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Computer Assisted Instruction (CAI) Integrated Case Method-Flipped Classroom: Innovative Instructional Model to Improve Problem-Solving Skill and Learning Outcome of TVET Students

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Abstract: The post-pandemic has affected all educational institutions, including TVET. The situation has shifted fully online learning into a blended one, conducted online through e-learning and onsite through face-to-face learning. In this learning, students must do self-directed learning before coming to the class, known as the flipped classroom method. On the other hand, to trigger their effort to do so, applying the case method is valuable to improve their problem-solving skill. Therefore, the flipped classroom and case method integration needs to be implemented. In the flipped classroom method, students must use CAI media to optimise the learning outcome. This study aims to see the effectiveness of integrating CAI into case method-flipped classrooms in improving the problem-solving skills and learning outcomes of TVET students. This study used a quasi-experiment with a pre-test and post-test control group design. The research instruments were a questionnaire and an achievement test with 62 participants. Based on the results, it was found that there was a significant difference in students' problem-solving skills and learning outcomes between control and experimental groups. Research findings showed substantial improvements in students' material understanding and problem-solving skills. Students reported high engagement and satisfaction with the proposed interactive learning model. Thus, it can be concluded that the CAI-integrated Case Method-Flipped Classroom effectively improves TVET students' problem-solving skills and learning outcomes. The novelty of this research is that it offers an innovation from various learning models in TVET that TVET educators can implement. The model provides time efficiency availability of such a lead-in that bridges the initial material to the primary material. Hence, the investigation results in this study provide a new knowledge reference for the TVET education curriculum.

Keywords: Computer Assisted Instruction (CAI), flipped classroom, case method, problem-solving skill, TVET

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1. Introduction

The Industrial Revolution era 4.0 has affected several human activities, including science, technology, and education (Lee et al., 2014). Since TVET education is also impacted by it, the curriculum in TVET education must be based on the existing industrial developments (Erol et al., 2016; Jaschke, 2014; Rahmadani et al., 2023). The challenge and responsibility of TVET education is to lead the graduates to have updated skills which meet the needs of the industrial revolution 4.0 (Almada-Lobo, 2015; Jalinus et al., 2023; Le et al., 2022). Problem-solving skills are one of the thinking skills needed in this era (di Gropello et al., 2011). Thus, TVET education must develop students' problem-solving skills (Jalinus et al., 2019; Jalinus & Nabawi, 2018). However, the results of the PISA test show that Indonesian students lack problem-solving skills. Their scores are below 500, the International Score Average set by the OECD. Based on the results of PISA 2012, Indonesia was in 64th rank out of 65 participating countries, one level above Peru (Gurría, 2018).

The lack of students' problem-solving skills happens because a conventional education system with teacher-centred learning is used in Indonesia, which can hinder the development of skills needed in the courses. Therefore, a new educational approach is required to change the learning process for better achievement. As the Ministry of Education, Culture, Research and Technology of Indonesia recommends, case methods and project-based learning must be implemented in education, especially in vocational high schools and TVET higher education. It is also stated as one of the assessments for Priority Performance Indicators of TVET in higher education (Direktorat Jenderal Pendidikan Tinggi, 2020). This method is part of a problem-based learning model that employs participatory and discussion-based learning so that TVET students acquire critical thinking, communication skills, and group dynamics. Recently, researchers have highlighted the effectiveness of problem-based learning in improving students' problem-solving skills (Ebiendele Ebosele Peter, 2012; Foster et al., 2018).

Furthermore, they recommend integrating those methods with technology in learning, which has not been fully implemented yet, so the students' skills have not improved optimally. Moreover, the post-pandemic has impacted all educational institutions, including TVET, which remains a shift from fully online learning into a blended one in which the learning is conducted in a blended manner; students study at home using an e-learning platform and face-to-face in-class. Independent learning at home, followed by a face-to-face discussion, is a flipped classroom (Hoshang et al., 2021). However, the integration of the case method and CAI-flipped classroom has not yet been found and implemented in learning. In contrast, its development is said to be effective in improving students' learning outcomes in recent years (Sams & Bergmann, 2012). This has proven that the flipped classroom has brought a new perspective to TVET education.

