Research Article https://doi.org/10.12973/ijem.9.4.745

International Journal of Educational Methodology
Volume 9, Issue 4, 745 - 759.
ISSN: 2469-9632
https://www.ijem.com/

An Exploration into the Impact of Flipped Classroom Model on Cadets' Problem-Solving Skills: A Mix Method Study

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Received: Received: June 13, 2023 ▪ Revised: August 1, 2023 ▪ Accepted: September 6, 2023

Abstract: Many education and learning experts currently recommend the flipped classroom model as an alternative to learning after the COVID-19 pandemic. This study aims to explore the impact of the flipped classroom model on social skills and problem-solving skills for cadets. This research used a sequential mix method involving 50 maritime students in semester 7 of the Engineering Study Program at the Maritime Sciences Polytechnic Makassar, South Sulawesi, Indonesia. Researchers used two main instruments, namely problem-solving skill tests and interviews. Furthermore, in the quantitative analysis, the researcher ran paired sample t-tests and one-way Multivariate Analysis of Covariance (MANCOVA) using the SPSS 25.00 program. In addition, researchers also analysed qualitative data from interviews using thematic analysis techniques. The results showed that the flipped classroom model proved to have a positive effect on the problem-solving skills of maritime students. Other findings state that the cadets also respond positively to the flipped classroom model. Researchers recommend that teachers use the flipped classroom model, especially in dealing with learning in the post-pandemic era, like today.

Keywords: *Flipped classroom, mix method, problem-solving skill.*

To cite this article: Ivan, M., Ulfah, M., Awalludin, Novarita, Nilawijaya, R., & Fitriyyah, D. (2023). An exploration into the impact of flipped classroom model on cadets' problem-solving skills: A mix method study. *international Journal of Educational Methodology*, *9*(4), 745-759. https://doi.org/10.12973/ijem.9.4.745

Introduction

Education is one aspect of human life that is constantly changing and dynamic. Aycicek and Yelken (2018) state that external factors drive these changes, such as the increasing human population and the development of information technology. In addition, Generation Z (digital natives) on campus increases student digital literacy (Helaluddin, Fitriyyah, et al., 2023). This situation also encourages the emergence of technology-based learning models. This means the traditional approach emphasising teacher-centred learning no longer aligns with current student expectations.

A student-centred learning approach currently dominates education. This is under the directions and policies of 21st-century education, which emphasise the importance of student-centred learning (Kazu & Kurtoğlu, 2020; Rafiola et al., 2020). In the modern education system, teachers are not the only source of information; instead, students must actively seek this information on their own with the guidance of teachers. In other words, students are the main actors in the learning process who must actively participate in class. Al-Shabibi and Al-Ayasra (2019) emphasised that student activity in this student-centred approach can be implemented with teamwork, problem-solving, and others.

One of the learning strategies that many experts recommend is learning by utilising the help of technology. Teachers must implement innovative learning strategies to achieve learning objectives in this situation. If it is related to the characteristics of Generation Z, technology in learning must be used to improve 21st-century skills (H. O. K. Ahmed, 2016; S.-C. Yang et al., 2019). The characteristics of students who are very close to technology are determining factors in implementing learning with technology (Helaluddin, Nurhayati, et al., 2023; Karabulut-Ilgu et al., 2018; C. C. R. Yang, 2017).

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One learning model that utilises technology is the flipped classroom model. This model is a choice for teachers after the COVID-19 disaster (Elian & Hamidi, 2018; Gunbatar, 2021). Flipped classrooms are a new pedagogical approach that prioritises group learning activities (Bedi, 2018; Schwarzenberg et al., 2018). Flipped Learning Network (2014) states that the flipped classroom model strongly supports students in understanding concepts supported by an effective, dynamic, interactive learning environment. In line with this statement, Bergmann and Sams (2012) stated that the flipped classroom model could maximise time in face-to-face classes more effectively and efficiently. Torres-Martín et al. (2022) stated that the flipped classroom is a form of learning that provides equal portions between the use of modern technology and learning activities in class. The flipped classroom model can improve various significant aspects for students, such as critical thinking skills, independent learning, and communication skills (Hung, 2015; Nouri, 2016). The flipped classroom model is a highly recommended learning model because this model applies technology applications on the one hand and maintains traditional educational principles on the other (Busebaia & John, 2020). Decloedt et al. (2020) support this by emphasising that the flipped classroom model is one of the best learning models because it still views the interaction between teachers and students as the primary learning activity besides technology.

