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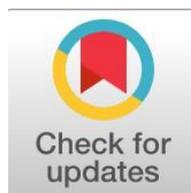

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Design Thinking for Continuous Improvement in Applied Engineering Courses

Design Thinking untuk Perbaikan Berkelanjutan pada Mata Kuliah Teknik Terapan

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Abstract

General Background: Higher education learning systems require continuous improvement to ensure learning quality, student participation, and satisfactory academic outcomes. **Specific Background:** In an applied engineering course at a higher education institution in West Java, student attendance averaged 74.45 percent per meeting and was associated with incomplete learning experiences and repeat rates. **Knowledge Gap:** Prior studies predominantly evaluated learning methods or attendance outcomes without systematically designing learning innovations grounded in student needs and experiential data. **Aims:** This study aims to apply design thinking as a structured framework to identify attendance-related barriers and enablers and to formulate learning system innovations in an applied engineering course. **Results:** Findings indicate strong student preferences for offline lectures and simulation-based learning, while attendance is primarily enabled by interesting lecture materials and constrained by work obligations. Significant relationships were identified between age and selected learning formats, as well as between gender and specific assessment types. Incremental innovations such as flipped classrooms and guest lectures, alongside radical innovations including experiential learning and AI-based learning platforms, were formulated through the ideate phase. **Novelty:** This study frames student attendance and learning quality as a design challenge and empirically integrates attendance data, student preferences, and structured innovation using design thinking. **Implications:** The results provide a data-driven framework for lecturers and academic managers to redesign applied engineering learning systems through continuous improvement grounded in participation behavior and student-centered innovation.

Highlights

- Student attendance reflects learning system configuration.

- Design thinking structures learning innovation based on empirical data.

- Continuous improvement aligns learning design with student needs.

Keywords

 Design Thinking; Continuous Improvement; Applied Engineering Education; Learning System Design; Student Attendance

I. Introduction

As an industry engaged in the field of education services, it is a requirement that the quality of the learning system must be achieved for the expected results and have an impact on learning satisfaction. Various factors cause the ineffectiveness of achieving goals, which can be seen from the level of student attendance to the final grades students obtain. The higher educational system should be able to provide accessible and available learning opportunities while maintaining good quality, so that learning can take place effectively. Education is a part of sustainable development [[1]. SDG-4 stated that quality education promotes the principles and practices of sustainable development to create opportunities for society in all areas of education [2].

Various previous studies have examined the quality of learning and student attendance from the perspective of learning outcomes, learning technology, and learning delivery models. However, most of these studies have focused on evaluating conditions or comparing learning methods, without systematically designing innovative solutions based on student needs and experiences.

The challenges faced by higher education include access and participation for the sustainability of learning, so that students can achieve the expected outcomes in each course they take. One of the common problems encountered in higher education is that lecture attendance does not reach 100%. This may lead to an incomplete understanding of the learning material, which in turn affects the final grades obtained. [3] stated that attendance contributes to learning outcomes.

Although the relationship between attendance and learning outcomes has been widely discussed in the literature, student attendance issues continue to arise in various higher education contexts. This indicates a research gap, particularly regarding the need for more innovative approaches oriented toward designing solutions, rather than simply measuring phenomena.

This study analyzes the learning system in the applied engineering course in higher education in West Java. Since this study program has been operating, this course has become compulsory and must be taken by students, and students must pass this course. However, the phenomenon that occurs shows that the student attendance rate has never reached 100 percent; even from the first meeting, it has indicated this (Table 1).

Course Meeting	Actual Attendance	Registered Students	Attendance (%)
1st Meeting	130	182	71.43
2nd Meeting	133	182	73.08
3rd Meeting	140	182	76.92
4th Meeting	144	182	79.12
5th Meeting	132	182	72.53
6th Meeting	128	182	70.33
7th Meeting	139	182	76.37
8th Meeting	148	182	81.32
9th Meeting	137	182	75.27
10th Meeting	148	182	81.32
11th Meeting	128	182	70.33
12th Meeting	133	182	73.08
13th Meeting	125	182	68.68
14th Metting	132	182	72.53
Average			74,45

Table 1. *The average attendance per course meeting*

The percentage of attendance per meeting did not reach 100 percent of the seven classes running. The average attendance of

the 14 meetings was 74.45 percent per meeting. The background of the students is a combination of working students (whether they are on shift or not) and those not yet working; some of them are married and have children, and some are not yet married.
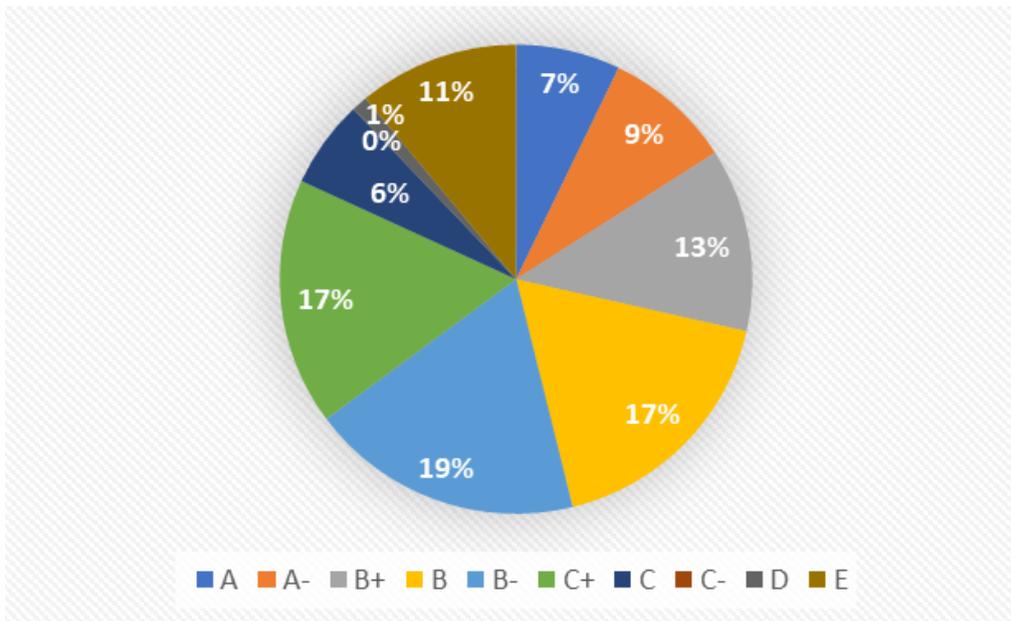
Figure 1. *Final grade achievement of the course*

