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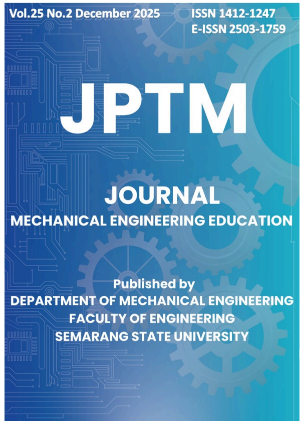

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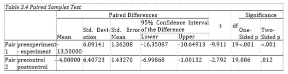

Table 3.4 Paired Samples Test

		Paired Differences					t	df	Significance	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			One-Sided p	Two-Sided p
Pair 1	preexperiment - experiment	-13,50000	6,09141	1,36208	-16,35087	-10,64913	-9,911	19	<,001	<,001
Pair 2	precontrol - postcontrol	-4,00000	6,40723	1,43270	-6,99868	-1,00132	-2,792	19	,006	,012

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Prastiyo pras, Muhammad Khumaedi, Kriswanto (Author) 1-6

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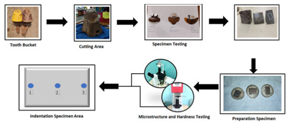

Figure 1. scheme for the research method

ANALYSIS OF MECHANICAL CHARACTERISTICS OF TOOTH BUCKET EXCAVATOR BASED ON DIFFERENT GRADE LEVELS

DOI: https://doi.org/10.15294/jptm.v25i02.33074

akhmad nurdin, Iqbal Zulfikar Alief Utama, Bagus Angger Prasetiyo, Rosyidi Hidayat, Fajar Paundra, Fajri Kurniawan, Dzikrina Salsabila Yasmin, Abdul Muhyi (Author) 7-11

Article ID 33074

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Figure 1. Exhaust Gas Emissions Tool

The Effect of Fuel Injection Duration on Exaust Gas Emissions of a 4-Stroke Engine 113.68 CC Using Bioethanol Fuel

DOI: https://doi.org/10.15294/jptm.v25i02.33503

Iqbal Zulfikar, Akhmad Nurdin, Angger Bagus Prasetiyo, Bambang Irawan (Author) 12-16

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Figure 1. Applications of composites in ballistic protection: (A) gloves, (B) bulletproof vest, (C) wheels, (D) helmet, (E) combat vehicle, (F) shield (Gaikwad et al. 2025).

A REVIEW ON THE POTENTIAL OF INDONESIAN NATURAL FIBERS AS BALLISTIC COMPOSITE MATERIALS

DOI: https://doi.org/10.15294/jptm.v25i02.35870

fajar paundra, Puji Basuki, Indah Puspitasari, Kuncoro Diharjo (Author) 17 - 25

Figure 1. Product Development Procedure

Table 1. Synthesis of the Most Effective HNF Formulations Based on Nanoparticle Type, Base Fluid, and Machining Application

Types of Hybrid Nanoparticles.	Basic Fluids	Machining Applications	Key Performance Reported
Al_2O_3 / MWCNT	Vegetable oil / Water	Milling; Stainless Steel Turning (AISI 304)	Better performance than single Al_2O_3; Reduce tool wear & chisel tip temperature.
Al_2O_3 / MoS_2	Vegetable Oil	Turning	Reduced cutting force, thrust, and surface roughness vs. a single NF Al_2O_3.
Al_2O_3 / CuO	(Not specified)	Turning (AISI 4340)	A ratio of 0.75% by weight CuO + 0.25% by weight Al_2O_3 provides the lowest surface roughness & cutting force.
hBN / Graphene (Grpt)	Vegetable Oil	Milling (Inconel X-750)	Best performance among other hybrids (hBN/MoS_2, Grpt/MoS_2) in cut style, temperature, roughness, and chisel life.
Al_2O_3 / Graphene	Water Deionization & Glycerol (25:75)	Turning (AISI D3)	Optimization with Machine Learning achieves a surface roughness of 0.16–0.45 µm with controlled temperature.
MoS_2 / CNT	(Not specified)	Nickel Alloy Grinding	Optimal lubrication effect on MoS_2:CNT mass ratio = 2:1 and 6% weight concentration.