Experts consider that the flipped classroom model has many benefits for student academic achievement. Flexible use of video lectures without being limited by space and time positively impacts students. The characteristics of the flipped classroom are under current student learning demands, which must be adapted to their abilities and speed (Erol Sahin, 2020; Khasawneh, 2022). In several references, the flipped classroom model is considered capable of improving students' critical thinking skills both inside and outside the classroom, the level of knowledge acquisition, and other essential skills (Kellinger, 2012; Maldonado Berea et al., 2019; Masadeh, 2021). Other positive impacts were also stated by experts who claimed the flipped classroom model was able to encourage active learning, excel in individual learning, and provide more time for students to study (Afacan & Kaya, 2022; Lee et al., 2022; Mojtahedi et al., 2020; Weiser et al., 2018).

Today, many skills must be mastered by college graduates, one of which is problem-solving skills. Bahar and Aksut (2020) emphasise that problem-solving skills are closely related to gaining conceptual understanding, defining problems, and identifying possible solutions. Mastering these skills can stimulate and encourage students to become confident individuals and think more creatively (Ozrecberoglu & Caganaga, 2018). In other words, students who master problem-solving skills can easily overcome their various problems.

The importance of problem-solving skills has become one of the focuses of 21st-century educational goals (Gongden, 2016; Wang et al., 2018). This skill is a cognitive process in finding the best and most effective way to achieve goals (Gunawan et al., 2020; Mefoh et al., 2017). Problem-solving skills are identified with a person's general talents, which include understanding problems and finding solutions (Mandani & Ochonogor, 2018). This skill contains five stages: focusing on problems, describing problems into concepts, planning solutions, implementing plans, and evaluating solutions (Docktor et al., 2015).

In reality, teachers face many challenges in developing problem-solving abilities for students. Problem-solving skills need to be taught in class because they can help students overcome their life problems (Greiff et al., 2013; Osman et al., 2018). Several studies have claimed that a lack of problem-solving capacity can limit the usefulness and power of students' ideas, knowledge, and skills (Faridah et al., 2021; Uyen et al., 2021). Another benefit of this skill is that it contributes to developing students' higher-level thinking (Ersoy, 2016).

Several previous studies have explored problem-solving skills in college. Previous studies have analysed the correlation between students' mastery of problem skills and their level of stress (Abdollahi et al., 2018), the effect of STEM education on problem-solving skills (Netwong, 2018), and the level of problem-solving skills in prospective social science teacher students (Gulec, 2020). In addition, several previous studies have also analysed these skills in learning science, mathematics, and statistics (Astuti et al., 2019; Djafar, 2022; Khalid et al., 2020). Specifically, previous studies investigated the effect of the flipped classroom method on improving student problem-solving skills (Alias et al., 2020; Faridah et al., 2021; Techanamurthy et al., 2020).

However, unfortunately, these three studies only used a quantitative approach with a quasi-experimental design. The results of the three studies show that the flipped classroom model has an impact on improving problem-solving skills. Researchers considered the three previous studies' limitations, such as the limited number of participants and using a single (quantitative) method. With these considerations, the researcher is interested in conducting further research using a mixed-method approach. This must be done so that the research findings are more comprehensive because they use two different types of approaches that can complement each other. The problems in this study are:

1. How does the flipped classroom model influence the improvement of maritime students' problem-solving skills?
2. How do maritime students perceive the use of the flipped classroom model in learning?

Literature Review

Flipped Classroom

The flipped classroom is a type of pedagogic approach that designs learning by focusing on the interaction of teachers and students while still prioritizing flexibility in learning (M. M. H. Ahmed & Indurkhya, 2020). Theoretically, the flipped classroom model is a student-centred learning approach that is similar to constructivism, connective, collaborative learning, and technology-based theory. From a modern perspective, this model is known as the reverse learning mode, which has two main activities, namely face-to-face and online learning activities (Fidan, 2023). The FC model facilitates students' learning at their own pace and style through short instructional videos and other media content outside the classroom (Jung et al., 2022; Strelan et al., 2020; Sun et al., 2022).

