to understand educational needs and objectives. Meetings with stakeholders, including instructional designers, and educators, were held to align goals and expectations. Initial planning included creating a design brief outlining the learning objectives, key content areas, and technology requirements for the Physics Mechanics AI learning module.

2.3.1 Savvy Start Phase

Iterative design is a basic strategy for creating successful learning modules, especially in the complicated and continuously changing field of artificial intelligence (AI). This method emphasizes continual improvement through iterative design, testing, evaluation, and refinement.

The next step is to develop the Physics Mechanics AI learning module on the Open Learning platform using AI text, AI video, AI graphics, AI animation, and AI audio. This phase will focus on content creation, including drafting initial content and collecting reference materials, such as notes and laboratory simulation tutorials, to develop the Physics Mechanics AI learning module.

2.3.2 Iterative Design

In designing the learning module for Physics Mechanics, the integration of AI tools plays a pivotal role in enhancing the educational experience. AI-driven content generation ensures that students receive comprehensive and up-to-date information tailored to their learning needs. These tools can analyze vast amounts of data to create engaging and interactive content, making complex physics concepts more accessible and understandable.

Quizzes generated by AI provide personalized assessment opportunities, adapting to each student's proficiency level. This ensures that students are consistently challenged and supported, reinforcing their understanding of Physics Mechanics through immediate feedback and targeted practice.

Videos learning material by chapter created with the help of AI offer dynamic and visually appealing explanations of theoretical concepts and practical applications. These videos can be customized to cater to different learning styles and incorporate that make the subject matter more relatable and engaging.

Lab simulations powered by AI enable students to conduct virtual experiments, providing a hands-on learning experience without the need for physical lab resources. These simulations offer a safe and controlled environment where students can explore and manipulate variables, observe outcomes, and gain practical insights into physics principles.

Appendix B shows that this application, Play. HT converts audio to text using machine learning models. It supports multiple languages and is highly accurate. It also uses speech synthesis that contains text-to-speech technology that converts written text into spoken words. It can be used to provide audio versions of text-based content, making learning more accessible and engaging.

2.3.3 Iterative Development Phase

In the iterative development phase of open learning, particularly for the subject of Physics Mechanics, the focus is on continuously refining and enhancing educational resources to meet the evolving needs of DAU students. This process involves the collection and creation of high-quality materials such as lecture notes, instructional videos, problem sets, and interactive simulations. Lecture notes are meticulously crafted to ensure they are comprehensive and accessible, catering to diverse learning styles. Videos are produced to visually demonstrate complex concepts, making them easier to understand.

Problem sets are designed to challenge students' understanding and application of principles, promoting active learning. Interactive simulations offer hands-on experiences that help students visualize and experiment with physical phenomena in a virtual environment. The experimental group is exposed to the learning module or intervention being tested to assess its effectiveness. Typically, this exposure is structured to isolate the impact of the module on specific outcomes. For instance, participants in the experimental group might receive access to the learning module with all its components, such as lectures, exercises, or interactive features, while ensuring that conditions are controlled to minimize other variables' influence. This setup allows researchers to compare the outcomes of interest, such as learning outcomes or behavioral changes, between the experimental group and a control group that does not receive the module or receives a different treatment.

Besides, this method also helps to evaluate whether the learning module effectively achieves its intended goals compared to alternative methods or no intervention at all. Appendix C shows that developing a learning module for Physics Mechanics in an open learning environment involves a combination of instructional design, content creation, and the integration of AI tools to enhance interactivity and personalization. This module collects and creates high-quality educational resources, including lecture notes, videos, problem sets, and interactive simulations.

