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THE READINESS AND CONSTRAINTS OF TECHNOLOGICAL INTEGRATION IN IMPLEMENTING THE CASE METHOD AND TEAM-BASED PROJECTS IN THE MECHANICS COURSE

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ABSTRACT

The case method and team-based projects in the mechanics course are designed to help science teacher candidates master the principles of mechanics. This study aims to analyze the readiness and constraints of technological integration in implementing the case method and team-based projects in the mechanics course of the natural science education program. The study was conducted using a survey method with respondents or samples consisting of two lecturers teaching the mechanics course, 64 pre-service science teachers, and an analysis of the mechanics course documents in the Science Education Study Program at a state university in Central Java, Indonesia. Data collection techniques for this study were carried out using a blended approach (online and face-to-face), a Google Forms questionnaire, online interviews (zoom meeting), and document review. Data analysis was carried out using the triangulation method, which combines various predetermined data and sources, including data from the mechanics course lecturers and students and the lecture tool documents. The results indicate that the readiness for implementing the case method and team-based project in the mechanics course is supported by a good understanding from lecturers and students and adequate resources. The student's understanding of the approaches used by the lecturer obtained concept approach (71.40%), direct instruction model (85.70%), and discussion method (78.60%). In its implementation, the case method follows the theory and expectations in the mechanics lectures in the curriculum documents. Meanwhile, team-based projects still need improvement and development in their application to the mechanics course. The skills trained in the mechanics course are still limited to critical thinking skills, communication, and collaboration. Generic science skills have been trained but have not been specifically labeled, and creative thinking skills have not been technically facilitated to be trained. The carrying capacity of the learning environment is quite good based on ICT. However, it is still dominated by PowerPoint presentations and virtual lab applications, while coding blocks and AR-VR have not yet been developed. The conclusion indicates that while there is strong readiness and adequate resources for implementing the case method and team-based projects in the mechanics course, significant constraints exist in developing creative thinking skills, generic science skills, and consistency in applying learning models.

Keywords: case method; mechanics course; science education; team-based project; technological integration

INTRODUCTION

In the field of science, particularly physics, mechanics is a branch that studies the motion of objects and is generally divided into two areas of focus: kinematics and dynamics. As a course managed by the Science Education program, mechanics is taught with a scientific approach that emphasizes utilizing scientific and communication skills, using the case method

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and team-based project to ensure students master and implement the basic mechanics concepts. These concepts include particle kinematics and dynamics of a particle, work and energy, impulse and momentum, particle systems, rotation of rigid bodies, and harmonic motion, following the curriculum's mandate.

Through case method and team-based projects in the mechanics course, pre-service science teachers are expected to master the nature of mechanics and various skills needed in the 21st century, including critical thinking, creative thinking, communication, collaboration, and generic science skills. Critical thinking skills refer to a set of abilities and competencies that are highly valued in various professional and personal contexts. These skills are essential for success and are typically transferable across different fields and industries (Cabero-Almenara et al., 2020; Hernandez-de-Menendez et al., 2020). Creative thinking skills refer to the ability to consider something in a new way (Paul & Elder, 2019). Communication skills are essential for effective and successful interactions with others (Vlachopoulos & Makri, 2019). They involve the ability to convey information, express thoughts and ideas, and understand and interpret the messages of others (Hargie, 2021). Collaboration skills are the abilities and attributes necessary to work effectively and productively with others toward a common goal (Atchison et al., 2021). Collaboration involves actively participating in a team or group, sharing ideas, coordinating efforts, and resolving conflicts to achieve desired outcomes. Generic science skills are basic, flexible, and oriented towards learning higher sciences or serving wider fields of study or work, not only in their expertise but also in other fields (Brotosiswojo, 2001). Generic science skills include skills in observation, sense of scale, symbolic language, logical frame, logical consistency, cause-and-effect law, modeling, logical inference, and abstraction.

Empirical experience and literature studies have shown that instructors' understanding of the learning stages in preparing learning experiences for programs that apply case methods and team-based projects is still varied and not up to expectations (Brown et al., 2019; Rahayu, 2020; Widyaningsih & Yusuf, 2020; Wijaya et al., 2021). Implementing the case method in lectures requires instructors to have adequate information about the students in their classes. Meanwhile, the team-based project is a learning method of the project-based learning model. Therefore, applying a team-based project is recommended to follow the syntax or steps of PjBL learning (Nofrion, 2022).