There are four core elements of the flipped classroom instructional design, namely time (in class and at home), space (online and offline), type of activity (individual vs collaborative), and use of technology (Kim et al., 2021). Furthermore, Flipped Learning Global Initiative (2019) offers four pillars in the FC model, namely: (a) a flexible environment, (b) a learning culture, (c) intentional content, and (d) professional educators. First, the FC model offers a flexible learning environment by offering flexibility to students in learning. Furthermore, the second pillar is a learning culture that establishes a student-centred pedagogical foundation. Furthermore, regarding intellectual content, the FC model emphasizes offering appropriate lesson content for cognitive learning for students. Finally, in the FC model, the teacher facilitates constructing knowledge and providing feedback to their students.

Several studies claim that applying the FC model improves students' problem-solving skills more effectively. Park and Han (2018) explained that the FC model can develop students' problem-solving skills because videos teach media they study at home independently. In addition, other studies have found that students who study actively with the FC model can improve their problem-solving skills because they learn something meaningful and contextual (Ariani et al., 2022; Hawks, 2014; Mason et al., 2013; Preeti, 2021; Soliman, 2016).

Problem-Solving Skills

The concept of "problem" can be interpreted as a form of the perceived discrepancy between the circumstances that occur and the expected state. These conditions encourage a person to experience confusion, obstacles, and difficulties in achieving a goal. On the other hand, problem-solving is a cognitive, emotional, and behavioural process aimed at overcoming obstacles and problems that must be addressed immediately (Yu et al., 2015). Thus, PS is an important skill that humans need throughout their lives and requires continuous improvement (Simanjuntak et al., 2021).

Problem-solving skills allow students to reflect on real-life lessonsa (Ancel, 2016). In other words, reflective thinking can be equated with the scientific method and has a clear structure. In general, this skill is accepted as consisting of five main stages, namely: (a) collecting data, (b) analyzing data, (c) determining alternative solutions, (d) intervening, and (e) evaluating (Dorimana et al., 2022; Faulkner et al., 2023).

In Mayer's (1998) view students must learn problem-solving skills in a realistic setting and practice to know what to do. Furthermore, Mayer argues that the learning of effective problem-solving skills contains three main dimensions, namely: (a) the cognitive dimension, which shows the ability to learn, (b) the metacognitive dimension, which shows the ability to acquire in a realistic setting, and (c) the motivational dimension which shows desire.

Concerning learning for engineering students, a mix-method study was conducted by Karabulut-Ilgu et al. (2018) regarding the effect of applying the flipped classroom model to student problem-solving skills. The findings of this study state that the FC model can potentially enhance learning activities such as interactions with peers, interactions with teachers, analyzing problems, and others. Other studies state that the FC model can assist engineering students in identifying, mobilizing, and investigating the knowledge they acquire to overcome the various problems they face (Lin, 2019; Ngo, 2022; Velegol et al., 2015).

Methodology

Research Design and Participants

This research aims to investigate the effect of the flipped classroom model on improving problem-solving skills. In addition, this research also seeks to explore students' perceptions of learning using the flipped classroom model. The perspective of maritime students is needed to provide supporting evidence for quantitative data so that research findings are more comprehensive. To answer the two formulations of the problem, the researcher applied a sequential mix-methods approach in collecting and analyzing research data. This study's initial phase was carried out by implementing quantitative and qualitative methods. The qualitative findings in the final stages of the research aim to support the quantitative findings. In other words, this study uses two stages of data collection and analysis in the same research to obtain more in-depth findings.

This research involved 50 maritime students at the Makassar Maritime Polytechnic, South Sulawesi, Indonesia, who were taking the Control Systems course. Two classes from the 7th-semester Engineering Study Program at the Makassar Maritime Sciences Polytechnic, South Sulawesi, Indonesia Indonesia from the four existing classes were randomly

selected. Furthermore, the researchers randomly assigned the two classes as experimental classes using the flipped classroom method and the control class using the conventional method. This research was conducted in the odd semester of the 2022/2023 school year, from September to November 2022.