The deficiency of blended learning with case method-flipped classroom is the lack of media use as learning support and preparation done by students before learning, resulting in inconsistencies in the learning impact on improving students' skills. However, CAI-based learning media can develop students' skills (Hawkins et al., 2016). Thus, computer use in the learning process plays an important role. Based on the previous studies, the integration of CAI into case method and flipped classroom have practical impact to improve TVET students' skill and learning outcomes, such as CAI in the form of interactive multimedia learning (Lv et al., 2022; Varadila et al., 2023), mobile learning (Ya et al., 2021), flipped classroom (Sakti & Sukardi, 2021), e-learning (Kham Le et al., 2023; Rini et al., 2023), and augmented reality (Huda et al., 2021). Therefore, in this study, the integration of CAI and case method-flipped classroom were conducted to describe their impact on improving the learning outcome and problem-solving skill of TVET students. Therefore, this study aimed to explain the impact of implementing Computer Assisted Instruction (CAI) integrated case method-flipped classroom to improve the problem-solving skills and learning outcomes of TVET students. The research questions of this study were as follows:

i) Does the Computer Assisted Instruction (CAI) integrated case method-flipped classroom impact TVET students' problem-solving skills?
ii) Does the Computer Assisted Instruction (CAI) integrated case method-flipped classroom impact TVET students' learning outcomes?
iii) Is there any significant difference in the impact of Computer Assisted Instruction (CAI) integrated case method-flipped classroom on TVET students' problem-solving skills according to gender?
iv) Is there any significant difference in the impact of Computer Assisted Instruction (CAI) integrated case method-flipped classroom on TVET students' learning outcomes according to gender?

2. Methods

2.1 Research Type

A quasi-experimental approach was used in this study since it is mainly used to see the theoretical perspective in cause-and-effect relationships (Bogdan, 1997). This research aimed to see if CAI integrated the case method-flipped classroom as the treatment impacted students' learning outcomes. The learning outcomes were assessed by giving a pre-test before the treatment was implemented and a post-test after. The two treatments used in the research are teacher-centred learning (TCL), implemented in the control group, and computer-assisted instruction (CAI), integrated case

method-flipped classroom, implemented in the experimental group. In Computer Assisted Instruction (CAI), an integrated case method-flipped classroom method implementation, students were provided materials on the website where they had to study at home before having a face-to-face class. After reviewing the materials, students solved the case given in class; the case was given as a detective game with a systematic solution procedure. This study used two instruments for research data collection: a problem-solving skill questionnaire (pre-test and post-test) and an achievement test (pre-test and post-test).

2.2 Research Design

The design used in this research was a quasi-experimental design with a non-equivalent control group design. This design is almost identical to the pre-test and post-test control group designs. The experimental group was the students of the vocational pedagogy class with section code 006, and the control group was the students of the vocational pedagogy class with section 007. Before the treatment, both groups were given a pre-test to determine the suitability of the group situation. After the treatment, both groups were given a post-test to assess their condition. The control group had experienced learning using TCL during vocational school, while the experimental group had never experienced knowledge using Computer Assisted Instruction (CAI) integrated case method-flipped classroom before. Figure 1 is the design on which this research is based on.

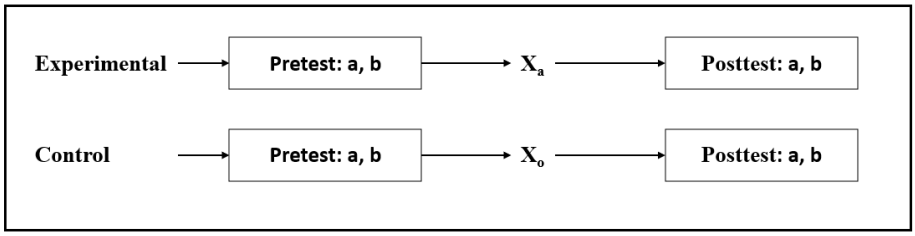

Fig. 1 - Research design

2.3 Population and Sampling

Universitas Negeri Padang is suitable for this quasi-experimental research since it meets the criteria for this study. The population of this study was 97 TVET students attending Vocational Pedagogy courses. Among them, 62 students were taken by using a random sampling technique to ensure that each member of the population had the same opportunity to be selected as a sample. Moreover, using this technique, the research results are more likely to represent the population. It was carried out using predetermined random numbers, where the population was sorted from 1 to 97. They were then divided into two homogeneous groups: the experimental group, where the students were treated using Computer Assisted Instruction (CAI) integrated case method-flipped classroom, and the control group. Demographic information of the research sample is provided in Table 1.

Table 1 - Sample

Groups	Number of students			Grand Total
	Male	Female	Subtotal	
Experimental	19	11	30	62
Control	19	13	32	

2.4 Research Procedures

This study had three stages: (1) pre-test, (2) treatment, and (3) post-test. The procedures used in this research shown in Figure 2.