These conditions have prompted survey research to review and analyze cases in science education, especially in mechanics lectures. This study focuses on observing the readiness and constraints in implementing the case methods and team-based projects in mechanics lectures from the aspects of the lecturer, students, and department manager as the policymakers.

This study is urgent due to the role of the mechanics course as a compulsory subject in the curriculum of the Science Education program, where mechanics serves as the foundation for understanding fundamental scientific concepts. As future science teachers, students must master both the theoretical aspects of mechanics and essential 21st-century skills such as critical thinking, creativity, communication, collaboration, and generic science skills (Retnowati & Subanti, 2020; Baran et al., 2021; Isdianti et al., 2021; Hasanah et al., 2023; Purwanto et al., 2023; Wibowo, 2023). These competencies are crucial for effective teaching and preparing students to face complex scientific challenges in various professional contexts. However, existing literature reveals significant gaps in instructors' understanding of effectively implementing case methods and team-based projects, which can hinder the development of these important skills (Hall et al., 2018; Hart et al., 2019; Servant-Miklos, 2020; Juuti et al., 2021; Xue et al., 2021; Huang, 2022;). Therefore, this study intends to assess readiness and identify constraints in applying these innovative pedagogical approaches in mechanics lectures, aiming to enhance pre-service science teachers' educational experience and outcomes.

METHODS

The study was conducted using a survey method, which involved collecting information from respondents by asking several questions through a questionnaire, interviews, and supporting documents (Hunt et al., 2019; Stylinski et al., 2020). This type of research includes individual recruitment, collection, and analysis of quantitative and qualitative data. The selection of the survey method in this study aims to confirm the readiness and constraints of implementation of the case method and team-based project to the respondents in the mechanics course in the Science Education Study Program, Faculty of Mathematics and Natural Sciences, at a state university in Semarang, Central Java, Indonesia.

The survey was conducted to gather insights from respondents at a specific time interval (Peng et al., 2020; Atchison et al., 2021). This is an observational study with no intervention, just pure investigation. Researchers use it to observe respondents' characteristics and analyze their readiness and constraints for implementing case methods and team-based projects.

The logical scheme of the steps carried out in the research methods developed based on Wang & Cheng (2020) can be seen in Figure 1.

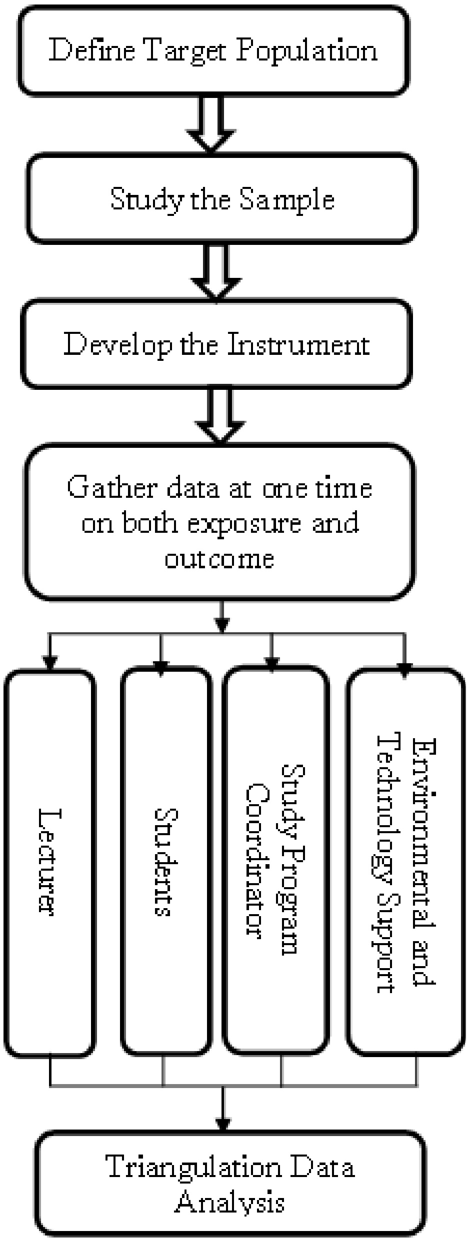

Figure 1. The Survey Method Flow Chart

The survey methods flow chart in Figure 1 starts by defining the target population. In this step, we identified the specific group of individuals the research aims to study and draw conclusions. The target population of this study was the lecturers, students, and documents on the mechanics course of the natural science education program.