2.4 Statistical Package for Social Science (SPSS)

SPSS was utilized for comprehensive data analysis derived from survey questionnaires and pretest-posttest measurements. SPSS was employed to compute essential statistical measures such as the mean, median, and standard deviation from the survey responses. These measures provided a quantitative overview of participants' perceptions and experiences regarding the studied variables. Additionally, SPSS facilitated the analysis of the pretest and posttest data, which was essential for assessing the effectiveness of interventions or instructional methods. Paired t-tests were conducted between the pretest and posttest scores within both the experimental and control groups to determine if there were statistically significant improvements in knowledge or skills attributable to the intervention (learning module) compared to the control condition. A significance level (α) of 0.05 was used, indicating that results with p-values less than 0.05 were considered statistically significant, suggesting real differences rather than random variation. Overall, SPSS served as a robust analytical tool in the study, enabling the description of central tendencies and variability in survey responses and the rigorous assessment of the impact of educational interventions through hypothesis testing and comparison of mean differences. This approach helped ensure the validity and reliability of the findings, providing valuable insights into the effectiveness of different instructional approaches in enhancing learning outcomes in Physics Mechanics.

2.5 Pretest-Posttest Design

In the evaluation of a learning module focused on Physics Mechanics, the pretest-posttest methodology plays a pivotal role in assessing its educational impact. Prior to introducing the module, a pretest is administered to gauge students' initial understanding and proficiency in fundamental concepts like Newtonian mechanics, kinematics, dynamics, and energy principles. This initial assessment provides a baseline measurement, identifying areas where students may need more support or clarification. Once students have completed the module, a post-test is conducted to measure their learning outcomes and determine how effectively the module has enhanced their knowledge and skills. By comparing pretest and post-test results, the researcher can assess the module's effectiveness in improving conceptual understanding, problem-solving abilities, and overall mastery of Physics Mechanics.

For the selection of experimental and control groups, we use systematic selection. In that case, the evaluators generally decide on their sample size and use systematic methods to achieve a non-biased representative sample, that is, a smaller set of youth who are likely to reflect the characteristics of the larger group [11]. Furthermore, to avoid participants rushing through or skipping questions due to time constraints, surveys should be concise and focused on essential learning outcomes. In terms of self-reporting accuracy, participants might overestimate their understanding; thus, combining self-reports with objective performance data provides a more comprehensive view. Besides this, contextual factors such as prior knowledge or external events can influence learning outcomes, making it important to include demographic questions to control for these variables. Several crucial process controls are required when performing pretest and post-test assessments in a college residential environment for a Physics Mechanics learning module to ensure the integrity and validity of the results. The first step is to set unambiguous procedural rules. This contains standardized testing protocols for time, environment, and

participant instructions. Second, strict supervision and monitoring by instructors or monitors are essential during testing sessions. Their presence discourages cheating and assures conformity to testing standards. Table 3 outlines the comparison between the experimental and control groups based on their familiarity with AI and exposure to the learning module.

Table 3 Comparison between experimental and control groups

Aspect	Experimental Group	Control Group
Participants	30 students from 1 DAU session 2022/2023	30 students from 2 DAU session 2023/2024
Selection Criteria	Familiar with AI or exposed to AI learning module	Not familiar with AI; no exposure to learning module
Pretest Conditions	Answered without learning module assistance in one hour	Answered without learning module assistance in one hour
Post-test Conditions	Received AI learning module and answered the questionnaire within one hour	Did not receive AI learning module; used own resources in one hour
Sample Size and Inclusion Rates	30 out of 58 students (51%) from 2 DAU 2022/2023 session	30 out of 42 students (71%) from 1 DAU 2023/2024 session
Purpose	Evaluate the impact of AI familiarity on learning outcomes	Establish a baseline for comparison with the AI-naive group

Table 3 is a controlled study designed to evaluate the effect of AI-based learning on student performance. The experimental group consists of students who are familiar with AI or have used an AI learning module, while the control group includes students with no prior AI experience. Both groups completed a pretest under identical conditions, but for the post-test, only the experimental group received assistance from the AI learning module, while the control group relied on their resources. The table also details the inclusion rates and sample sizes, highlighting that the goal is to compare the learning outcomes between the two groups.