APPLICATION OF FLIPPED CLASSROOM AND AI BASED ON IGNASIAN PEDAGOGICAL PARADIGM IN MACHINE MODELING CLASSES

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DOI:

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Keywords: machine modelling, flipped classroom, generative AI, ignatian pedagogy

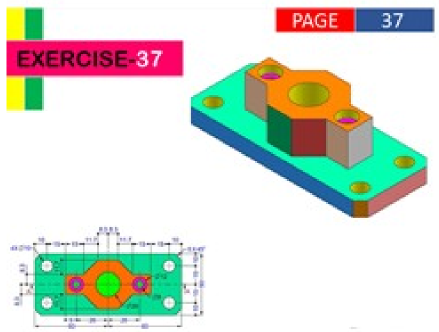

Figure 4. Exercise number 37 in the Solidworks workbook.

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Abstract

This research develops an innovative learning model in the machine modeling classroom using flipped classroom and generative AI methods and it is based on ignasian pedagogy. This research was held parallel in 2 classes, class B1 using the flipped classroom method and class B2 using conventional methods. This study aims to determine the significance of increasing final scores using the independent t-test in the application of flipped classroom in machine modeling classes with assessment rubrics based on the 4C components, namely competence, conscience, compassion, and commitment. The results of the t-test showed that the final score of class B1 was higher than class B2 even though it was not statistically significant. Although statistically insignificant, qualitative observations show that increased engagement, preparedness, and conceptual mastery among students using the FC–Gen AI–IP model. This study highlights the potential of integrating Gen AI and IP into the flipped classroom

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framework to enrich learning experiences in CAD-based engineering courses.

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APPLICATION OF FLIPPED CLASSROOM AND AI BASED ON IGNASIAN PEDAGOGICAL PARADIGM IN MACHINE MODELING CLASSES

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Abstract

This research develops an innovative learning model in the machine modeling classroom using flipped classroom and generative AI methods and it is based on ignasian pedagogy. This research was held parallel in 2 classes, class B1 using the flipped classroom method and class B2 using conventional methods. This study aims to determine the significance of increasing final scores using the independent t-test in the application of flipped classroom in machine modeling classes with assessment rubrics based on the 4C components, namely competence, conscience, compassion, and commitment. The results of the t-test showed that the final score of class B1 was higher than class B2 even though it was not statistically significant. Although statistically insignificant, qualitative observations show that increased engagement, preparedness, and conceptual mastery among students using the FC–Gen AI–IP model. This study highlights the potential of integrating Gen AI and IP into the flipped classroom framework to enrich learning experiences in CAD-based engineering courses.

Key words: machine modelling, flipped classroom, generative AI, ignatian pedagogy

INTRODUCTION

The rapid development of technology in this day often utilizes various kinds of technology or software that can be used to support teachers to provide a more dynamic experience in the classroom. One of the various tools used is artificial intelligence (AI). AI is the ability of a machine or computer system to simulate and perform tasks that typically require human intelligence, such as logical reasoning, learning, and problem-solving (Morandín-Ahuerma, 2022). One of the types of AI that is often used is generative AI, which has the ability to create content of writing, voice, video, or coding (Bail, 2024). In the learning process, gen AI also has a positive impact such as a significant increase in learning outcomes (Ahn, 2024), Getting a diversification of learning styles according to each student (Zhang, 2024), and provide a student-centered perspective, which is learning that can be adjusted to needs and practicing critical thinking skills (Sardi et al., 2025).

Along with the use of Gen AI in the learning process, the flipped classroom model has emerged as an approach that has proven to be effective in optimizing learning time in the classroom. Flipped classrom has a different learning activity framework than the traditional one, which is usually done in the classroom, such as the delivery of substantive material, transferred to the environment outside the classroom. Before class session (Jantakoon et al., 2025) Students are required to assimilate important concepts independently through video media, academic literature, or other online resources. Furthermore, time in the classroom is best used for in-depth discussions, difficult problem-solving, collaborative projects, and other interactive activities. These activities significantly help learners understand ideas well and use them in the real world (Peramunugamage, Ratnayake, Karunanayaka, & Jayawardena, 2024).