The study sample step involved selecting a representative subset of the target population to participate in the survey. The study sample or subjects consisted of two lecturers who taught the mechanics course, 64 fifth-semester students who had taken the mechanics course, and the Science Education study program coordinator.

The instrument development step in survey research involved creating effective questionnaires and interview guidelines to collect the necessary data. The student questionnaire consisted of 22 items in the form of questions and statements. From the lecturers' perspectives, the interview guide consisted of 14 questions about the readiness and constraints of implementing case methods and team-based projects in the mechanics course. The questionnaire was used to collect research data from student respondents. At the same time, interviews were conducted with lecturers teaching mechanics courses, and documents were obtained from the Science Education study program coordinator.

The questionnaire development process involved several steps, beginning with a literature review to explore existing pedagogical methods and necessary competencies for effective teaching in mechanics, which informed the questionnaire content. Key focus areas were identified, such as understanding the case method and team-based projects by lecturers and students, perceptions of available technological resources, and the skills needed for effective implementation. The questionnaire featured quantitative Likert scale questions to measure readiness and qualitative open-ended questions to gather insights on constraints. A pilot test with a small group helped refine the questions for clarity and relevance. The final version included demographic sections, readiness assessments, perceived constraints, and suggestions for improvement. This structured approach facilitated the collection of detailed data, providing insights into the readiness levels and challenges in adopting innovative teaching methods in the mechanics course.

The questionnaire developed for this study addressed several aspects to analyze the readiness and constraints related to integrating technology in applying the case method and team-based projects in the mechanics course. The questionnaire aspects included understanding these methods among lecturers and students, including their definitions, implementations, and perceived effectiveness. The questionnaire also assessed the development of essential skills such as creative and critical thinking, communication, collaboration, and generic science skills based on feedback from lecturers, students, and related documents. It also investigated how the case method and team-based projects correspond to problem-based learning and project-based learning models as viewed by both groups. Lastly, it assessed the availability and effectiveness of various technological tools (Virtual Labs, AR-VR, and coding block platforms).

Data collection techniques for this study were carried out using a blended approach (online and face-to-face), a Google Forms questionnaire, online interviews (zoom meetings), and document review. The documents obtained from the Science Education Study Program Coordinator consisted of the curriculum, semester learning plan, and evaluation tools for the mechanics course in the even semester of the 2022/2023 academic year.

Triangulation data analysis in survey methods involved cross-verifying information collected from multiple sources to ensure the reliability and validity of the findings. In this study, the data collected from various sources, including student questionnaires, lecturer interviews, and documents from the Science Education Study Program Coordinator, were subjected to triangulation analysis to comprehensively understand the readiness and constraints of implementing the case method and team-based projects in the mechanics course. The readiness and constraints of the case method and team-based projects in the mechanics course depended on several factors, including the participants' knowledge and skills, the resources available, and the overall objectives of the learning or project experience. Here are some considerations regarding the readiness and constraints of these surveys: participant knowledge and skills, lecturer or facilitator expertise, available resources, clear objectives and expectations, collaborative skills and interpersonal, supportive learning environment, assessment, and evaluation. This triangulation approach enhanced the robustness and credibility of the survey findings, facilitating more informed conclusions and recommendations for future action.

FINDINGS AND DISCUSSION

Based on the results of interviews with two lecturers, a survey of 64 students, and an analysis of supporting documents for the mechanics course (Curriculum, Semester Learning Program, and Evaluation) in the Science Education Study Program, the comprehension of lecturers and students regarding the implementation of the case method and team-based project in mechanics courses is presented in Table 1.

Table 1. Lecturers' and Students' Comprehension on the Implementation of Case Method and Team-Based Project in the Mechanics Course

Aspect of Understanding	Lecturer	Students	Document
Definition/ term	The first lecturer describes the case method and team-based project as learning models. The second lecturer states that case methods and team-based projects are learning methods. Both of the lecturers explain that they have implemented various types of cases, including completed cases based on facts (for analysis purposes), open cases that are not yet resolved (for prediction, recommendations, and conclusions), and original documents (news articles, reports, data collections, ethnography), such as the case of a plane crash. The second lecturer also states that they have yet to fully maximize the implementation of project-based methods, especially those based on teams or groups.	Based on the survey responses, the student's understanding of the approaches used by the lecturer during the lecture is as follows: concept approach (71.40%), direct instruction model (85.70%), and discussion method (78.60%).	The Semester Learning Plan document states that lectures implement case methods and team-based projects, with conceptual achievement and discussion activities.