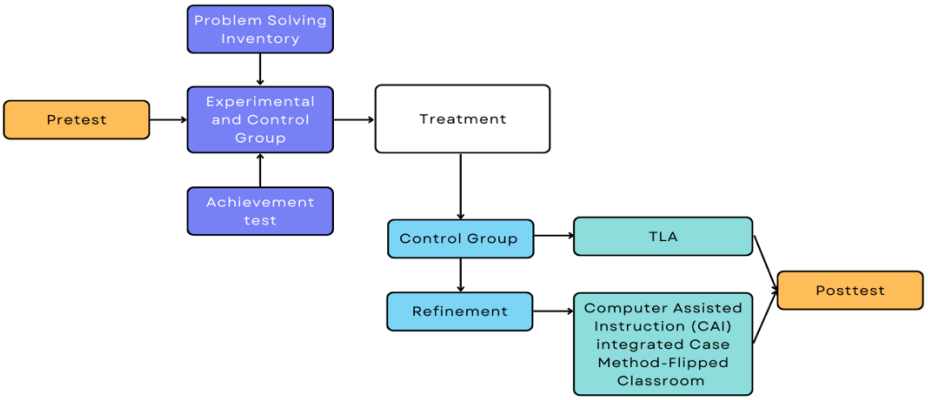

Fig. 2 - Research procedures flowchart

2.4.1 Computer Assisted Instruction (CAI) Integrated Case Method-Flipped Classroom

Implementing computer-assisted instruction (CAI) integrated case method-focused classroom learning can create an interactive and student-centred learning experience. Five steps were done in this research: 1) The teacher prepared learning materials that aligned with the learning objectives and selected relevant cases to enrich students' understanding. These materials were in texts, videos, simulations, or other digital resources that could be accessed through computers or electronic devices. 2) Pre-Class Activities: Students were given access to learning materials and cases before class began. They were required to read, watch videos, or undergo interactive activities to gain a basic understanding of the topics to be covered. 3) In-Class Activities: The teacher facilitated students' discussion and collaboration in solving the given case during the class session. The teacher provided guidance, moderated discussions, and provided feedback as students interacted with the case and shared their thoughts. 4) Problem Solving and Case Analysis: Students were challenged to implement their learned knowledge and skills in analysing and solving problems related to the case. They worked individually or in groups to identify solutions, present their arguments, and discuss the implications of any choices made. 5) Evaluation and Feedback: The teacher provided formative feedback to students on their performance in solving the case and understanding the learning material. Evaluation was carried out through online tests, assignments, group discussions, or presentations. The teacher used computer learning software to collect and manage evaluation data.

2.4.2 TCL Approach

The Teacher-centred Approach to learning emphasises the teacher's role as the primary source of knowledge and leader in the learning process. This study did two steps: 1) The teacher prepared learning materials; 2) The teacher directly conveyed the subject matter to the students by using traditional teaching methods, such as lectures, questions and answers, and repetition exercises. This approach focused on transferring knowledge from the teacher to the students and administering the assessment.

2.5 Instruments

This study collected two quantitative data: problem-solving skill data collected through a questionnaire and learning outcome data collected using an achievement test. The achievement test consisted of 45 multiple-choice questions, while the problem-solving skill questionnaire used a 5-point Likert scale consisting of 25 questions. The questionnaire was adapted from Heppner (1998). A pilot study was carried out on these two instruments to obtain the results of their validity and reliability.

2.5.1 Problem Solving Skill

The problem-solving skill instrument in this study used the problem solving inventory (PSI) (Heppner, 1988). PSI was chosen since it has already been used in over 100 investigations to measure students' problem-solving skills and has been referred to as one of the most widely used instruments. The indicators of the instrument can be seen in Table 2.

Table 2 - Problem-solving inventory

No	Indicators	Total
1	Problem-Solving Confidence	14 statements
2	Avoidance Style Approach	7 statements
3	Self-Control	6 statements

2.5.2 Achievement Test

The test used in this study was designed to collect information about students' knowledge of vocational pedagogy courses. The indicators of this test include (1) analysing the teaching-learning process in a vocational context and identifying factors that influence learning effectiveness; (2) evaluating learning methods and strategies in vocational education and providing suggestions for improvement; and (3) applying vocational pedagogy concepts and theories in the context of teaching and learning.

Table 3 - Achievement test

No	Indicators	Sub-indicators	Total
1	Analysing the teaching-learning process in a vocational context and identifying factors that influence learning effectiveness	- Case study analysis of issues in vocational education - Teaching ethics and professional behaviours in vocational contexts - Integration of industry needs in the vocational curriculum	15 items
2	Evaluating learning methods and strategies in vocational education and providing suggestions for improvement	- Techniques for evaluating students' performance in vocational contexts - Development of vocational practice performance evaluation instruments - The use of formative and summative tests in vocational education	17 items
3	Applying vocational pedagogy concepts and theories in the context of teaching and learning	- Principles of vocational curriculum development - Discipline management in vocational classes - Understanding of job market demands and skills required by industries	18 items

2.6 Validity of The Research Design

2.6.1 Internal Validity

The internal validity controls in this study were intended to ensure that the results were the result of the treatment given to the experimental group. The internal validity controls included (1) history, (2) maturation, (3) instrument influence, and (4) inter-group contamination.