Figure 1 shows the distribution of final grade achievements in applied engineering science courses. The student pass rate in this course was 87.91 percent, and the repeat rate was 12.09 percent. According to [4], embedding a culture of continuous improvement can promote rapid improvement and sustainability. Therefore, to ensure the effective implementation of this applied engineering course sustainability, continuous improvement efforts are necessary. In contrast to previous research, which tended to be descriptive or evaluative, this study positions the problem of attendance and learning quality as a design challenge that requires a structured innovation process. This study will analyze the current learning system and design innovations as a manifestation of continuous improvement to improve the quality of the learning system in the applied engineering course. The novelty of this research lies in the application of design thinking as a systematic framework for understanding student needs, formulating learning problems, and developing learning innovations.. The main objective of this study is to implement design thinking to stimulate innovation in the applied engineering course.

II. Method

This research applied the steps of the design thinking. According to [5], design thinking is becoming a trend in the fields of engineering education and management, where several researchers associate design thinking with 21st-century skills that are highly demanded by industry. According to [6] and [7], there are five phases in design thinking: empathize, define, ideate, prototype, and test. Empathize is the stage of understanding users through observation, interviews, or surveys. Define formulates the synthesis of user needs and problems. Ideate generates as many ideas as possible. A prototype creates a tangible model of the solution. Test evaluates the prototype with users and collects feedback.

The object of this research is 7th-semester students who have taken this applied engineering science course in the 5th semester. The main topic asked is related to the learning system, including the form of learning, assignments, and exams taken for one semester. The research design is exploratory. Design thinking in the front-end of innovation in this research focuses on the empathize, define, and ideate phases to better understand the voice of the students and formulate the strategies to answer them. The prototype and testing phases were developed as a proposed solution to address the problems identified in the applied engineering course.

In the empathize phase, an analysis of students' preferences regarding the variables of the current learning system was carried out. Using an electronic questionnaire, the data collection technique was carried out by surveying students who had taken one applied engineering science course in one of the study programs in the higher education service industry in Karawang. Using the Slovin formula with a 90 percent confidence level requires 100 samples. From the total electronic questionnaire distributed to all students registered in this applied engineering science course, with 182 people, 102 samples were returned, conforming to the minimum sample size. The types of data used in this study are primary and secondary. The data taken are from students' perceptions of their preferences for the learning system indicators. The secondary data used are attendance data and students' final grade achievements. Data analysis was conducted on a questionnaire designed using a Likert scale of 1-5 (1 indicates that students strongly dislike the learning system indicators, 2 indicates dislike, three is neutral, four like, and five strongly like).

In the define phase, a correlation analysis and a Barriers/Enablers analysis were conducted. The correlation between student categories (profile backgrounds) and learning form indicators was analyzed. Barriers/Enablers analysis was carried out to

find the factors affecting the course attendance. Those analyses were carried out to better define the needs of the students. During the ideate phase, both radical and incremental innovations were formulated. The Incremental and radical Innovation design is proposed to carry out continuous improvement.

The research framework in this study is shown in Figure 2. The research framework in this study is based on the problems in the learning system, indicated by the average attendance per meeting of 74.45 percent and the achievement of the final grade with a repeat rate of 12.09 percent. The level of student preference is measured using a Likert scale for the learning system that has been implemented.
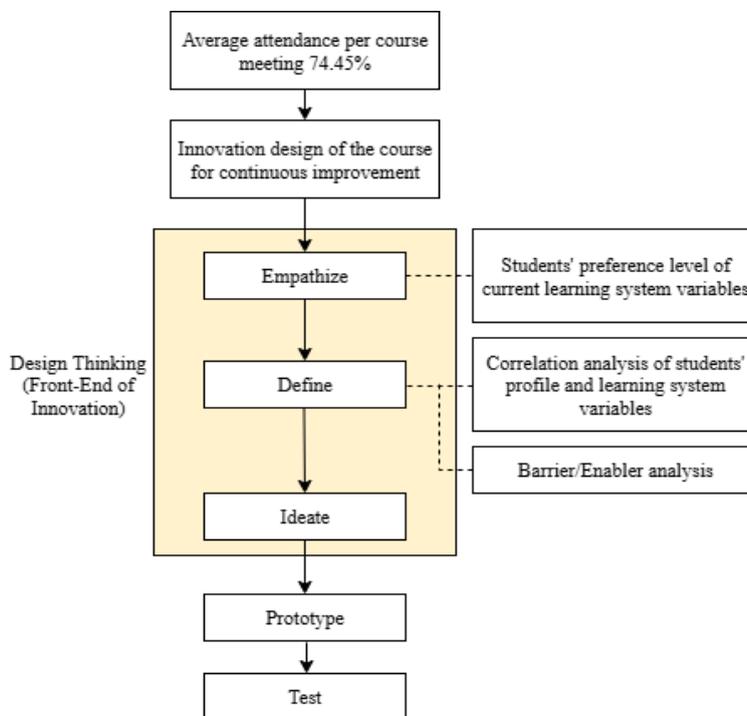
Figure 2. *Research Framework*

Problems related to the learning system are caused by various factors. Several studies have analyzed the learning system in Indonesia, such as research on online and offline learning systems [8], [9], as well as [10], which studied the e-learning learning system. Research by [11] analyzed the student learning experience in terms of various indicators in the learning system.

There are many possible factors related to student absence, both from the student's factors and the form of learning that is less interesting in lectures, assignments, or exams prepared by the lecturer. Therefore, this study seeks to find out the barriers and enablers of course attendance that do not reach 80 percent, and there has never been a single lecture meeting with 100 percent attendance. Information was collected to determine the students' preference for online learning, offline learning, lecture-based learning, problem-solving exercises, simulation-based learning, individual assignments, group assignments, offline exams, and online exams.