Aspect of Understanding	Lecturer	Students	Document
Syntax	Both lecturers state that the case method and team-based project adapt the syntax of problem-based and project-based learning.	According to 85.70% of students, the syntax or flow of the course adopts the team-based project method.	The syntax flow of the case method and team-based project is not written in the semester learning plan document, but the approach used is Identification, Development, Evaluation, and Application (IDEA).
The readiness of the equipment	Available syllabus, teaching materials, exam blueprints, mid-term and final exams, Elena, Phyphoxs.	Available syllabus, teaching materials, exam blueprints, mid-term and final exams, Elena, Phyphoxs.	Available syllabus, teaching materials, exam blueprints, mid-term and final exams, Elena, Phyphoxs.

Based on these points, we can explain the following triangulation analysis. The lecturers have different statements about how the case method and team-based project are utilized as learning models and methods. The case method and team-based project are learning methods. The case method is a discussion-based participatory learning method for solving cases or problems (Büchler et al., 2021; Ito & Takeuchi, 2021). The team-based project method is a learning method that involves cooperation between team members in completing tasks or projects. The team-based project method is built on learning activities and real project-based assignments that provide challenges for students related to everyday life to be solved in teams or groups (Veselov et al., 2019; Xue et al., 2021). However, both lecturers argue that the case method and team-based project are considered important in the context of lectures. The various cases indicate diversity in the teaching materials, including real-world examples and open-ended cases. This supports an experiential learning approach. The second lecturer's acknowledgment of not fully maximizing project-based methods, especially those involving teams or groups, suggests a potential area for improvement in the teaching practices. The survey responses indicate that the students have a relatively high understanding of the concept approach, direct instruction model, and discussion method. This implies that these teaching approaches have been effectively employed during the lectures. The Semester Learning Plan document reinforces implementing case methods and team-based projects, aligning with the lecturers' statements. It also highlights the integration of conceptual achievement and discussion activities, corresponding to the students' reported understanding.

In conclusion, the triangulation analysis reveals a consensus among the lecturers regarding using the case method and team-based project as learning methods. It also suggests optimizing further project-based methods involving teams or groups. The survey results indicate a good understanding of the teaching approaches mentioned by the lecturers, and the Semester Learning Plan document supports the implementation of these approaches in the lectures.

Both lecturers have stated that the syntax of case method and team-based project adapts the syntax of problem-based and project-based learning. This implies that there is an alignment between these teaching methods. However, we need to corroborate this information with other sources. About 85.70% of the students report that the syntax or flow of the course adopts the team-based project method. This suggests a consistent perception among most students regarding the teaching approach. Their feedback reinforces the idea that the course follows a team-based project structure. Although the syntax flow of the case method and the team-based project is not explicitly written in the Semester Learning Plan document, it states that the approach used is Identification, Development, Evaluation, and Application (IDEA). While this information does not directly confirm the syntax of problem-based and project-based learning, it provides insight into the overall instructional approach. By examining these three sources of information, we can identify some consistent patterns. Both lecturers and most students affirm that the course adopts a team-based approach. The Semester Learning Plan document indicates an instructional approach based on the IDEA model, which might be aligned with the syntax of problem-based learning and project-based learning. Based on this analysis, some information triangulation supports the notion that the syntax of case method and team-based project aligns with the syntax of problem-based and project-based learning. However, it is important to note that the absence of explicit information in the Semester Learning Plan about problem-based learning and project-based learning makes it necessary to consider additional evidence or seek clarification from the course instructors or curriculum developers for a more conclusive analysis.

The triangulation analysis of the data provided on the equipment's readiness shows consistency in the information provided. The syllabus, teaching materials, exam blueprints, and inclusion of mid-term and final exams indicate that the necessary resources and assessment plans are in place.

Based on the results of interviews with two lecturers, a questionnaire of 64 students, and an analysis of supporting documents for the mechanic course (curriculum, semester learning plan, and evaluation) in the Science Education Study Program, the skills developed by lecturers in implementing case method and team-based project in the mechanics course are presented in the following Table 2.