2.6.2 External Validity

The external validity controls were indented to ensure that the study results could be generalised to the population. The external validity controls included (1) population validity and (2) ecological validity.

2.7 Pilot Test

The pilot test in this research was conducted to identify potential problems, measure the reliability and validity of the instruments, and assess the extent to which the instruments were effective before being used in the primary research. The first step is selecting a small sample as a pilot test sample, consisting of 35 students who were not part of the research sample, representing the population being studied and the characteristics of the actual population. Next, the instruments were given to the pilot test samples while documenting any problems or questions they faced when filling out the instruments. Then, the results of the pilot test were reviewed, and issues or difficulties that emerged during data collection were identified. Invalid items will be discarded or replaced with new items. The pilot test was then conducted again to ensure the instrument reached the desired quality level. After doing so, the pilot test results were analysed using the Cronbach alpha coefficient. The questionnaire on problem-solving skills got a reliability value of

0.761, which was at an acceptable level. In line with this, the achievement test got a reliability value of 0.753, which was also satisfactory. Furthermore, the level of difficulty of the questions on this achievement test was 0.54, which indicated that the test was neither difficult nor too easy. It was concluded that these two instruments were valid and reliable.

2.8 Data Analysis Technique

The data analysis in this study used parametric statistical tests, t-tests, and ANCOVA. The pre-test scores on problem-solving skills and learning outcomes were used as covariates to analyse covariance (ANCOVA). The benefit of ANCOVA is that it statistically controls the third variable, known as the confounding variable. If the p-value is less than 0.05, it is considered statistically significant. The hypotheses of this research were as follows:

H01: There is no statistically significant difference in students' problem-solving skills mean scores between the control and experimental groups.
H02: There is no statistically significant difference in the mean scores of students' learning outcomes between the control group and the experimental group.
H03: There is no statistically significant difference in terms of gender in the mean scores of students' problem-solving skills between the control group and the experimental group.
H04: There is no statistically significant difference in terms of gender in the mean scores of students' learning outcomes skill between the control group and the experimental group.

3. Results and Discussion

The development of technology allows students to learn more effectively and efficiently. One of the utilisations of technology as a learning tool is the flipped classroom method. In the flipped classroom method, the situation is significantly different from a conventional classroom method. Students will not get any homework, but they must study the varied material thoroughly at home, such as watching educational videos, discussing online, or reading textbooks. In classroom meetings, the teacher can give assignments as a substitute for homework. Thus, the teacher can find students who master the material and those who do not understand the material. At this stage, the teacher actively encourages students to understand the material. This research integrates computer-assisted instruction (CAI) with a case method-flipped classroom.