The problem in the applied engineering science course is that lecture attendance does not reach 100% per meeting. Student absence causes incomplete learning of the course materials received by students, which can affect the understanding of the lacking material and make the learning achievement less effective.

Correlation tests are carried out to see if there is a relationship between the student profile and the indicators of the selected learning system, namely the form of learning, exams, and assignments. The students have a work background that is grouped into three types of students: students only, students working who are affected by shifts, and students who are not affected by shifts. Other profiles observed are gender, marital status (students can be single, married, and have no children, or married and have children, which can affect their busyness), age, and study status.

Possible barriers to course attendance are elaborated, which cause the attendance rate to be less than optimal. Related to the learning system in lectures, exams, and assignments, information is explored to determine the enablers for course attendance. Various elements of the learning system have specific objectives that can be achieved using appropriate methods, media, and learning strategies. Students can successfully pass the learning process by combining them appropriately with learning objectives. This research focuses on the variables chosen for the learning system that are fully under the control of the lecturer, while the infrastructure (such as building, AC, projector, et cetera) that supports the learning system was not included because their maintenance is under the university's management control.

III. Result and Discussion

A. Profile of Respondents

The profile of respondents who filled out this questionnaire is shown in Figure 3. Female respondents numbered 87%, and male respondents numbered 13%. Respondents' age ranged from 33% <21 years, 53% aged 21-25 years, 9% aged 26-30 years, and 5% aged > 30 years. Of the study status of students, 96% are regular students, and 4% are students who are repeating this course. Marital status consists of single students, as many as 87%, students who are married and have children, as many as 11%, and students who are married and do not have children, as many as 2%.
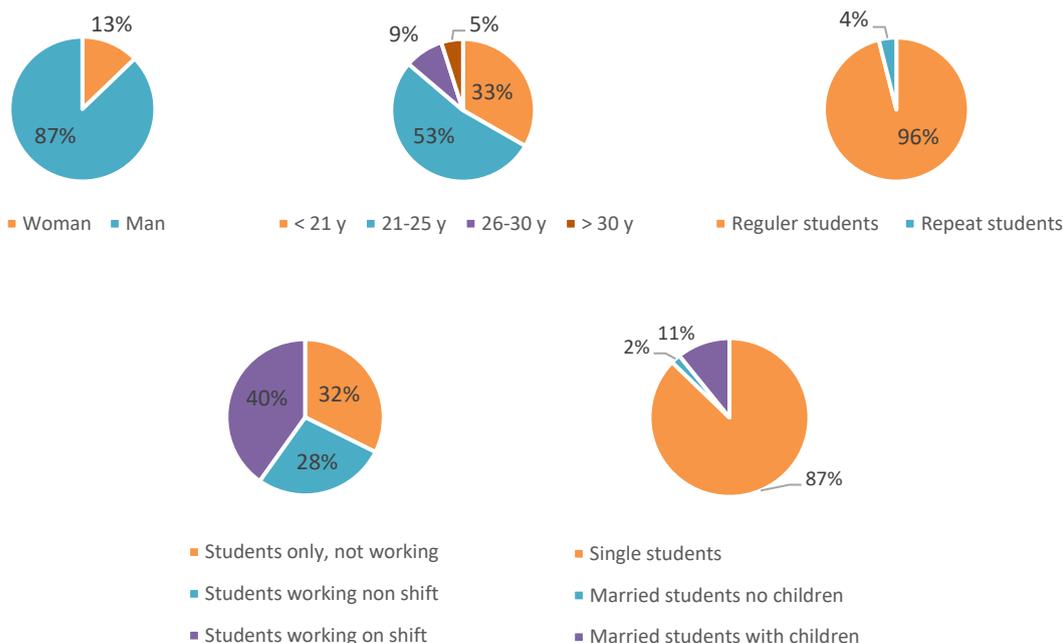
Figure 3. *Respondent Profile*

This respondent profile is an important foundation in understanding student preferences, barriers, and attendance patterns, so that the results in the empathy phase can be interpreted contextually and cannot be separated from the demographic characteristics of students.

B. Empathize Phase of Design Thinking

During the empathize phase, an analysis was conducted on students' preferences regarding the learning system. Students' preference level was identified and is shown in Figure 4. Students who like and strongly like this applied engineering science course are 84%. This shows that most students like this course.
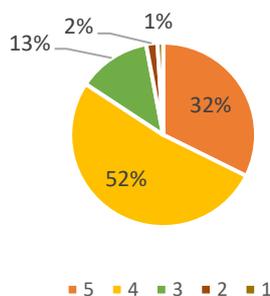
Figure 4. *Course Preference Level*

The preference level is also identified as related to the learning system. Based on the results of the questionnaire for students with a sample of 102, the respondent profile is obtained, as shown in Figure 5. The level of preference for the learning system uses five scales, namely five very much like, four like, three neutral, two dislikes, and one very much dislikes. Figure 4.2 shows the level of student preference for online and offline lectures. In terms of student preferences for online lectures, the highest results were obtained on the scale of liking and neutral, each at 32%. However, students who like and strongly like online lectures are 53%. At the same time, offline lectures show the highest results, with students strongly liking them at 46%, while students who like and strongly like offline lectures are 85%.
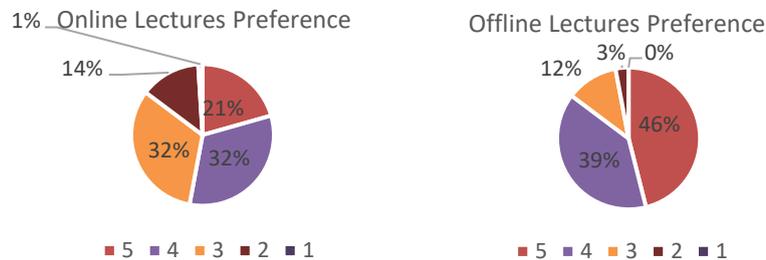
Figure 5. *Level of student preference for online and offline lectures*

These results show that in this applied engineering science course, students show a higher level of preference for offline lectures than online. This is because most of this course's material requires applying calculations, so it is easier to understand if students follow it directly in class, so that when there is something they don't understand, they can ask the lecturer directly.