3. Results and Discussion

This project focuses on two main findings. Firstly, identifying common challenges in Physics Mechanics education through standardized chapter assessments. Secondly, it analyzes the effectiveness of a learning module intervention designed to improve student performance in this subject. Pretest and posttest assessments were conducted on both experimental and control groups, with t-testing revealing significant improvements in the experimental group post-intervention compared to controls. These findings highlight the learning module's efficacy in enhancing conceptual understanding and problem-solving skills, underscoring its potential to address educational challenges in Physics Mechanics effectively [14]. Table 4 shows one of the aspects that affect the performance in Physics Mechanic which is chapter assessment.

Table 4 Problem questions for the first scale assessment of teaching and learning problems that affect performance in Physics Mechanics

1	2	3	4	5
Very easy	Easy	Not Sure	Difficult	Very Difficult
Item			Mean Value	
Chapter assessment			2.7698	

From Table 4, the mean value for chapter assessment is 2.7698 which suggests that on average the student is unsure whether the chapter assessments are easy or difficult since the value is close to three.

Table 5 Problem questions for the second scale assessment of teaching and learning problems that affect performance in Physics Mechanics

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
Item		Mean Value		
Problem: Course Structure (RPP)		4.1311		
Problem: Teaching Delivery		4.2611		
Problem: Motivation		3.9333		
Problem: Quality Learning		3.8733		

Table 5 indicates the common problems that DAU students are facing according to course structure learning, teaching delivery, motivation to learn, and quality of learning while learning Physics Mechanics by survey questionnaire. From Table 5, Teaching Delivery (M=4.2611) has the highest average value which shows that teaching delivery is viewed as the most significant problem while learning Physics Mechanics. The way of teaching delivery should be clear, and the pace of teaching was not at the right speed, so it makes it difficult for students to follow the progression of topics and understand the overall flow of the subject matter [12]. To address these issues, it could involve incorporating more interactive and student-centered teaching methods, providing clearer and more detailed resources, and ensuring that assessments are clearly structured and presented well into the course.

3.1 Pretest Evaluation for the Experimental and the Control Group

An independent t-test was conducted to determine whether there was a significant difference in pretest scores between the experimental group and the control group as shown in Table 6.

Table 6 Data analysis of the pretest evaluation for the experimental group and the control group

Group	No.	Mean	Standard Deviation	T-test	Degree of freedom	Significant
Experiment	30	59.47	19.185	0.824	58	0.415
Control	30	55.10	21.796			

Table 6 shows that there is a slight, non-significant difference in the pretest evaluation scores between the control group (M=55.10, SD=21.796) and the experimental group (M=59.47, SD=19.185; $t(58) = 0.824$; $p=0.415 > 0.05$). This indicates that students from both groups had a close, insignificant difference in their level of knowledge about the subject of Physics Mechanics at the beginning of the study. When a t-test yields a positive value, it generally indicates that the mean of one group is higher than the mean of the other group being compared. This means that the experimental group score is better than the mean in the control group.

3.2 Post-Test Evaluation for the Experimental and Control Group

Table 7 shows the post-test scores between experimental and control groups.

Table 7: Data analysis of the post-test evaluation for the experimental and control group

Group	No.	Mean	Standard Deviation	T-test	Degree of freedom	Significant
Experiment	30	65.83	13.539	0.906	58	0.023
Control	30	61.47	22.656			

Table 7 shows that the experimental group, which used the AI module, had a mean post-test score of 65.83, whereas the control group, which did not use the AI module, had a mean post-test score of 61.47. This mean-score difference indicates that the experimental group outperformed the control group.

4. Conclusion

In conclusion, students will have a personalized approach to learning programs based on their own unique experiences and interests based on the application of AI. By using AI tools for the teaching and learning process, AI systems allow people to learn with the help in education learning of education assistants such as bots. Well-designed learning modules can lead to a deeper understanding of Physics Mechanics concepts among students. Clear explanations, interactive examples, and engaging activities can contribute to better comprehension in multimedia educational systems and its improvement using AI tools for a higher education platform. Multimedia education has been shown in many cases to a certain extent. It can be seen that the experimental group, which used the AI module, had a mean post-test score of 65.83, whereas the control group, which did not use the AI module, had a mean post-test score of 61.47. This mean-score difference indicates that the experimental group outperformed the control group. This strengthens the argument that the AI module contributed to the improved performance of the experimental group. It can provide better teaching results that provide students with more knowledge than conventional learning methods. AI in education can streamline the learning process, making it more efficient. Students can progress at their own pace, review difficult concepts as needed, and skip areas they already understand, making their study time more effective. In summary, the higher post-test scores for the experimental group indicate that the AI module significantly improved their learning experience, resulting in better academic performance than the traditional learning methods employed by the control group.