Data Collection and Analysis

Problem-Solving Skills Test

In the quantitative data collection session, the researcher used an instrument in the form of a problem-solving skills test. This test of problem-solving skills refers to the test developed by Polya (1973). Researchers developed this test based on the Control Systems course. There is one essay question in this skill test which covers four aspects, namely: (a) understanding the problem, (b) making a plan, (c) implementing the plan, and (d) reflecting or looking back. Thus, the lowest score on this test is four by 16 as the highest score. Before being used, this instrument was tested and had a reliability of 0.86. That is, the problem-solving skills test is feasible to use in collecting data. Table 1 is a guideline for scoring problem-solving skills.

Table 1. Guide to Scoring Problem Solving Skills (Masduki et al., 2020)

No	Indicator	Score
1.	None of the abilities have been shown yet	1
2.	Demonstrates ability in just a fraction of the time	2
3.	Shows most of ability	3
4.	Shows all capabilities	4

The data collected from the problem-solving skills test, both pretest and post-test, were analyzed quantitatively with the help of the SPSS 25.00 application. The researcher ran several tests in this quantitative analysis to determine the mean score, standard deviation, t-test, and one-way MANCOVA. The t-test aims to explore whether there are significant differences between the two study groups using these different methods. Next, the researcher ran a one-way MANCOVA test to explore and control for the effect of covariates on the experimental and control classes in the post-test session.

Semi-Structured Interview

In the qualitative phase, researchers used another instrument to collect data: semi-structured interviews. The researcher developed five semi-structured interview questions consisting of the main points, namely: (a) students' responses/feelings after learning with the flipped classroom model, (b) the learning activities they like, and (c) the positive impact they feel with the flipped classroom model Flipped classroom. The interviews were directed only to 25 maritime students in the experimental group using the flipped classroom learning method. The semi-structured interview aims to explore maritime students' perceptions and attitudes towards using the flipped classroom method in learning. Experts suggest using semi-structured interviews because researchers can explore the perceptions of maritime students in depth due to their more flexible nature during the data collection process (Balta et al., 2016; Bokiev & Ismail, 2021; Helaluddin et al., 2020; Ruslin et al., 2022). The researcher involved two education experts to validate and provide advice on the interview questions.

Next, the researcher analyzed the data from the interview with a specific qualitative approach. The researcher used thematic analysis techniques in analyzing this qualitative data. This technique is one of the analytical techniques in a qualitative approach widely used by researchers in exploring different perspectives and generating arguments or unusual points of view (Braun & Clarke, 2006; Nowell et al., 2017).

Regarding the credibility of qualitative data, researchers used member-checking techniques in analyzing the data. This technique verifies and cross-checks data by involving cadets as data sources (Candela, 2019; Creswell, 2007; Morse et al., 2002). In this activity, the researcher transcribed the interview results and gave them to the participants. In this context, participants can revise, add, and curate parts of the transcript if they do not follow the intentions they convey.

In addition to the member-checking technique, researchers also use peer review techniques to determine the credibility of the qualitative data in this study. This technique is a common technique used by researchers by involving other researchers in analyzing research findings (Helaluddin, Nurhayati, et al., 2023; Mendelsohn, 1977; Ragone et al., 2011). This peer engagement aims to minimize and avoid bias and subjectivity in research (Hirschauer, 2010; Smith, 2006). With the review from these colleagues, the quality of research findings can be improved.

Procedure

Learning activities for the Electronics Course begin at the beginning of the odd semester of the 2022/2023 academic year, namely September 5, 2022. The research process was conducted in 8 meetings consisting of two modes: online and face-to-face. The flipped classroom model is also based on the condition of COVID-19, which has yet to wholly subsided.