Generative AI

The use of generative AI should be widely accepted in domestic, educational, professional, and social environments, because of its great potential and alignment with the development of the digital culture of the current and future generations (Clarisa, Danawan, & Fani Chandra Wijaya, 2020). Other research conducted by Alier et al suggests that Gen AI can be leveraged to compile customized quizzes, generate questions for essays, or even to evaluate essays (Alier, García-Peñalvo, & Camba, 2024). The use of Gen AI as an evaluation instrument can reduce the burden of teacher tasks and provide students with quick feedback on the results of their work. Surveys that have been conducted by research state that AI in the world of education provides benefits such as tailored learning and customizable teaching, but also presents challenges related to privacy, and human involvement that can abuse the use of AI, therefore it must be handled with caution (Robiul, Arya, & Zakariyya, 2023).

Flipped Classroom

The flipped classroom model is a method in which learning activities that are generally carried out in the classroom are carried out outside the classroom, so that time in the classroom can be devoted to more in-depth thinking activities (Dwitias Sari, Cintiya Manalu, Puji Annastasya, & Riviandy Harahap, 2022). The inverted classroom model is an innovative teaching strategy that emphasizes learner-centered learning by reversing the conventional classroom system. The flipped classroom learning method through video learning has advantages such as students have the flexibility to access and learn lecture materials at any time and from any location, learning takes place adaptively according to the capacity and rhythm of each student's learning, the structured videos helps students gain a deeper understanding, and students feel more prepared and confident to participate in learning sessions after watching the previous material (Feliciano Pinontoan & Walean, 2020).

Ignasian Pedagogy

The Ignasian Pedagogical Paradigm consists of five steps that are applied in the process, namely context, experience, reflection, action, and evaluation (Erlita Tri Anggadewi, Maria Raditya Hernawa, Andy Rudhito, Satria Nugraha, & Josepha Retno Priyani, 2020). Context plays an important role in the learning process. Context relates to the things that are involved. Factors that contribute positively and negatively to the learning process. Context related to the understanding of student personality carried out by the teacher. There are several findings during the application of the ignasian pedagogy paradigm, including the learning model applied to improve students' formative test results, students' communication skills have improved, and the learning model used has succeeded in fostering sensitivity and empathy in students (Kristanto, 2017).

The application of flipped classrom in the learning process provides many benefits such as improving cognitive abilities, improving concept understanding, and increasing student engagement (Clarisa et al., 2020). The application of flipped classroom can be enriched by implementing the Ignasian Pedagogical (IP) paradigm. IP is rooted in the Jesuit educational tradition, offering a broad framework that emphasizes on five key steps: Context, Experience, Reflection, Action, and Evaluation (Erlita Tri Anggadewi et al., 2020). In the context of the flipped classroom model, IP can also be integrated into pre-class activities intended as an initial "experience" and allow students to interact independently with the material. Learning time in the classroom can be utilized as "Reflections" and "Actions", discussions, problem-solving, and projects, learners are constantly evaluated. IP maximizes knowledge transfer, however, it also produces affective and psychomotor training. IP slowly, aligns himself with education that tends to develop the student's personality (Fakhri, Andayani, Kaswar, Zahra Adistia, & Fadhilatunisa, 2023). The Flipped Classroom and Generative AI Model Based on the Ignasian Pedagogical Paradigm will be applied to the Mechanical Modeling course at the Mechanical Engineering study program of Sanata Dharma University. The learning process in this class involves the use of computer aided design (CAD)-based design software, namely Solidworks. Solidworks is a leading 3D CAD software that is widely applied in the industry for the design, analysis, and simulation of various mechanical components as well as assembly (Hindroyuwono, Marvianto, Almaida, & Arafat, 2024). Designing using Solidworks has a complex flow with a variety of approaches, requiring a repetitive practice, deep understanding, and problem-solving skills. Traditional learning approaches often do not provide a comprehensive and inadequate perspective for mastery of concepts.