Overall, while many students prefer the traditional face-to-face learning environment for its interactive and engaging nature, the introduction of innovative learning modules has been designed to support and enhance their educational experience. These modules provide flexibility and accessibility, allowing students to access resources and learning materials at their own pace and convenience. By integrating these modules with in-person instruction, educators can offer a more comprehensive and adaptive approach to learning, catering to diverse student needs and helping them succeed in various educational settings. The students' perspectives have been chosen, as they are the beneficiaries of the Teaching Act and can provide key information about this form of education, thus contributing to the sustainability of the educational process. E-learning, like any form of education, also has its own set of positive and negative aspects. Decoding and understanding them will help educational institutions create strategies for more efficient delivery of educational content to the beneficiaries of this process.

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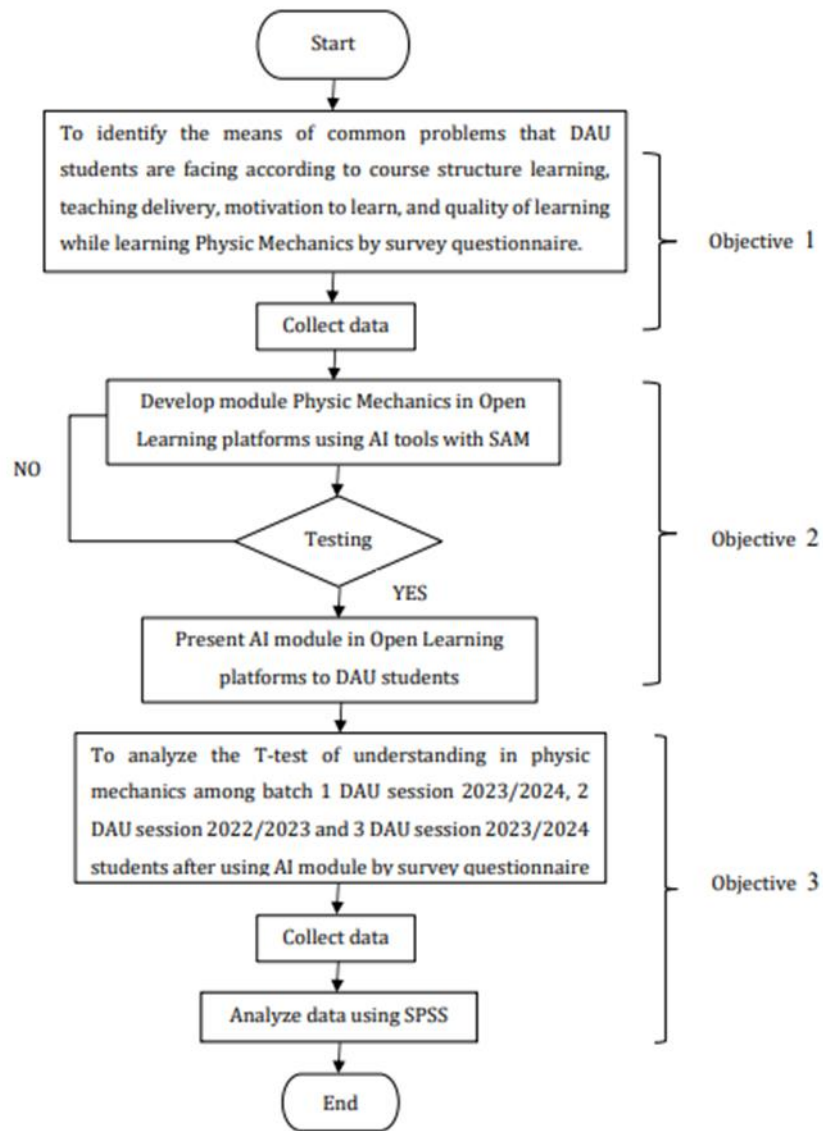
Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