Table 2. The Skills Developed through the Implementation of Case Method and Team-Based Project in the Mechanics Course

Aspect	Lecturer	Students	Document
Creative Thinking Skills	Not yet trained	Not yet trained	Graduate Learning Outcomes 1. Apply knowledge of the basics of natural science, integrated natural science, and interdisciplinary natural science. 2. Make decisions based on data/ information to complete tasks and evaluate tasks performed 3. Demonstrate a scientific attitude in integrated science learning, laboratory work, and professional assignments. Course Learning Outcomes 1. Students can explain the concepts of mechanics, including particle kinematics (position, velocity, acceleration) and particle dynamics (Newton's laws of motion, Friction, Newton's Law of Gravity), work and energy, impulse and momentum, particle systems, rotation of a rigid body, harmonic motion. 2. Students are skilled at applying mechanics concepts in everyday life. 3. Students can develop competence in uncovering various phenomena in mechanics.
Critical Thinking Skills	Trained	Not yet trained	
Communication Skills	Trained	Trained	
Collaboration Skills	Trained	Trained	
Generic Science Skills	Already trained (Not explicitly labeled)	Not yet trained	

Based on the data in Table 2, all three sources (lecturer, student, and document) indicate that creative thinking skills still need to be trained through implementing the case method and team-based project in the mechanics course. According to literature references, creative thinking skills can be trained and developed in various academic domains and school subjects or lessons (Ritter et al., 2020). Creative thinking skills can be grown or improved through student-centered learning through group clinical problem-solving; this is relevant to the planned team-based project method (Zhao et al., 2020). There needs to be more consistency among the sources regarding the need for more development in this skill. The data needs to be more consistent in developing critical thinking skills. While the lecturer believes critical thinking skills have been trained, students and the document still need to be trained. There is agreement among all three sources that communication skills have been trained through the implementation of the case method and team-based project in the mechanics course. All three sources agree that collaboration skills have been developed through implementing the case method and team-based project in the mechanics course. Consistency among the sources indicates that generic science skills still need to be trained through implementing the case method and team-based project in the mechanics course. Generic science skills can be trained using software or programming-based application assistance that can accommodate predictions and actions, which are used for coordination and execution (Scholz et al., 2020).

By triangulating the information, we can identify patterns and inconsistencies in the skills developed through implementing the case method and team-based project in the mechanics course. Communication and collaboration skills are consistently reported as being trained, while creative thinking, critical thinking, and generic science skills must be more consistent and developed according to the different sources.

Based on the results of interviews with two lecturers, questionnaires of 64 students, and analysis of supporting documents for mechanics lectures (Curriculum, Lesson Plans, and Evaluation) in the Science Education Study Program, Table 3 presents the skills developed by lecturers in applying the case method and team-based projects in mechanics lectures.

Table 3. The learning model for applying the case method and team-based project methods in the mechanics course

Learning Model	Lecturer	Student	Document
Problem-Based Learning	applying	not yet	applying
Project Based Learning	applying	applying	applying
Cooperative Learning	applying	not yet	not yet

Based on the data in Table 3, there needs to be more consistency between the lecturer and students regarding implementing problem-based learning. The lecturer claims it is being applied, while the students report that it has not yet been implemented. The document aligns with the lecturer's statement. There is a discrepancy between the lecturer's perception and the students' experience. There is agreement among all three sources that project-based learning is being applied to the mechanics course. The lecturer, students, and documents indicate that this learning model is being implemented. There is consistency among the lecturer and document in stating that cooperative learning still needs to be implemented. However, the students' responses differ, indicating they have yet to experience this learning model. There is a discrepancy between the lecturer's and students' perspectives. By triangulating the information, we can identify patterns and inconsistencies in the learning model for applying the case method and team-based project methods to the mechanics course. Project-based learning is consistently applied according to all three sources. However, there are discrepancies between the lecturer's and students' perceptions regarding implementing problem-based learning and cooperative learning.

Based on the results of interviews with two lecturers, questionnaires of 64 students, and analysis of supporting documents for mechanics lectures (Curriculum, Lesson Plans, and Evaluation) in the Science Education Study Program, Table 4 presents the skills developed by lecturers in applying the case method and team-based projects in the mechanics course.