In general, there is some material in the course, namely: (a) basic principles of IC and LSI element circuits, (b) essential electronic control equipment, (c) electronic control equipment, (d) automatic control systems, and (e) monitoring systems. The first meeting was conducted by giving an overview of the learning process using the flipped classroom or conventional model for the control class. After that, the lecturer gave an initial test (pretest) with a duration of about 90 minutes. At the following week's meeting, learning materials were provided through the WhatsApp group application, such as ppt slides, learning videos, and teaching materials in pdf format. In general, the research procedures in the experimental class are presented in Table 2.

Table 2. Instructions Procedures in Experiment Class

Week	Class Design	Content and activities
1	In-class	Pre-test
2	Out of class	Distribute lesson material in videos, links to example paragraphs, and paragraph material in pdf format to WhatsApp.
	In-class	Discuss material on the basic principles of IC and LSI element circuits (discuss learning videos, question and answer)
3	Out of Class	Distribute lesson material in the form of videos and materials in pdf format to the WhatsApp group.
	In-class	Discuss electronic control equipment 1 (lecture, question and answer, & discussion)
4	Out of Class	Distribute study material in the form of videos, links to learning materials, and materials in pdf format to the WhatsApp group.
	In Class	Discuss electronic control equipment 2 (lectures, watching learning videos, and discussions)
5	Out of Class	Distribute lesson material in the form of videos and materials in pdf format to the WhatsApp group.
	In Class	Discuss automatic control systems (lectures, discussions, watching learning videos and commenting on them, and writing independently)
6	Out of Class	Distribute lesson material in the form of videos and materials in pdf format to the WhatsApp group.
	In Class	Discuss monitoring system 1 (lectures, watching videos, collaboration in teams, and discussions)
7	Out of Class	Distribute lesson material in the form of videos and materials in pdf format to the WhatsApp group.
	In Class	Discuss monitoring system 2 (lectures, watching videos, collaboration in teams, and discussions)
8	In-Class	Post-test

In addition, the teacher delivered Electronics Subject material through a designed textbook for the control group. The same material as the experimental group was delivered using a lecture system assisted by a PowerPoint presentation. Afterwards, the teacher continued the learning activity with the question-and-answer method. Of the 100 minutes allocated for each meeting, the teacher divides it into two parts, namely a 50-minute lecture session and a 50-minute discussion/question-and-answer session.

Results

Results of Data Analysis (Quantitative Phase)

As we know that developing problem-solving skills is one of the fundamental skills for cadets, this study aims to explore the impact of two different learning models to find the most effective way to develop these skills. In this study, the collected data were analyzed using a mix-method approach, namely a quantitative approach in the initial session and a qualitative one at the end of the study. To test the impact of using the flipped classroom model and the conventional model, the researcher ran two paired sample t-tests.

Table 3 below shows the average difference between the scores of maritime students' problem-solving skills in both sessions (pre-test and post-test) for the experimental and control groups. The table shows that both groups have an average score of problem-solving skills in the post-test, which is higher than the pre-test. This means there is an increase in the value of cadets in the two groups that use these different learning models. Furthermore, Table 3 shows differences in the participants' academic writing in the pre-test and post-test of the experimental and control groups.

As Table 4 shows, there was a significant difference between the scores of cadets' problem-solving skills in the pre-test and post-test sessions. The table shows the two learning procedures on the maritime students' problem-solving skills, which increased significantly. The table is the result of an independent sample t-test which aims to find differences between the effectiveness of the flipped classroom model and the conventional model in improving maritime students' problem-solving skills.

Table 3. Descriptive Statistics

Groups	Mean	Std. Deviation	N	Std. Error Mean
PSS (Experimen-Pre)	8.24	1.589	25	.318
PSS (Experimen-Post)	13.44	1.583	25	.317
PSS (Control-Pre)	8.48	1.475	25	.295
PSS (Control-Post)	9.64	1.287	25	.257

Table 4. Paired Sample t-Test

Groups						95% Confidence Interval for Difference	
	Mean	Std. Dev	Std. Error Mean	t	Sig. (2-tailed)	Lower	Upper
Experiment	-5.200	1.528	.306	-17.021	.000	-5.831	-4.569
Control	-1.160	1.700	.304	-3.412	.002	-1.862	-.458

Next, we ran the Kolmogorov-Smirnov and Shapiro-Wilk tests to investigate the normality of the data and to control for any outliers. The test results showed that the data were standard in both groups, with no outliers. Researchers ran two independent sample t-tests to check for possible differences between the two groups (experiments with the FC model and controls with the conventional model) before and after carrying out the two learning procedures. Table 5 presents the average differences between cadets in the two groups at the pretest session. In conclusion, the average score of maritime students problem-solving skills in the two groups is almost the same.