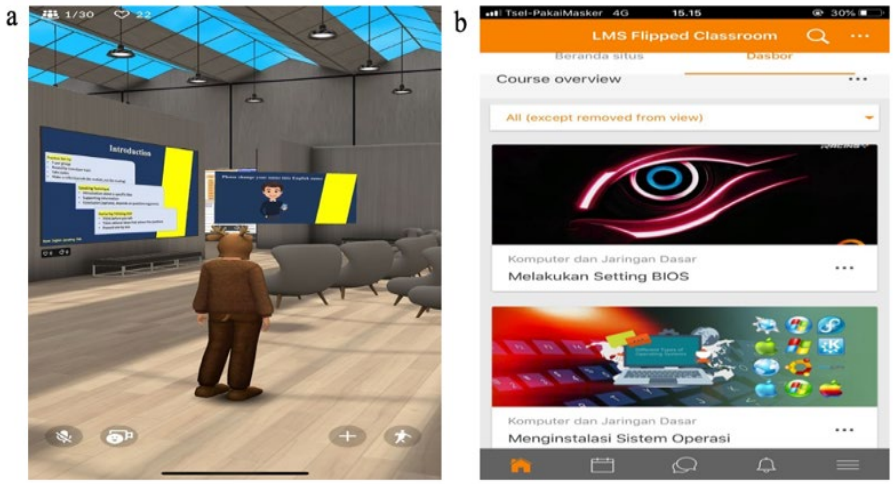

Fig. 3 - CAI used (a) GoXR virtual learning and (b) learning management system

Figure 3 presents the form of CAI used in learning, where students are asked to collect diagnosed cases, collect information, and determine the right solution for the case, as well as to construct their knowledge. Computer Assisted Instruction (CAI) integrated Case Method-Flipped Classroom as a learning technique that students are expected to solve problems through an in-depth approach, students study material at home and carry out problems in the form of assignments during learning.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01//EN">
<html>
<head>
  <title>Halaman dengan style saya yang pertama</title>
  <style type="text/css">
  body {
    padding-left: 11em;
    font-family: Georgia, "Times New Roman",
          Times, serif;
    color: purple;
    background-color: #d8da3d }
  ul.navbar {
    list-style-type: none;
    padding: 0;
    margin: 0;
    position: absolute;
    top: 2em;
    left: 1em;
    width: 9em}
  h1 {
    font-family: Helvetica, Geneva, Arial,
          SunSans-Regular, sans-serif}
  ul.navbar li {
    background: white;
    margin: 0.5em 0;
    padding: 0.3em;
    border-right: 1em solid black}
  ul.navbar a {
    text-decoration: none}
  a:link {
    color: blue}
  a:visited {
    color: purple}
  </style>
</head>