Table 4. The carrying capacity of the IT/ ICT-based environment and technology in mechanics courses

Environmental and technological Aspects	Lecturer	Student	Document
MS PowerPoint	carrying	carrying	carrying
Virtual Lab (Java Lab, PhET Simulation)	carrying	carrying	carrying
Software Applications (Phyphox, Tracker)	carrying	carrying	carrying
Augmented-Virtual Reality (AR-VR)	not yet	not yet	not yet

Environmental and technological Aspects	Lecturer	Student	Document
Coding Block (Scratch, CoSpaces Edu)	not yet	not yet	not yet

Based on the data in Table 4, there is consistency among all three sources that MS PowerPoint is being used and has the carrying capacity in the mechanics courses. There is agreement among all three sources that Virtual Lab, including Java Lab and PhET Simulation, is being used and has the carrying capacity in the mechanics course. All three sources indicate that software applications, such as Phyphox and Tracker, are used and have the carrying capacity in the mechanics course. There is consistency among all three sources that Augmented-Virtual Reality (AR-VR) still needs to be implemented or utilized in the mechanics course. There is agreement that it needs to have the carrying capacity at present. All three sources indicate that Coding Block tools, such as Scratch and CoSpaces Edu, still need to be implemented or utilized in the mechanics courses. There is agreement that they need the carrying capacity at present.

By triangulating the information, we can identify patterns and consistencies in the carrying capacity of the IT/ICT-based environment and technology in the mechanics courses. Microsoft PowerPoint, Virtual Lab (Java Lab, PhET Simulation), and Software Applications (Phyphox, Tracker) are consistently reported to have the carrying capacity. On the other hand, Augmented-Virtual Reality (AR-VR) and Coding Block tools (Scratch, CoSpaces Edu) still need to be implemented or utilized in the mechanics course. The mechanics course paradigm in the 21st century should integrate technology and software in learning. Students are taught to use simulation software, 3D modeling software, and relevant hardware to understand and analyze mechanical systems. This enables students to conduct simulations, virtual experiments, and numerical analysis to solve complex mechanics problems (Azhikannickal, 2019; Kaps & Stallmach, 2021; Vidak et al., 2021). Scratch can simulate abstract concepts in physics learning (Adler & Kim, 2018; Lopez & Hernandez, 2015). Science learning media based on Augmented Reality (AR) has an excellent level of applicability and can be used in science learning (Taufiq et al., 2021a). Science learning media based on Augmented Reality (AR) has very feasible criteria for embedding problem-solving skills (Taufiq et al., 2021b).

In the context of this study discussion, it is the basis for implementing the team-based project method in the mechanics course. Project-based learning is a learning model for applying the team-based project method where both focus on group work and practical application. While there are similarities in team collaboration and practical application, the main difference between project-based learning and team-based projects lies in their more specialized focus and structure. Project-based learning generally focuses more on individual projects that involve problem-solving and independent discovery. In contrast, a team-based project emphasizes group work and collaboration in completing shared tasks or projects. In addition, the word "case method" is also the word that has the highest number of references. In the context of the discussion, this study shows the application of the case method as a learning method in mechanics courses, but the preference is more for team-based projects. The word "implementation" has a smaller number of references among the words analyzed, if related to the results of the previous data, triangulation analysis supports the finding that the implementation of the case method and team-based project aligns with the theory and expectations in the mechanics course as stated in the curriculum document. The documents and lecturers' and students' understanding of the definition and syntax of the case method and team-based project is not uniform.

Word Cloud Analysis Data Triangulation

Figure 2. Word Cloud Analysis

The analysis of lecturers' and students' comprehension of implementing the case method and team-based project in the mechanics course in Table 1 reveals distinct perspectives. The lecturers provide diverse definitions for these teaching approaches, with one emphasizing them as learning models and the other categorizing them as learning methods. Both lecturers elaborate on the implementation of various case types, such as completed cases for analysis, open cases for prediction and recommendations, and original documents as part of the teaching strategy. However, the second lecturer notes a need for more fully maximizing project-based methods, especially those involving teams or groups. This discrepancy highlights potential variations in the lecturers' depth of understanding of implementation. Conversely, as reflected in the survey responses, the student's understanding demonstrates a substantial grasp of the approaches used during lectures, with a majority recognizing the concept approach, direct instruction model, and discussion method.