This research aims to develop and test an innovative flipped classroom learning model, integrated with Generative AI, and based on the Ignasian Pedagogical Paradigm. This model is specifically designed to be applied to Machine Modeling courses using Solidworks software, in the hope of increasing learning effectiveness, facilitating a more personalized and adaptive learning experience, and preparing learners with relevant skills to face industry challenges.

Therefore, the implementation of generative AI on flipped classrooms that allow learners to learn the basics of Solidworks independently before class, which has the ability to create custom exercises, provide adaptive feedback, and simulate complex design scenarios, will significantly improve the effectiveness of learning in these machine modeling classes.

METHODS

This research is conducted in two classes of Machine Modeling, namely class B1 and class B2. In class B1, the Flipped Classroom (FC) approach is applied combined with Gen AI and IP. While class B2 uses conventional learning methods (non-FC). The material studied in these two classes is to learn the basics of using Solidworks software in creating 3D models.

In Class B1, FC activities are applied in the 5th, 6th, 7th, 9th, and 10th weeks. The learning structure of FC consists of:

1. Pre-Class
    a. Students were given a video of the next meeting material.
    b. Students do a pre-test to measure the understanding of the video material.

c. This activity serves as the "Context" and "Experience" of IP
2. In-Class
   a. The lecturer reviews the material for 15–30 minutes.
   b. Students work on exercises and discussions in pairs or small groups.
   c. At the 10th meeting, students made presentations and design practices from group assignments that had been given at the previous meeting.
   d. Each group leader only directs, prohibited to do direct practice, thus encouraging leadership skills.
3. Post-Class
   a. Students get independent assignments from the reading material given before class and also the workbook discussed at the next meeting.
   b. This activity strengthens the "Reflection" and "Action" stages of the IP.

To evaluate the learning outcomes of the Machine Modeling course from two classes (one class using Flipped Learning/FL and one class not), an assessment rubric based on the 4C components was used, namely Competence, Conscience, Compassion, and Commitment. Grading based on a thorough assessment based on the 4C components with details:

- Assigment 1 Scoring weight 15% (Competence)
- Mid semester exam Scoring weight 40% (Competence)
- Pre-Class Completion (FL preparation) Scoring weight 10% (Conscience)
- Activeness in the classroom Scoring weight 5% (Conscience)
- Assigment 2 Scoring weight 15% (Compassion)
- Percentage of attendance Scoring weight 15% (Commitment)

Based on the data obtained from the assessment rubric, the final score will be obtained based on the assessment component. The final score data will then be carried out an Independent Sample t-test to compare the scores of the two classes statistically. This test is used to see if there is a significant increase in grades in B1 compared to B2. This test was carried out in order to get an objective picture of the impact of the implementation of FC on student learning outcomes.

The data needed for the independent t-test is dependent variable and independent variable. Dependent variables are the final score obtained based on the assessment rubric. Independent variable is 2 sample groups tested. Group 1 is B1 class applied the Flipped Classroom (FC) approach combined with Gen AI and IP, while group 2 is B2 class using conventional learning method (non-FC). The steps in data analysis are as follows:

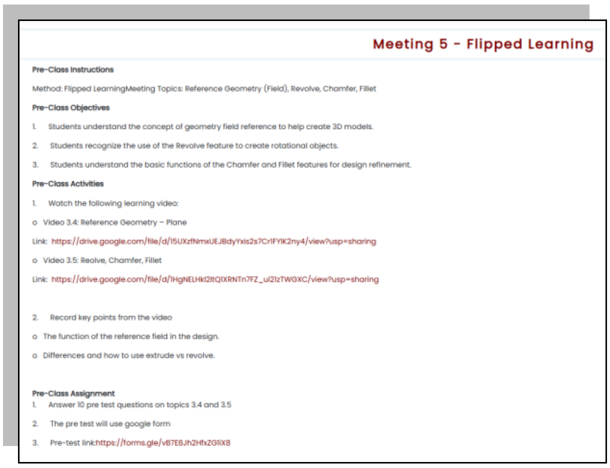
1. Enter the final score data into two separate columns or one grade column with one category (FL/non-FL) column.
2. Define the value variable as a numeric variable and the group variable as a nominal/categorical variable.
3. Do the T-Test
4. Interpretation of Results

RESULTS AND DISCUSSION

Flipped classroom was held as many 5 meetings in class B1, with the learning structure as described earlier, consisting of pre-class, in-class, and post class. Here is a screenshot example for a machine modeling learning structure using FC.