<body>
```

Fig. 4 - Part of CAI source code

The following table 2 shows the mean and standard deviation of students' learning outcome and problem-solving skill. The results shows that the mean of pre-test scores of the experimental group on the variable of problem-solving skill (72.23) and learning outcome (66.07), and the control group on the variable of problem-solving skill (72.09) and learning outcome (66.02) before being treated have similar values. It means that the experimental and control group have the same initial ability. It is a good starting point to implement Computer Assisted Instruction (CAI) integrated case method-flipped classroom treatment to the experimental group. Therefore, the higher mean of post-test scores of experimental groups than that of the control group was expected due to the treatment, if other confounding variables could be controlled.

Table 4 - Statistical descriptive data on research variables

Variables	Experimental Group (n=30)				Control Group (n=32)			
	Pre-test		Post-test		Pre-test		Post-test	
	M	SD	M	SD	M	SD	M	SD
Problem Solving Skill	72,23	12,29	83,83	10,74	72,09	12,7	74,07	7,84
Achievement Test	66,07	8,16	84,30	8,44	66,02	8,93	68,96	11,96

Several factors of internal and external validity had been controlled, in terms of extraneous variables that threaten the research findings (Rubin & Babbie, 1989), such as the influence of the teaching style of the lecturers, the discussed topics, the students' interaction of the experimental and control group, and the maturity of the students. It was done so as not to affect the results (post-test). Consequently, the results were expected to be influenced by Computer Assisted Instruction (CAI) integrated case method-flipped classroom treatment.

The results also show that the post-test scores of both groups increase. It is shown by the experimental group which is much better on the variable of problem-solving skill (83.83) and learning outcome (84.30) than that of the control group on the variable of problem-solving skill (74.07) and learning outcome (68.96).

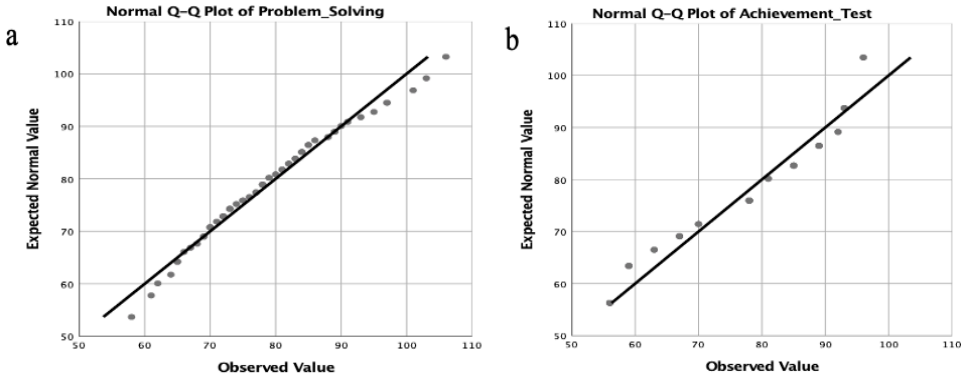

Fig. 5 - Normality result of (a) problem solving skill and (b) learning outcome

Figure 5 above is the results of the saphiro-wilk analysis which shows that the distribution of data on the variable problem-solving skill [p > 0.05, W = 0.851] and learning outcome [p > 0.05, W = 0.896] is normal. In addition, the results of Levene's Test analysis for homogeneity test also shows that the pre-test variance of problem-solving skill [p > 0.05, Levene's Statistics = 0.425] and learning outcomes [p > 0.05, Levene's Statistics = 0.390] has no significant difference between the experimental group and the control group. Therefore, it can be assumed that the research data are normal and homogeneous, and meet the requirements to perform parametric analysis. The scores of the achievement test and problem-solving skill questionnaire were analysed by using independent sample t-test, and the results are shown in Tables 5 and 6 below.

Table 5 - Comparison of pre-test scores

Variables	Groups	N	M	SD	t	Df	P
Problem Solving Questionnaire	Experimental Group	30	72,23	12,29	0,014	60	0,17
	Control Group	32	72,09	12,7			
Achievement Test	Experimental Group	30	66,07	8,16	0,045	60	0,404
	Control Group	32	66,02	8,93			

Table 5 shows that there is no significant difference between problem solving skill pre-test mean score of the experimental group and that of the control group (df=60, t=0.014, p-value=, p > 0.005). It means that the experimental group and the control group have similar pre-test mean. Therefore, it can be concluded that the impact of the treatment will appear on the post-test scores. The t-value can be seen in the experimental group and the control group; if the t-count is greater than the t-table, the null hypothesis is rejected (Elliott & Woodward, 2006). In addition, it can also be seen in the P-value, in which if the P-value > 0.005 then the null hypothesis is rejected. Based on the data above, this can be interpreted that both the experimental and control group have the same conclusion. The results show that there is no significant difference between pre-test mean score of learning outcome of the experimental group and that of the control group (df=60, t=0.045, p-value=, p > 0.005). It means that the two groups have similar learning outcome. On problem-solving skill and learning outcome post-test mean, the independent sample t-test was also used to see the significant difference on gender between the two groups after being treated.

Table 6 - Comparison of male and female students on treated variables

Variables	Male (n=18)		Female (n=12)		t	df	P
	M	SD	M	SD			
Problem Solving Questionnaire	84,16	11,81	83,27	9,09	0,214	28	0,666
Achievement Test	85	9,15	85	7,46	0,66	28	0,371

Table 6 shows that there is no significant difference between male and female in problem solving skill (df=28, t=0,214, p-value=0.666, p > 0.005) and learning outcome of vocational pedagogy courses (df=28, t=0.66, p-value=, p > 0.005). It is indicated by the similar male and female post-test scores. Therefore, this proves that there is no dominant gender based on the results of the data collected from the experimental and control group.

In the case of problem-solving skill, the results of data processing using Levene's test show that the assumption of the variance equation of the two groups (male and female) is not homogeneous (F=4.516, P-value=0.001, P<0.05). It means that they are not significantly different as previously discussed. The result is in line with the previous research which found no significant difference in problem solving skill and learning outcome based on gender by using quasi-

experimental design (Adeyemi, 2017). Meanwhile, the result contradicts with the previous research which reported that male students were more dominant in learning outcomes in engineering majors (Lawrenz et al., 2009).

Table 7 - Comparison of post-test and pre-test in group

Observations	Groups	N	Paired Sample T-test				
			Mean Differences	SD	t	df	P
Pre-test -Post-test of Problem-Solving Skill	Experimental Group	30	11,6	13,351	4,759	29	0,000
	Control Group	32	2,18	1,546	0,869	31	0,391
Pre-test -Post-test of Learning Outcome	Experimental Group	30	18,23	6,885	34,625	29	0,000
	Control Group	32	2,94	14,679	1,204	31	0,328