Figure 6 shows students' preferences for lecture-based learning, problem-solving exercises, and simulation-based learning. In lecture-based learning, students are neutral with the highest response at 39%, but students who like and strongly like lectures are 50%. The problem-solving exercises obtained the highest results, with students liking it by 36%, and the total number of students who liked and strongly liked problem-solving exercises was 61%. Likewise, simulation-based learning obtained the highest results, showing that students liked it by 40%, and the total number of students who liked and strongly liked simulation-based learning was 64%.
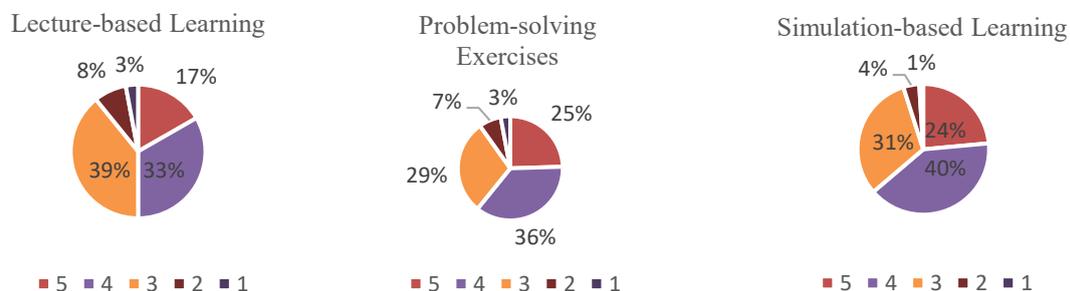
Figure 6. *Level of student preference for lecture-based learning, problem-solving exercises, and simulation-based learning*

The results show that students prefer learning in the form of simulations (64%), followed by problem-based learning (61%) and lecture-based learning (50%). The form of simulation-based learning can train students to choose the best solution by comparing it with various alternatives. This can broaden their horizons and train their analytical thinking ability to be able to choose the best solution based on certain criteria from the available choices. Problem-solving exercises can help students understand the concept of obtaining optimal results and understand the meaning of the results achieved. Lecture-based learning helps students understand science by opening up insights into the concepts of the material being studied and how to analyze and draw conclusions. The high preference for simulation-based and problem-solving learning indicates that students tend to value applied and contextual learning experiences. This finding suggests that student absenteeism is not solely due to a lack of interest, but rather to a mismatch between the learning design and students' actual needs.

Figure 7 shows individual and group assignments. Individual assignments received the highest score, namely neutral at 43%, but students who like and strongly like individual assignments are 50%. In comparison, group assignments are preferred by students by 31%, with a total of students who like and strongly like group assignments as much as 55%.
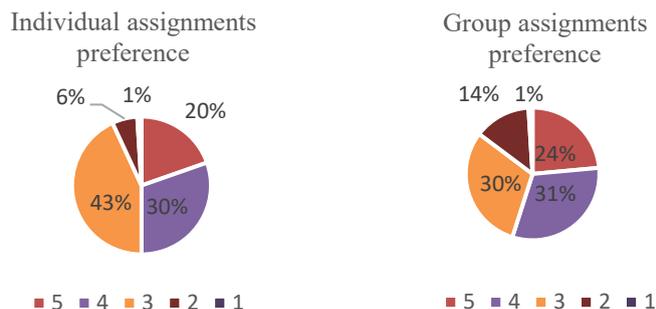
Figure 7. *Level of student preference for individual and group assignments*

The results show that student assignments appear neutral, and there is no significant difference between individual assignments (50%) and group assignments (55%). Group assignments are slightly preferred over individual assignments.

Figure 8 shows the level of student preference for offline and online exams. Regarding offline exams, most students answered neutrally at 36%, but students who like and strongly like them are 49%. Meanwhile, online exams are preferred by 43% of students, and the total number of students who like and strongly like them is 77%.
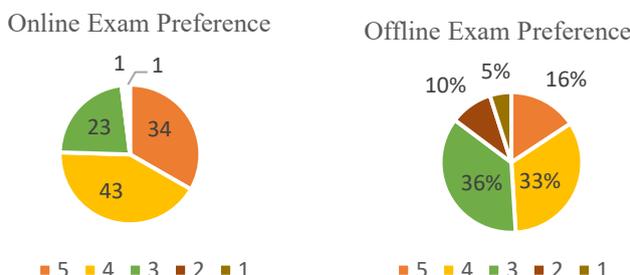
Figure 8. *Level of student preference for offline and online exams*

The results show that online exams are preferred over offline exams. This is likely because online exams are usually conducted with an open-book system, which can help students work on questions due to limitations in memorizing existing calculation formulas. Besides, online exams make the students more relaxed in their selected places when taking them.

Related to student preferences, several variables in the learning system that were initially suspected of causing students to be lazy in attending lectures were not proven. This is because, at the level of preference for the choices of like and strongly like answered by students on the nine variables related to lectures, assignments, and exams, most students (more than 50%) answered like and strongly like. Only related to offline exams (49%) and individual assignments (50%) did not reach a preference level of more than 50%.

C. Define Phase of Design Thinking

In the Define phase, a correlation analysis was conducted to more clearly identify students' needs, to foster their enthusiasm and motivation to participate in lectures. Based on the case study in this applied engineering science of higher education, variables were assessed for their correlation for further analysis. The correlation analysis was conducted using a correlation test based on the available data type. Five indicators in the student profile variable (work background, gender, marital status, age, study status) correlate with the learning system variable, consisting of 9 variables (online lectures, offline lectures, lecture-based learning, problem-solving exercises, simulation-based learning, individual assignments, group assignments, offline exams, and online exams), as well as the enabler and barrier of the course attendance.