The pre class contains material for the next meeting which contains reading materials in the form of PDFs and videos on the practice of using Solidworks in making 3D designs. Material in the form of readings and videos is given to students, so that students can prepare early to understand the material that will be discussed at the next meeting, so that they have an understanding of the basic concepts of the material before class starts. It is hoped that students will be more prepared to participate in learning activities while in class at the next meeting. The pre class is also featured with a pre test which is used to measure students' understanding of the reading materials and videos provided. This pre-test is useful for lecturers to find out the level of student readiness before entering in-class activities, as well as to help students to evaluate their respective understandings. Another benefit for lecturers for this pre-test, lecturers can find out which concepts students still do not understand. This can be seen from the questions that many students answered incorrectly in the pre-test. The concept that many students still do not understand will be discussed by lecturers when in class.

The in-class activity began with the lecturer reviewing the material that had been given during pre-class for approximately 15 to 30 minutes. The lecturer also discussed a lot about the pre-test questions that were still answered incorrectly by students by providing a deepening of the material if necessary, the lecturer directly gave examples with practice using Solidworks. After the review and pre-test reading session, the activities in class continued with the lecturer giving several practice questions according to the material being studied. Students can freely work independently or have discussions in small groups. At this stage, lecturers play more of a role as facilitators who provide guidance and direction, as well as provide direct feedback when students have difficulty solving problems during practice using Solidworks. With this approach, students not only understand concepts theoretically but are also able to apply them practically through hands-on activities.


Meeting 5 - Flipped Learning

Pre-Class Instructions

Method: Flipped LearningMeeting Topics: Reference Geometry (Field), Revolve, Chamfer, Fillet

Pre-Class Objectives

1. Students understand the concept of geometry field reference to help create 3D models.
2. Students recognize the use of the Revolve feature to create rotational objects.
3. Students understand the basic functions of the Chamfer and Fillet features for design refinement.

Pre-Class Activities

1. Watch the following learning video:
   - Video 3.4: Reference Geometry – Plane

   Link: https://drive.google.com/file/d/15UXzfNmxUEJBdyYxis2s7CrIFYIK2ny4/view?usp=sharing
   - Video 3.5: Reolve, Chamfer, Fillet

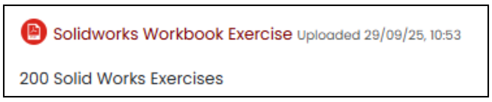
   Link: https://drive.google.com/file/d/1HgNELHkI2ItQIXRNTn7FZ_ui21zTWGXC/view?usp=sharing

2. Record key points from the video
   - The function of the reference field in the design.
   - Differences and how to use extrude vs revolve.

Pre-Class Assignment

1. Answer 10 pre test questions on topics 3.4 and 3.5
2. The pre test will use google form
3. Pre-test link:https://forms.gle/vB7EBJh2HfxZGIiX8

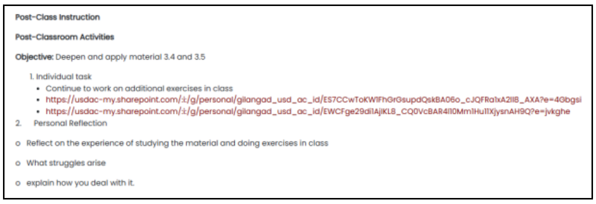
Figure 1. Screenshot of the FC learning structure in the B1 Machine Modeling class.


Solidworks Workbook Exercise Uploaded 29/09/25, 10:53

200 Solid Works Exercises

Figure 2. Screenshot of the Solidworks workbook link.

Post class activities contain reflections and actions that need to be taken by students related to the material that has been learned in class. The most important exercise is to continue the unfinished exercises when they are done in class. In addition, lecturers also complete the Solidworks workbook in the Learning Management System (LMS) as an additional exercise for post classes. This workbook contains 200 design exercises using Solidworks, with a variety of shapes to practice using specific features.