In the experimental group, the mean of students' post-test scores on problem solving skill (83.83) is greater than that of the pre-test score is (72.23). In addition, its post-test mean in learning outcome is 84.30, while the pre-test mean is 66.07. Paired sample t-test shows that the difference between the experimental group on problem solving skill ($t(29) = 4.759$, $p < 0.05$) and learning outcome ($t(29) = 34{,}625$, $p < 0.05$) is statistically significant. This is proven by the students' post-test mean of the experimental group on learning outcome which is also greater than the pre-test mean is. This indicates that students' problem-solving skill and learning outcome of the experimental group are significantly improved.

For the control group, the post-test's mean in problem solving skill (74.07) is higher than that of the pre-test is (72.09), and the post-test's mean in learning outcome (68.96) is also higher than that of the pre-test is (66.02). Although the control group's post-test's mean on problem-solving skill and learning outcome are higher than those of the pre-test are, the result of the paired sample t-test show that there is no significant difference between students' problem-solving skill ($t(31) = 0.869$, $p > 0.05$) and learning outcome ($t(31) = 1.204$, $p < 0.05$) of this group. It is because the increase mean from the pre-test to the post-test is not too significant.

Both the mean of post-test on problem solving skill and learning outcome of the experimental and the control group increase from that of the pre-test. However, the increase of the experimental group is higher than the control group both in terms of problem-solving skill and learning outcome as shown in Table 5. The results are in line with several previous studies conducted by various researchers (Çoban Budak et al., 2018; ÖZEN, 2016; Sumitha & Rexlin, 2016). In addition, the findings are also in line with PBL's goal of instilling epistemological competence, as popularized (Savin-Baden, 2007).

Figure 6 shows the frequency of score comparison on problem solving skill between the control group and the experimental group. There are 6 students in the control group who get score ranged 51-65, while there is only one student in the experimental group who does so. In the score range of 66-80, there are 20 students in the control group and 11 students in the experimental group. In the range of score 81-96, the frequency of students who get these scores in the control group is 7, while in the experimental group is 13. In the range of score 96-110, no one get these scores in the control group, while there are 5 in the experimental group. This proves that the highest frequency in the range of the highest score comes from the experimental group. It is proven by the covariance analysis in Table 6.

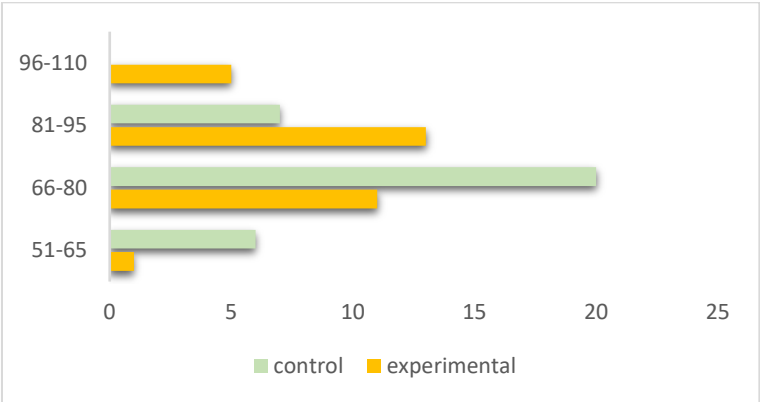

Fig. 6 - The effect of Computer Assisted Instruction (CAI) integrated case method-flipped classroom compared to conventional method on students' problem-solving skill

The analysis of covariance presented in Table 6 shows a significant difference between the experimental group and the control group in problem-solving skills (F (l,59) = 19,510, p < 0.05, 2 = 0.145). The effect size eta-squared is interpreted as a small effect if it has a value of 0.01, a medium impact if it has a value of 0.06 and a significant effect if it has a value of 0.14. In this study, its value is 2 = 0.145, meaning it has a significant effect size.

Table 8 - ANCOVA analysis result of problem-solving skill

Source	df	Mean square	F	p	η^2
Pre-test	1	144,706	18,673	0,000	0,191
Group	1	1687,538	19,510	0,000	0,145
Error	59	86.497			
Total	62				

In general, the results of this study indicate that Computer Assisted Instruction (CAI) integrated case method-flipped classroom is more effective in improving students' problem-solving skills than conventional teaching methods. The results also show that students' learning outcomes in the experimental group also improved. These results align with research based on Computer Assisted Instruction (CAI), case method and flipped classrooms (Foster et al., 2018; Hartanto et al., 2022; Sakti & Sukardi, 2021). Figure 6 shows the students' pre-test and post-test scores in the experimental and control groups. As shown there, the increase of the experimental group's score is higher than that of the control group and is categorised as significant at = 0.05. The most done in the flipped classroom implementation is by using videos made by lecturers, and students must watch them beyond class time. Therefore, there are inconsistencies in the research results dealing with the flipped classroom implementation to improve students' problem-solving skills (Wulansari & Nabawi, 2021) and learning outcomes (Campillo-Ferrer & Miralles-Martínez, 2021). The existing research has also not investigated the various combinations of the flipped classroom (Sakti & Sukardi, 2021).

The 3rd and 4th null hypotheses were tested by using ANCOVA. In the experimental group, there are 30 complete pairs of the pre-test and post-test data for analysis; twelve students are females (N = 12), and eighteen are males (N = 18). The means and standard deviations of students' scores of the experimental group on problem-solving skills and achievement tests concerning the pre-test and post-test are provided in Table 9.

Table 9. Mean and standard deviation of problem-solving skill and achievement test of the experimental group (N = 30 students)

Grouping		Mean	Standard deviation
Problem Solving Skill	Female		
	Pre-test score	72	12.859
	Post-test score	73,27	9,09
	Male		
	Pre-test score	75.92	12.334
	Post-test score	84,16	11,81
Achievement Test	Female		
	Pre-test score	62.78	8.44
	Post-test score	85	7,46
	Male		
	Pre-test score	62.42	8.641
	Post-test score	85	9,15

Table 9 depicts the mean score and standard deviation of problem-solving skill and achievement test between male and female students in experimental group. The result shows that problem-solving skill scores of post-tests between females (M=73.27; SD=9.09) and males (M=84.16; SD=11.81) have few differences. At the same time, the post-test scores of the achievement test show that females (M=85; SD=7.46) and males (M=85; SD=9.15) are not different. ANCOVA analysis results for problem-solving skill and achievement test scores between male and female students can be seen in Table 10.

Table 10 - ANCOVA analysis result of problem-solving skill and achievement test between genders