Examining the syntax reveals that both lecturers assert that the case method and team-based project adopt the syntax of problem-based learning and project-based learning. However, interestingly, the students' perspectives suggest a higher association with the team-based project method. The Semester Learning Plan document indicates that while the syntax flow is not explicitly outlined, the overall approach follows the Identification, Development, Evaluation, Application (IDEA) model. Lastly, regarding equipment readiness, both lecturers and students report the availability of essential resources, including syllabi, teaching materials, exam blueprints, and specific tools like Elena and Phyphox. This alignment indicates a cheerful readiness to implement the proposed teaching methods in the mechanics course.

In the future, the development of implementing the case method and team-based project in the mechanics course could benefit from incorporating insights from educational psychology and instructional design literature. In this context, providing additional resources and materials aligned with the varied definitions and teaching strategies discussed by the lecturers could bridge the comprehension gap. Additionally, drawing on the principles of collaborative learning outlined by Slavin (2015), future developments should prioritize faculty collaboration and training, ensuring a shared understanding of teaching approaches and fostering a consistent implementation across courses. This collaborative approach aligns with the recommendations of Cansoy and Parlar (2018), emphasizing the impact of collective teacher efficacy on student learning outcomes. Moreover, future initiatives could leverage the identified student preferences for the team-based project method by integrating more collaborative and project-based activities into the curriculum, aligning with the findings of Johnson et al. (2014) on the positive effects of cooperative learning. This multidimensional strategy, informed by educational literature, can enhance faculty and student experiences in mechanics courses, promoting a more cohesive and effective teaching environment (Bilgin & Gul, 2020; Wang & Degol, 2016).

Table 2 illustrates the skills developed through implementing the case method and team-based projects in the mechanics course, assessing the lecturer and students across different aspects. The lecturer needs to gain training in creative and critical thinking skills, indicating a potential area for improvement in instructional methods (Vong & Kaewurai, 2017). However, it is noteworthy that students have been trained in communication and collaboration skills, essential attributes in professional settings (Alward & Phelps, 2019). The absence of training for the lecturer and students in generic science skills suggests an opportunity to incorporate more diverse and foundational scientific skills into the course. Moving to the learning outcomes, the mechanics course appears robust, covering a broad spectrum from fundamental concepts like particle kinematics to practical applications in everyday life. The emphasis on students explaining, applying, and developing competence in various mechanics phenomena aligns well with the overarching goals of scientific education, connecting theoretical knowledge to real-world scenarios (Khasawneh, 2024; Van den Beemt et al., 2020).

In summary, while the lecturer's training gaps in critical areas need attention, the positive development of students' communication and collaboration skills and the comprehensive coverage of mechanics course learning outcomes are promising. Further details on the specific training methodologies and examples illustrating the application of these skills would enhance the interpretation of the results and provide valuable insights for refining the Mechanics course.

Table 3 outlines the learning model for applying the Case Method and Team-Based Project methods in mechanics courses, focusing on the lecturer's and student's involvement. The table presents three distinct learning models: Problem-Based Learning, Project-Based Learning, and Cooperative Learning. The lecturer currently applies Problem-Based and Project-Based Learning, indicating an active role in these instructional approaches. However, the lecturer still needs to implement cooperative learning. On the student side, engagement in Problem-Based Learning has yet to be observed, while students actively participate in Project-Based Learning. Unfortunately, Cooperative Learning has not been initiated among the students. This suggests a varied adoption of learning models, with potential implications for the overall learning experience and outcomes in the Mechanics course.

The observed mix of applied learning models could have implications for the dynamics of the course. Problem-based, project-based, and cooperative learning bring unique benefits to student understanding and skill development (Anazifa & Djukri, 2017; Brassler & Dettmers, 2017; Karan & Brown, 2022). While the lecturer's involvement in specific methods is evident, it questions the reasons behind the selective application. Further exploring the rationale for choosing particular learning models and their potential synergies could provide a more comprehensive understanding of the instructional strategies employed in the mechanics course (Basu et al., 2016). Additionally, investigating the impact of these learning models on student engagement, performance, and skill acquisition would contribute valuable insights for refining the teaching approach in future course interactions (Koulouri et al., 2014; Yew & Goh, 2016).