Post-Class Instruction

Post-Classroom Activities

Objective: Deepen and apply material 3.4 and 3.5

1. Individual task
   - Continue to work on additional exercises in class
   - https://usdac-my.sharepoint.com/:t:/g/personal/gilangad_usd_ac_id/ES7CCwToKWIFhGrGsupdQskBA06o_cJQFRa1xA2lIB_AXA?e=4Gbgsi
   - https://usdac-my.sharepoint.com/:t:/g/personal/gilangad_usd_ac_id/EWCFge29di1AjIKL8_CQ0VcBAR4I10Mm1Hu1IXjysnAH9Q?e=jvkghe
2. Personal Reflection
   - Reflect on the experience of studying the material and doing exercises in class
   - What struggles arise
   - explain how you deal with it.

Figure 3. Post class instructions at meeting week 6.

For example, in the post class instruction at meeting 6 in the machine modeling class, the lecturer instructed students to do 3 exercises in the workbook, namely exercises 37, 38, 82. The exercises given are adjusted to the material given in class. The material at meeting 6 discussed the features of holes and threads, which focused on learning the features to make holes and threads on design objects. This will make the exercises given in line with the material given in class. Students are also allowed to discuss difficulties when doing independent exercises. An example of question number 37 can be seen in Figure 4.

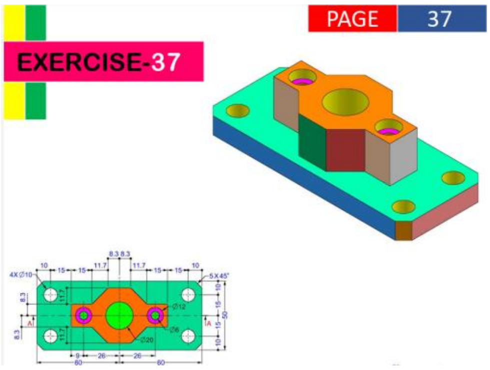


Figure 4. Exercise number 37 in the Solidworks workbook.

Reflection is also a post class activity even though some reflective questions have been given during the oral in class. Reflection questions are given at the end of class and students are taught to also use AI Genes to help them reflect. Gen AI is used as a tool to compile deeper and more personal reflections for each student, more Gen AI is used by students to better understand the definition of each feature in Solidworks, and better understand terms in the world of 3D design. For example, the term vertex is a term commonly used in machine modeling using Solidworks. When students are still confused about understanding the term vertex, the use of Gen AI really helps them in understanding technical terms that are often used in communication related to machine modeling. With the help of Gen AI, students can get simpler, faster, and tailored explanations to their learning context. In addition, Gen AI allows students to learn independently and be more confident when facing new terms in the world of machine modeling.

Meeting 10, assignment 2 was carried out which was a group task. There are 4 groups formed with group leaders selected from 4 students who achieve the highest average score from assignment 1 and mid semester exam. At meeting 9, students were given material in PDF form and asked to create a summary of the material using the help of AI NotebookLM. The group was also informed that at the next meeting, which was meeting 10, the group was asked to present and practice using Solidworks from 2 questions taken from PDF reading materials. During the in class activity, the group leader is not allowed to practice directly during the presentation, so the leader plays the role of a director who shares his knowledge with members and ensures that they are able to practice the material well. Through task 2, it is designed to foster an attitude of caring, mutual help, and communication skills and sharing knowledge with fellow friends in the group. Task 2 is an assessment of the compassion aspect.

Figure 5. Group presentation during assignment 2.

The learning process by applying IP-based FC and assisted by Gen AI has been carried out in the B1 machine modeling class. As a comparison of the effectiveness of the application of FC in class B1, it will be compared with the B2 machine modeling class that does not apply the FC method in the learning process. The tabulation of data from 2 classes can be seen in Table 1.