The correlation is implemented most commonly using Spearman for ordinal data types. For a nominal data type, implement chi-square association. According to [12], the Spearman coefficient is employed when analyzing a relationship based on ranks. This approach is particularly appropriate for Likert-scale and ranked data, as it does not assume interval-level measurement or normal distribution. The results of the correlation analysis identified a significant relationship. Some variables correlated significantly at the 95% confidence level, which provides a strong basis for concluding. The 95% confidence level ($\alpha=0.05$) is widely adopted in social and educational research as it balances statistical rigor and sensitivity in detecting meaningful relationships. The variables correlated were the relationship between age and online lectures, and age and problem-solving exercises, which showed significance at a high level of confidence, indicating the relevance of the relationship. On the other hand, the relationship between gender and individual assignments, gender and offline exams, age and online exams, and age and simulation-based lectures showed significant results at a lower level of confidence (80-90%),

thus offering opportunities for further exploration. These findings are interpreted as exploratory rather than confirmatory, indicating emerging patterns that warrant cautious interpretation rather than definitive conclusions. The rest of the variables didn't correlate significantly. The absence of significance suggests that no observable association was detected within the limitations of the current dataset and analytical scope. These findings extend previous studies emphasizing the relationship between attendance and learning outcomes, demonstrating that certain student characteristics, such as age and gender, not only confirm existing literature but also add a design-based perspective to understanding student attendance.

The 95% confidence level provides more reliable results, while lower confidence levels reveal potential relationships that require further research. In addition, it is recommended that additional studies be conducted to validate less significant relationships or those that only appear at low levels of confidence by utilizing larger samples or more detailed analysis methods. Given the exploratory nature of this study, such follow-up research is necessary to enhance statistical power and confirm the stability of these relationships. These findings provide initial exploratory insights into the variables studied. However, the relationships identified through correlation analysis also need to be interpreted contextually, because the implementation of student preference-based learning innovations can face structural constraints such as time constraints, academic policies, and lecturers' capacity to accommodate variations in learner needs.

Regarding the enabler of course attendance, as many as 55% of students are motivated to attend the course because of the learning material. The second order of students is motivated to attend the course because it is held offline. The third order that encourages students' attendance at this course is that they are happy with the lecturer in charge, especially in the teaching style. Therefore, it must be maintained when managing the course. The fourth order is because of the attendance prerequisites. This is somewhat concerning because students in this category are prone to not trying their best to understand the material, only fulfilling the obligation to attend, so they must be directed. The last order is motivated by online learning. Students in this category are generally busy with their work, so online learning makes it easier to manage time.

Effective learning can provide understanding according to the learning outcomes for students. Knowledge of the material in each lecture can be achieved if every student who takes the course is present at each lecture session, so that students can learn the learning material by listening, reading, practicing, discussing, asking questions, or sharing their opinions. The diverse backgrounds of students are a challenge for lecturers to create satisfying learning experiences for the students. It is hoped that they can understand the material clearly. Attendance at lectures is the first step towards understanding the material. Therefore, student absence can be the cause of less effective learning outcomes.

While student preference for diverse learning formats is relatively high, these findings also indicate that preference alone does not automatically guarantee increased attendance. This highlights an implementation challenge, where learning innovations need to be accompanied by management of diverse student contexts to have a significant impact on lecture participation.

Based on the results of the questionnaire, barriers and enablers were identified in the case of attending the course. Figure 9 shows barriers and enablers to attending the course. The barriers of course attendance from the highest response are unable to leave work (28%), having difficulty managing time with other lecture schedules (27%), doing a lot of lecture assignments (19%), family matters that cannot be avoided (14%), being sick (11%), dislike the lecturer (1%). The enablers of course attendance, starting from the largest, are the interesting lecture material (55%), the offline learning (18%), the lecturer (11%), the prerequisites for attendance (10%), and the online learning (6%).
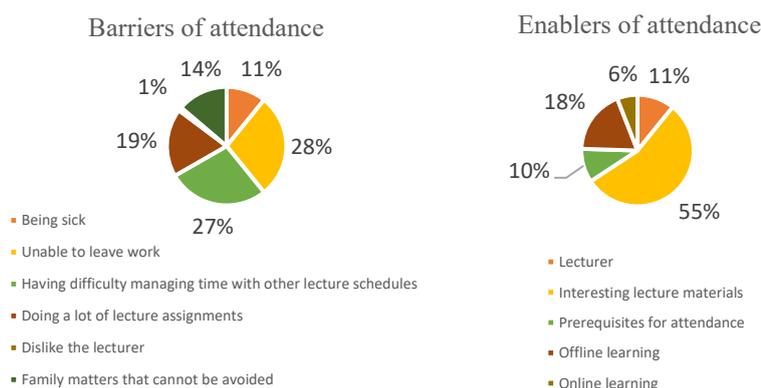
Figure 9. *Barriers and Enablers of Course Attendance*

Regarding barriers, being unable to leave work is the most common answer (28%). This is because as many as 68% of students in the respondent profile are working students, and 40% are on shifts. This causes students to have to be good at arranging their schedules to attend lecture meetings in the available classes. The second barrier is the difficulty of dividing time with other lecture schedules. This is because students on shifts sometimes have to choose conflicting lecture schedules. The third barrier is doing a lot of lecture assignments. A reasonably tricky challenge for working students is good time management so that assignments do not interfere with lecture time. The next barrier is family matters that cannot be left, being sick, and the last barrier is that one respondent answered that they did not like the lecturer. In this case, lecturers cannot please all students, but they must remain wise and motivate students to succeed in their studies. These findings imply

that learning innovation cannot be viewed as a single solution, but must be combined with learning management strategies and institutional policies that support flexibility, especially for students with workloads and family responsibilities.

D. Ideate Phase of Design Thinking

Based on an understanding of student needs and the factors influencing attendance, the next phase focuses on formulating innovative solutions that are not only responsive to student preferences but also realistic in the context of higher education. According to [13] any teaching method that does not deviate from the main objective can be categorized as an innovative teaching method. The essence of the teaching process is to transfer information or knowledge into students' understanding and to provide means and experiences that foster an innovative mindset.

In the ideate phase, an analysis of innovations in the learning system was carried out. Absence from lectures can have short-term impacts on academic achievement and, in the long term, may reduce the likelihood of continuing to the next level of education [14]. In addition, education is a key variable in a country's development, and SGD-4 can lead to real changes in individual behavior [15]. Therefore, innovation in education, especially in the learning system, needs to be carried out to achieve this goal.