Table 4 outlines the carrying capacity of the IT/ICT-based environment and technology in the mechanics course, focusing on the lecturer's and student's involvement. The table presents various aspects, including the use of MS PowerPoint, Virtual Lab tools (Java Lab, PhET Simulation), Software Applications (Phyphox, Tracker), Augmented-Virtual Reality (AR-VR), and Coding Blocks (Scratch, CoSpaces Edu). The lecturer actively utilizes and carries the mentioned technologies, including MS PowerPoint, Virtual Lab tools, and Software Applications, indicating a comprehensive integration of diverse technological resources in the teaching process. However, it is noteworthy that Augmented-Virtual Reality and Coding Blocks still need to be incorporated, presenting potential areas for future development. On the student side, the capacity to carry these technologies is observed across all aspects, suggesting active student engagement with the diverse IT/ICT tools used in the mechanics course. The comprehensive utilization of these technologies could positively impact the learning experience, providing students with a varied and interactive approach to mastering mechanics concepts (Alsawaier, 2018; Su & Cheng, 2015; Vlachopoulos & Makri, 2017).

Table 4 underscores the lecturer's commitment to leveraging IT/ICT tools to enhance the mechanics learning environment. The active use of presentation software, virtual labs, and various applications showcases a technologically enriched teaching methodology. However, the absence of Augmented-Virtual Reality and Coding Blocks suggests room for further exploration of immersive and coding-based educational tools. A deeper analysis of the effectiveness of these technologies in supporting student comprehension, engagement, and skill development would offer valuable insights into the overall impact of the IT/ICT-based environment (Goldhammer et al., 2016; Wang et al., 2014) in the mechanics course. Moreover, understanding the reasons behind the non-utilization of Augmented-Virtual Reality and Coding Blocks could inform future decisions about integrating these potentially beneficial technologies into the mechanics curriculum (Strzys et al., 2018; Tondeur et al., 2017).

Several recommendations can be made based on the comprehensive analysis of lecturers' and students' comprehension, skills development, learning models, and the IT/ICT-based environment in the mechanics course. Firstly, there is a need for a more uniform understanding between lecturers and students regarding implementing the case method and team-based project. Establishing clear definitions and alignment of teaching methods is recommended to ensure a cohesive learning experience. Additionally, optimizing project-based methods, particularly those involving teams or groups, should be prioritized to address potential gaps in understanding. Secondly, there is a consistent call for developing creative thinking skills among students, emphasizing incorporating student-centered learning and problem-solving activities. This could enhance the experiential learning approach and foster a more innovative mindset. Thirdly, there needs to be more consistency in implementing learning models, with project-based learning being consistently applied. At the same time, problem-based learning and cooperative learning show inconsistencies between lecturers and students. Bridging this gap through more straightforward communication and alignment when applying these learning models is recommended. Fourthly, it is advised that augmented virtual reality (AR-VR) and coding blocks be integrated into the IT/ICT-based environment. This can provide a more interactive and immersive learning experience, aligning with the current technological advancements in education.

CONCLUSION

Based on the results, the understanding of the lecturer, student, and document regarding the definition and syntax of the case method and team-based project is not uniform. In its implementation, the case method aligns with the theory and expectations in the mechanics course as stated in the curriculum document. However, there is still a need for improvement and development in applying team-based projects in the mechanics course.

The skills trained in the mechanics course are still limited to some 21st-century skills. Based on interview data and questionnaires, it is evident that only critical thinking, communication, and collaboration skills are being trained, while the graduate learning outcomes and course learning outcomes require more than that. Therefore, there is a need for development in preparing the mechanics course program.

The lecturers choose and implement problem-based and project-based teaching models, as stated in the syllabus document. However, according to the students, their learning experience during the course still mainly revolves around direct instruction, focusing on deepening concepts and having many discussions. In this regard, it can be understood that there are still challenges in implementing the syntax flow of the case method and team-based project.

The learning environment is adequately supported by IT/ICT. However, it is still dominated by PowerPoint presentations, virtual labs (V-Lab), and specific applications without utilizing coding blocks and AR-VR. The recent development of information technology in education has opened up new insights for more creative learning management. By utilizing information technology, the development of the learning program becomes more targeted, flexible, and capable of enhancing students' imagination, concretizing abstract science concepts through modeling, animation simulation, and making learning more exciting and interactive. One example is Coding Blocks with Scratch, a visual programming language for a learning environment that allows beginners (students, teachers, or lecturers) to learn programming without worrying about correct syntax writing.

This study implies that while there is good readiness and resource availability for implementing case methods and team-based projects in the mechanics course, improvements are needed in developing creative thinking skills, generic science skills, and consistency in applying the learning models. It is recommended to enhance comprehension of the case method and team-based projects among lecturers and students and to advance technological integration, especially focusing on AR-VR and coding blocks.

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