Table 1. Final Score of B1 class and B2 class

No.	B1	B2
1	57.63	74.42
2	90.66	0.00
3	47.10	86.04
4	1.20	52.73
5	68.34	0.00
6	84.71	76.88
7	88.23	43.04
8	86.85	64.13
9	18.97	84.88
10	65.38	88.10
11	45.97	67.69
12	59.60	88.54
13	58.76	74.18
14	97.05	38.42
15	96.93	67.69
16	84.37	82.00
17	86.83	76.90
18	88.60	84.58
19	93.40	89.25
20	96.80	64.19

The independent t-test is performed based on the procedure instructions in accordance with IBM SPSS Statistics for Windows Version 23.0 which is performed using Microsoft Excel (Kim & Kim, 2019). The first step is to create 2 independent groups that are not related to each other. In this case, group 1 is the final grade of class B1 and group 2 is the final grade of class B2. The group as can be seen in Table 1. The next step is to conduct an independent t-test through Microsoft Excel. The test was carried out using the data analysis menu using the t-Test method: Two-Sample Assuming Equal Variances, this method is used for a type of independent t-test that is used to compare the average of two independent groups assuming that both groups have the same variance (variance) (Malone & Coyne, 2025). The results of the independent t-test can be seen in Table 2.

Table 2. Results of the independent t-test

	B1	B2
Mean	70.867925	65.1844
Variance	718.5793668	707.7119815
Observations	20	20
Pooled Variance	713.1456742	
Hypothesized Mean Difference	0	
df	38	
t Stat	0.673021051	
P(T<=t) one-tail	0.252503283	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.505006566	
t Critical two-tail	2.024394164	

Based on the results of the independent t-test, it can be seen in Table 2. The parameter used to determine the significance of the implementation of FC is the P-value or significance value (Mata, Kimia, Putu, & Yunithasari, 2024). If the P-value is less than 0.05, then there is significance in the results of the t-test. On the other hand, if the P-value is more than 0.05, then there is no significance in the test results (Liang, Fu, & Wang, 2019). The value of the P-value can be seen in P(T<=t) two tails with a result of 0.505006566, this result indicates that there is no significance of the application of FC in class B1 to class B2.

These results show that although there is a difference in values in classes B1 and B2, these differences are not statistically significant enough to be concluded as a direct effect of the application of FC in class B1. The increase in grades that occurred in class B1 cannot be said to come only from FC, but could potentially be influenced by other factors such as student readiness, learning motivation, class dynamics, or the effectiveness of different pre-class and in-class implementations in each group. Future research needs to be carried out with a longer duration, larger and more uniform samples, and more stringent variables to obtain a more comprehensive picture of the application of FC in different classes. If we look at the average score, class B1 has a higher average score of 70.87, while class B2 is 65.18. Other aspects can also be seen in other average scores, for example, if we look at the commitment aspect, there will be a significant difference in scores, namely 86.55 for class B1 and 68.85 for class B2. Statistically, the average score of class B1 is higher when compared to class B2, but there is no significant value.

The learning structure with the application of FC that has been described, starting from pre class, in class, and post class, was applied to 5 meetings in the B1 machine modeling class. Each stage is designed to complement each other, starting from preparing reading materials and videos to improve student understanding, deepening the material and direct practice using practice questions in class, to reflection that can be assisted using Gen AI after class. The implementation of this FC, students are expected to be able to build a stronger understanding of concepts, thereby improving their skills in 3D machine modeling using Solidworks.

CONCLUSIONS

Based on the results of the study on the effect of the application of FC on the machine modeling class are drawn:

1. Class B1 which applied flipped classroom and class B2 which used conventional learning, P(T<=t) two tail was obtained with a result of 0.505006566. If the P-value is greater than the significance limit of 0.05, this result indicates that there is no statistically significant increase in value.
2. The application of FC in class B1 has not provided a statistically significant improvement in learning outcomes compared to class B2. It can be concluded that although the FC model offers a more active and independent learning approach, its implementation in this study has not shown a strong impact on student achievement of grades.
3. Even without statistically significant differences in student performance, the implementation of the flipped classroom model had positive impacts on classroom activity and student engagement. Students in class B1 discussed topics more actively, asked more questions, and prepared for class attendance better than others. Such qualitative improvements suggest that the FC model allows for a more interactive, student-centered environment, which might indeed bring greater understanding and long-term development of skills, even if not immediately evident from the quantitative assessment results.

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