Based on the results obtained, some patterns of the lectures should be maintained due to the conformance of the students' desire, such as offline lectures, simulation-based learning, and problem-based learning, since more than half of the respondents liked them. However, some form of lecture needs to be improved, so innovations need to be proposed. Based on the enablers of course attendance, which is only 55% motivated by learning materials, this needs to be considered to carry out a different form of learning that students might prefer. Two types of innovation can be proposed for continuous improvement: incremental or radical innovation. However, the implementation of innovation-whether incremental or radical-has the potential to face challenges such as infrastructure readiness, lecturers' readiness for changing roles, and the need for additional training to ensure the innovation's long-term sustainability. Incremental innovation refers to enhancements made within the boundaries of existing conditions or improvements upon what already exists. Radical innovation involves solutions that are entirely new or have never been done before.

An incremental innovation that can be proposed for this course is integrating offline and online learning better by proposing the flipped classroom. [16] mention that the flipped classroom is an active student-centered learning. The flipped classroom approach offers advantages over traditional teaching methods in higher education [17]. The Flipped Classroom methodology involves shifting the practical components of learning, such as activities and problem-solving, traditionally completed by students outside the classroom, into the classroom setting. Meanwhile, tasks typically conducted during class, such as lectures and information delivery, are assigned as preparatory work before the class session [18]. The flipped classroom approach is characterized by the comprehensive use of video or digital media lessons provided to students before class, enabling them to familiarize themselves with the learning materials beforehand. Additionally, students are required to complete assignments or quizzes either before or at the beginning of the class session. During in-class activities, instructors facilitate the learning process by addressing students' questions and encouraging collaboration among them to practice and apply the concepts introduced earlier [19]. So in the flipped classroom, students learn outside the classroom using the internet through audio or video from experts and then attend class to discuss case studies, games, simulations, or experiments. In this way, online learning is integrated with better offline learning. Another innovation for this course is to bring in practitioner speakers as guest lecturers to share best practices in the industry related to this course, such as the PPIC or inventory/warehouse section. According to [20], guest lectures can enhance student motivation by helping them conceptualize employability through the relevance of lecture content to real-world work contexts, which prepares them for future challenges. Guest lectures are also considered a method that brings relevance into the classroom and enhances student engagement [21].

A radical innovation that can be proposed for this course is experiential learning that has never been executed before, namely, students visiting the industry to learn in the production planning or inventory control section. According to [22], experiential learning with real-world projects enabled students to utilize their subject-specific knowledge while remaining adaptable to changes, considering various limitations, and determining the most viable solutions for the industry collaborators. Engaging with a range of individuals, such as instructors and industry representatives, can further broaden students' understanding and allow them to put their knowledge into practice, thus preparing them to manage the challenges of an increasingly intricate and multifaceted professional environment. Another radical innovation that can be done for this course is accommodating an AI-based platform for learning. [23] mentioned that an AI-based learning platform acts as a virtual educator in the engineering field, allowing for tailoring each student's experience to gain learning effectiveness. According to [24], incorporating AI into engineering education is not just about technological advancement; it is critical to prepare students to thrive in the increasingly complex and demanding field of engineering today.

Based on the innovative design, Table 2 shows the continuous improvement for the applied engineering course to achieve learning effectiveness.

Before	Improvement Plan	Innovation Types
Lecture-based learning	Fipped-classroom	Incremental
Internal Lecturer	Guest lecturer	Incremental

Lecture-based learning	Experiential learning	Radical
Problem-solving exercises, simulation-based learning	AI-based platform for learning	Radical

Table 2. *Continuous Improvement plan for the course*

While the proposed innovations show potential for improving the quality of learning and student attendance, their implementation requires institutional readiness, academic policy support, and faculty capacity to manage learning changes sustainably. Without such system support, the innovations risk remaining partial solutions that are difficult to sustain in the long term. It is expected that the continuous improvement plan will increase the course attendance and foster a more effective learning process.

E. Prototype & Test Phase of Design Thinking

To ensure that proposed innovations do not stop at the conceptual stage, the prototyping and testing phases are crucial in assessing feasibility, student acceptance, and initial impact on attendance and learning engagement. The prototype and test phases operate as the iterative design. The prototype phase focuses on transforming ideas into tangible forms (from low to high fidelity), while the testing phase focuses on examining the prototype and refining the design through iterative cycles to validate the model.
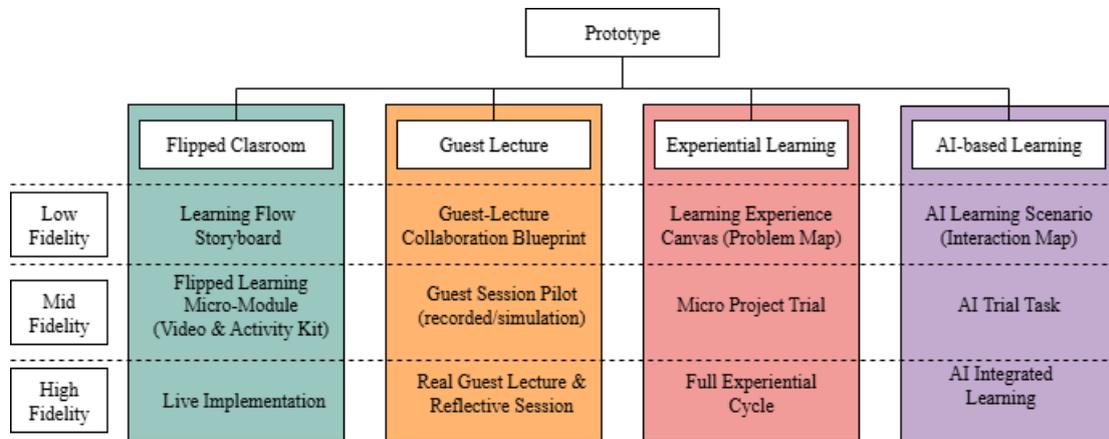

Figure 10. *Prototype iterative fidelity*

In the flipped classroom model, the storyboard of the learning flow serves a conceptual function that illustrates how students progress through each stage, beginning with pre-class engagement through video materials, followed by problem-solving activities during class sessions, and concluding with a brief reflection phase. The flipped micro-module acts as an initial prototype in the form of a short instructional video accompanied by a structured activity sheet, designed to stimulate student learning engagement and ensure their readiness before attending the in-class session. The live flipped session is the prototype stage implemented directly in the classroom to observe student interaction, engagement, and adaptation. The lecturer will then evaluate whether the design is effective in fostering student participation in the learning process.