Source	Dependent Variable	df	f	P-Value
Pre-test PS	Problem-solving skill	26	0,266	0.515
Pre-test AT	Achievement Test	26	0,48	0.829

Table 10 compares male and female students' mean scores and standard deviations of pre-test and post-test data. In the experimental group, the mean of problem-solving skill post-test scores of male students, which is 84.16 (SD = 11.81), is higher than that of female students, which is 73.27 (SD = 9.09). Meanwhile, the mean post-test achievement test scores of female students, which is 85 (SD = 7.46), is like that of male students, which is 85 (SD = 9.15). However, as shown by Table 10, the results of the ANCOVA for each variable, problem-solving skill reaches [F (1.26) =0.266, p > 0.05], which means the difference is not statistically significant. In line with this, the difference in achievement test results is also not statistically significant [F (1.26) =0.48, p > 0.05]. As a result, the null hypothesis is not rejected; there is no statistically significant difference in the mean of problem-solving skill and achievement scores between female and male students in the experimental group. The findings suggested that, in this study sample, students' genders did not contribute to problem-solving skills and achievement tests.

Several previous findings show that female students' interest in engineering is much lower than male students, thus having an impact on complex problem-solving abilities in engineering activities (Rozendaal et al., 2003). Female students are also more active in learning, particularly in social relationships and providing input (Tomai et al., 2014). This helps them understand learning material, which stresses student collaboration and discussion. Nonetheless, in Computer Assisted Instruction (CAI) integrated Case Method-Flipped Classroom, the variations of issues on understanding between female and male students are not absolute and might vary for everyone (Güney-Frahm, 2018). In the Computer Assisted Instruction (CAI) integrated Case Method-Flipped Classroom, which tends to emphasise group learning activities where students must participate actively, girls' test achievement scores increase (Santrock, 2009), so it can be parallel to the achievement test for boys. Women also get higher scores in verbal language, including reading and writing assessments, and tasks requiring more detailed attention and planning (Linn and Hyde in Santrock, 2009; Warrick and Naglieri in Slavin, 2008).

Computer Assisted Instruction (CAI) integrated Case Method-Flipped Classroom aims to create a learning environment focusing more on students, centring on problem-solving and integrating technology in the learning process. This approach can have several potential advantages, such as increasing student engagement, developing analytical skills, increasing conceptual understanding, and stimulating critical thinking. Computer Assisted Instruction (CAI) includes using computer technology, such as interactive learning software, videos, simulations, and other digital resources, to assist in the delivery of course material (Fortuna et al., 2023). This approach can provide a more exciting and adaptive learning experience for students.

The Case Method involves giving students fundamental or situational cases relevant to the studied subject. Students are then allowed to analyse cases, identify problems, formulate solutions, and make context-based decisions. Flipped Classroom involves a traditional reversal between in-class and out-of-class learning tasks. Students learn material outside of class (usually through videos or reading materials), while class time is used for discussion, collaboration, and more interactive activities to develop deeper understanding. The novelty of this research is to offer varied innovations between CAI, case method, and flipped classroom as a learning model. The advantage of this model is the availability of materials given before the class starts, so there will be time efficiency and the availability of such a lead-in that will bridge the initial material to the main material. Teachers and students will have more opportunities to discuss substantial things or even broaden the scope of the material. The learning process will be more interesting due to varied digital videos or animations. Another novelty of this research is to investigate the impact of Computer Assisted Instruction (CAI) integrated case method-flipped classroom on students' problem-solving skills and learning outcomes which will certainly add new innovative learning model references for educators.

4. Conclusion

This study investigated the effectiveness of Computer Assisted Instruction (CAI) integrated case method-flipped classroom on TVET students' problem-solving skills and learning outcomes. The research covered by this study is in line with what TVET higher education have been looking for in an effective SCL (Student-Centered Learning) approach. The results of this study prove that the learning procedure of Computer Assisted Instruction (CAI) integrated case method-flipped classroom is effective in improving TVET students' problem-solving skills and learning outcomes.

The researcher has designed a learning procedure of Computer Assisted Instruction (CAI) integrated case method-flipped classroom, especially for Vocational Pedagogy courses, which can be generally implemented in other vocational courses of TVET in higher education. The learning procedure is expected to be useful for relevant stakeholders in higher education since it contributes to teaching and learning objectives and develops research related to the implementation of learning models in TVET education.

The findings of this study will contribute to existing knowledge, particularly in determining the effect of Computer Assisted Instruction (CAI) integrated case method-flipped classroom on TVET students' problem-solving skills and learning outcomes. This study provides information on whether Computer Assisted Instruction (CAI) integrated case method-flipped classroom is feasible and can be implemented in the context, sample, and population of TVET

education students. Therefore, the TVET curriculum development division can develop an effective curriculum based on the SCL approach using computer-assisted instruction (CAI), an integrated case method-flipped classroom.

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