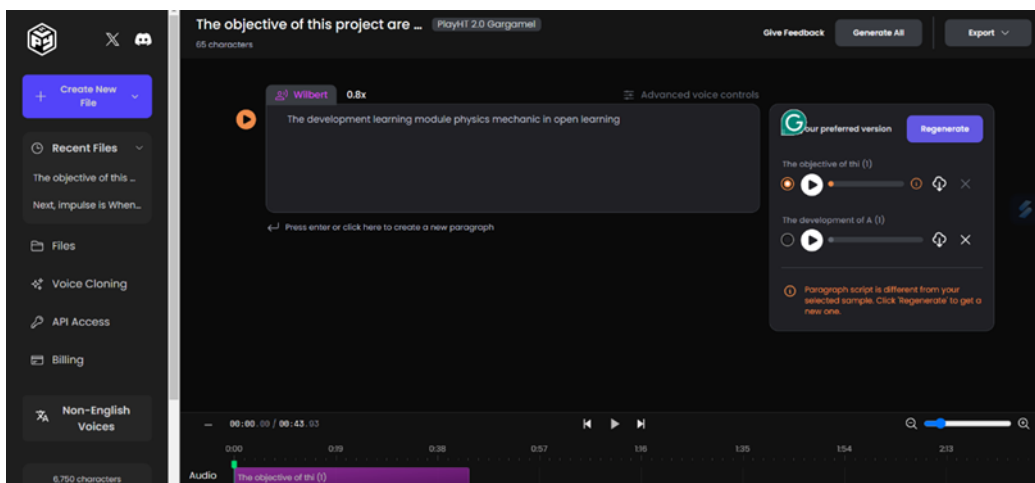
Author Contribution

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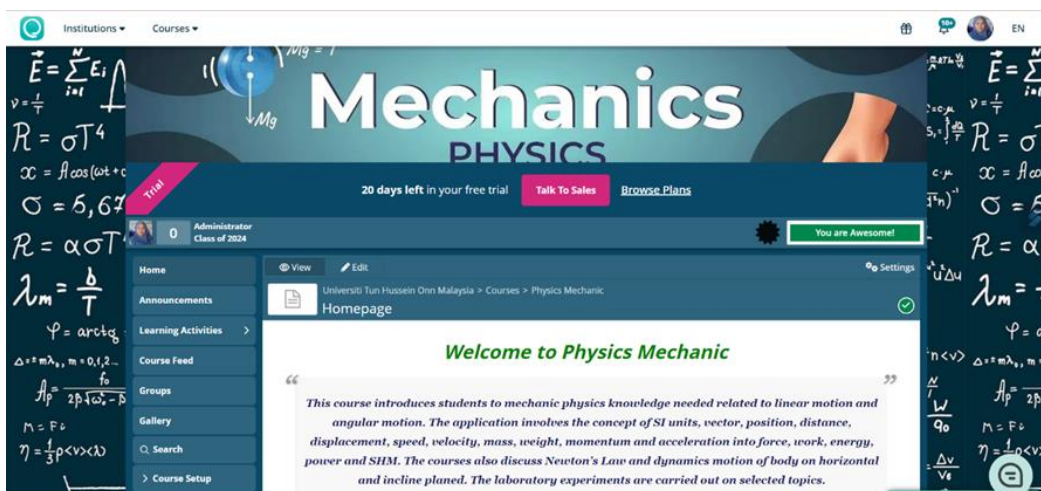
Appendix A: Flow Chart of the Sequential Processes of the Study



Appendix B: AI Tools Audio using Play.HT



Appendix C: Development Learning Module Physics Mechanics in Open Learning



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