The collaboration blueprint is a systematic plan that outlines the involved stakeholders, targeted learning outcomes, the mode of delivery (either synchronous or recorded), and its alignment with the competencies defined in the course. The pilot guest session serves as an initial trial stage in the form of a simulation or recorded session, used to evaluate content relevance, time allocation, technical flow, and the initial responses of the students before the official session is implemented. The actual guest lecture and reflection session refers to the implementation phase with the real industry professionals, followed by reflective activities to ensure that the session generates cognitive impact and industrial relevance for students.

The learning experience canvas is a design instrument that visualizes the learner experience pathway when interacting with engineering cases or problems, while highlighting key learning touchpoints and expected outcomes. The micro project trial is a small-scale experimental phase, intended to observe how the students respond to application-based tasks before entering the full main project phase. The implementation of the full experiential cycle encompasses the entire sequence of project-based learning, starting from problem briefing, exploration, and experimentation, to presentation of results, with observation focused on students' sense of ownership over their learning and the quality of engineering reasoning they develop.

An AI-based learning scenario is a conceptual framework that outlines the role and function of AI within the learning process, as well as how students will interact with it as a form of cognitive scaffolding. The AI trial task serves as an exploratory phase where students are asked to test AI on a specific task and develop an AI-augmented learning journal that records the AI's suggestions and documents how these interactions influence their reasoning process. The AI-integrated learning is a phase where AI is fully embedded throughout the entire learning process to evaluate the extent to which AI enhances learner autonomy, analytical capability, and professional judgment within engineering contexts.

In the testing phase, a structured evaluation cycle is used where student engagement, decision quality, reflective insight, and tool usability are observed using formative assessment. The test phase was not only conducted to examine the technical feasibility of the prototype but also functioned to validate whether the learning strategies developed were capable of addressing the main issue of student attendance rate. An increase in attendance and active participation can be used as the key indicator of the effectiveness of the learning prototype. Therefore, design thinking-based learning innovation needs to be understood not only as a pedagogical intervention but also as an organizational change process that requires continuous evaluation, institutional support, and adaptation to student dynamics.

IV. Conclusion

Based on the research results obtained, design thinking in the front-end of innovation in the course includes the empathize phase, the define phase, and the ideate phase. In the empathize phase, the level of student preference for the highest learning system variables at the level of liking and strongly liking online lectures is 53%, offline lectures are 85%, lecture-based learnings are 50%, problem-solving exercises are 61%, simulation-based learning is 64%, individual assignments are 50%, group assignments are 55%, offline exams are 49%, and online exams are 77%.

In the define phase, the correlation results show a 95% confidence level, indicating a significant relationship between age and online lectures, and age and problem-solving exercises. The relationship between gender and individual assignments, gender and offline exams, age and online exams, and age and simulation lectures showed significant results at a lower level of confidence (80-90%). Barrier/Enabler analysis of the student attendance that has an impact on the ineffectiveness of the learning system show that the barriers for attending this course from the highest are unable to leave work (28%), difficulty managing time with other lecture schedules (27%), doing a lot of lecture assignments (19%), family matters that cannot be avoided (14%), being sick (11%), dislike of the lecturer (1%), and the enablers of student attendance are consecutively due to interesting lecture materials (55%), offline learning (18%), lecturer's teaching style (11%), attendance prerequisites (10%), and online learning forms (6%).

In the ideate phase, the proposed incremental innovation design uses a flipped classroom and more interesting group project assignments by solving real problems, which were taken as a case study in the company. The Radical Innovation design in the proposed learning system brings guest lectures from practitioner speakers and experiential learning in collaboration with industries. The proposed learning innovations were not designed conceptually, but directly derived from empirical findings on attendance barriers and learning preferences, ensuring alignment between student needs and instructional design.

The prototype phase developed progressively through low, mid, and high fidelity levels, enabling lecturers to design a learning strategy that was not merely conceptual but evolved dynamically based on students' responses. The implementation of learning prototypes such as the flipped micro-module, industry guest lecture blueprint, experiential learning map, and AI-based learning interaction demonstrated strong potential to trigger early student engagement, which then acted as a motivational driver for attendance. The test phase did not merely function as a technical evaluation of prototype feasibility but served as a validation mechanism to determine whether the learning intervention effectively addressed the core issue of students' attendance. Improvement in attendance and active participation were used as the primary indicators of intervention success.

This study implies that university lecturers should consistently pay attention to the results of the courses and innovate to improve learning effectiveness. Lecturers should not hesitate to revise the instructional model based on observed participation data and shifts in student motivation. Practically, this study provides a structured blueprint for lecturers and program managers to redesign the learning system using design thinking as a continuous improvement mechanism grounded in participation and attendance data.

From a practical perspective, this study contributes to the literature by positioning design thinking not merely as a pedagogical method but as a systematic innovation framework that integrates student preferences, attendance behaviour, and continuous improvement in higher education learning systems. This study is subject to several limitations, including the use of a cross-sectional design and a case context limited to a single course and institutional setting. Future research is encouraged to employ longitudinal or experimental designs to assess the long-term impact of design thinking-based learning innovations, expand the study across multiple courses or institutions, and further examine the scalability of AI-supported and experiential learning interventions.

References

1. S. Küfeoğlu, "SDG-4 Quality Education," in *Emerging Technologies, Sustainable Development Goals Series*, Springer, Cham, pp. 255–275, 2022, doi: 10.1007/978-3-031-07127-0_6.
2. I. B. Franco and E. Derbyshire, "SDG 4 Quality Education," in *Actioning the Global Goals for Local Impact, Science for Sustainable Societies*, Springer, Singapore, pp. 57–68, 2020, doi: 10.1007/978-981-32-9927-6_5.
3. G. A. Tetteh, "Effects of Classroom Attendance and Learning Strategies on the Learning Outcome," *Journal of International Education in Business*, vol. 11, no. 2, pp. 195–219, Nov. 2018, doi: 10.1108/JIEB-01-2017-0004.
4. W. J. Glover, J. A. Farris, and E. M. Van Aken, "The Relationship Between Continuous Improvement and Rapid Improvement Sustainability," *International Journal of Production Research*, vol. 53, no. 13, pp. 4068–4086, Jul. 2015, doi: 10.1080/00207543.2014.991841.
5. S. Guaman-Quintanilla, P. Everaert, K. Chiluiza, and M. Valcke, "Impact of Design Thinking in Higher Education: A Multi-Actor Perspective on Problem-Solving and Creativity," *International Journal of Technology and Design Education*, vol. 33, no. 1, pp. 217–240, Mar. 2023, doi: 10.1007/S10798-021-09724-Z.

6. R. Wolniak, "The Design Thinking Method and its Stages," *Systemy Wspomagania w Inżynierii Produkcji*, 2017. [Online]. Available: https://bibliotekanauki.pl/articles/113710.pdf

7. E. Y. L. Au and R. S. Goonetilleke, "Leveraging Design Thinking to Enhance Engineering Teaching: An Operational Model," *IEEE Transactions on Education*, vol. 68, no. 1, pp. 95–102, 2025, doi: 10.1109/TE.2024.3467387.

8. R. Rohmanto and T. Setiawan, "Perbandingan Efektivitas Sistem Pembelajaran Luring dan Daring Menggunakan Metode Use Case dan Sequence Diagram," *INTERNAL (Information System Journal)*, vol. 5, no. 1, pp. 53–62, Jun. 2022, doi: 10.32627/INTERNAL.V5I1.506.

9. A. S. Zenab and S. Sukawati, "Studi Komparasi Hasil Belajar Mahasiswa Melalui Metode Daring dan Luring pada Mata Kuliah Bahasa Indonesia," *Semantik*, vol. 11, no. 2, pp. 245–256, Sep. 2022, doi: 10.22460/SEMANTIK.V11I2.P245-256.

10. F. Nadziroh, "Analisa Efektifitas Sistem Pembelajaran Berbasis E-Learning," 2018. [Online]. Available: https://journal.unusida.ac.id/index.php/jik/en/article/view/28/19

11. A. Nindiani, A. Suhara, and Gusni, "Kano Approach for Developing Learning Experiences in the Educational Service Industry." [Online]. Available: https://repository.widyatama.ac.id/items/804ec940-ab9b-4fc2-87de-b9fb3fe7cc6b

12. K. Ali and A. Al-Hameed, "Spearman's Correlation Coefficient in Statistical Analysis," *International Journal of Nonlinear Analysis and Applications*, vol. 13, no. 1, pp. 3249–3255, Mar. 2022, doi: 10.22075/IJNAA.2022.6079.

13. P. C. N. Subramani and V. Iyappan, "Recent Trend of Teaching Methods in Education," *India Journal of Applied and Advanced Research*, vol. 2018, no. 3, pp. 20–22, 2018, doi: 10.21839/jaar.2018.v3S1.161.

14. S. Cattan, D. A. Kamhöfer, M. Karlsson, and T. Nilsson, "The Short- and Long-Term Effects of Student Absence: Evidence from Sweden," 2021, doi: 10.1920/WP.IFS.2021.621.

15. A. Diemer, F. Khushik, and A. Ndiaye, "SDG 4 'Quality Education', the Cornerstone of the SDGs: Case Studies of Pakistan and Senegal," *Journal of Economics and Development Studies*, vol. 8, no. 1, 2020, doi: 10.15640/jeds.v8n1a2.

16. F. Ozdamli and G. Asiksoy, "Flipped Classroom Approach," *World Journal on Educational Technology: Current Issues*, vol. 8, no. 2, pp. 98–105, 2016.

17. H. Galindo-Dominguez, "Flipped Classroom in the Educational System," *Education and Information Technologies*, 2018. [Online]. Available: https://www.jstor.org/stable/27032855

18. T. Låg and R. G. Sæle, "Does the Flipped Classroom Improve Student Learning and Satisfaction? A Systematic Review and Meta-Analysis," *AERA Open*, vol. 5, no. 3, Jul. 2019, doi: 10.1177/2332858419870489.

19. H. Al-Samarraie, A. Shamsuddin, and A. I. Alzahrani, "A Flipped Classroom Model in Higher Education: A Review of the Evidence Across Disciplines," *Educational Technology Research and Development*, vol. 68, no. 3, pp. 1017–1051, Jun. 2020, doi: 10.1007/S11423-019-09718-8.

20. D. G. Pepple et al., "Using Guest Lectures to Enhance Student Employability: Pedagogical Considerations," *Cogent Education*, vol. 12, no. 1, Dec. 2025, doi: 10.1080/2331186X.2025.2452076.

21. L. Li and R. Guo, "A Student-Centered Guest Lecturing: A Constructivism Approach to Promote Student Engagement," 2015. [Online]. Available: http://www.aabri.com/copyright.html

22. P. S. Seow, G. Pan, and G. Koh, "Examining an Experiential Learning Approach to Prepare Students for the Volatile, Uncertain, Complex and Ambiguous (VUCA) Work Environment," *The International Journal of Management Education*, vol. 17, no. 1, pp. 62–76, Mar. 2019, doi: 10.1016/J.IJME.2018.12.001.

23. N. A. S. Bahri et al., "Benefits of AI-Driven Learning Platform in Engineering Education Context," *International Research Journal on Innovations in Engineering, Science and Technology*, vol. 9, pp. 32–35, Dec. 2023, doi: 10.3991/ijet.v15i06.11231.

24. C. L. Kok et al., "Preparing Future Engineers: Strategies for Integrating AI Platforms in Higher Education," in *Proceedings of the IEEE Region 10 Annual International Conference (TENCON)*, 2024, pp. 1869–1872, doi: 10.1109/TENCON61640.2024.10902925.