Table 5. Descriptive Statistics (Pre-Test Both Groups)

Group	Mean	Std. Deviation	N	Std. Error Mean
Experiment	8.24	1.589	25	.318
Control	8.48	1.475	25	.295

Table 6 presents the results of the analysis, which shows a difference between the pre-test of the two groups (experimental and control) related to the achievement of the problem-solving skills score of the maritime students. The table indicates no significant difference between the pre-test maritime students in the problem-solving skills of the two groups (in the pre-test session). In other words, the scores of maritime students' problem-solving skills in the two groups were similar before the learning model procedure: the flipped classroom model in the experimental group and the conventional model in the control group.

Furthermore, Table 7 shows the differences in the mean of the two groups in the post-test session. Table 7 shows that the average problem-solving skills of maritime students in the experimental group are superior to those in the control group. Table 8 shows a difference between the experimental and control groups' pre-tests in achieving problem-solving skills scores. In other words, the table shows a significant difference between the maritime students' post-test problem-solving skills scores in the two groups. In conclusion, the flipped classroom model is a learning model that is more effective in developing maritime students' problem-solving skills than the conventional model in the control class.

Table 6. Independent Samples t-Test (Both Groups Pre-Test)

			t-Test for Equality of Means						
	Levene's Test for Equality of Variances							95% confidence interval of the difference	
	F	Sig.	t	df	Sig. (2-Tailed)	Mean Differences	Std. Error Differences	Lower	Upper
PSS (Pretest)	.014	.908	-.554	48	.582	-.240	.434	-1.112	.632

Table 7. Descriptive Statistics (Post-Test Both Groups)

Group	Mean	Std. Deviation	N	Std Error Mean
Experiment	13.16	2.035	25	.407
Control	9.76	1.535	25	.307

Table 8. Independent Samples t-Test (Both Groups Post-Test)

	Levene's test for equality of variances		t-Test for Equality of Means						
								95% confidence interval of the difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean differences	Std. Error differences	Lower	Upper
PSS (Posttest)	1.723	.196	6.670	48	.000	3.400	.510	2.375	4.425

Table 9 presents the data processing results, which show the average difference between maritime students' problem-solving skills in the two groups in the pre-test and post-test sessions. Table 9 shows the average score of problem-solving skills in the two groups, which is higher in the post-test than in the pre-test session. Next, Table 10 presents differences in the maritime students' problem-solving skills in the two groups' pre-test and post-test. The table states a significant difference between problem-solving skills in the pre-test and post-test sessions. Thus, using the flipped classroom model in learning can significantly develop problem-solving skills for maritime students.

Table 9. Descriptive Statistics (Pretest & Posttest Both Groups)

	Mean	N	Std. Deviation	Std. Error Mean
Know the problem (Ex-Pre)	2.12	25	.726	.145
Know the problem (Ex-Post)	3.36	25	.638	.128
Making a plan (Ex-Pre)	1.92	25	.400	.080
Making plans (Ex-Post)	3.32	25	.557	.111
Execute the plan (Ex-Pre)	1.96	25	.735	.147
Execute the plan (Ex-Post)	3.36	25	.569	.114
Reflection (Ex-Pre)	2.24	25	.523	.105
Reflection (Ex-Post	3.40	25	.577	.115

Table 10. Paired Sample t-Test (Pretest & Posttest Both Groups)

	Paired Differences							
				95% Confidence Interval				
	Mean	Std. dev	Std. Error mean	Lower	Upper	t	df	Sig. (2-tailed
Know the problem (Exp)	.000	.866	.173	-.357	.357	.000	24	1.00
Drawing up a plan (Exp)	-.200	.577	.115	-.438	.038	-1.732	24	.096
Execute the plan (Exp)	-.080	.862	.172	-.436	.276	-.464	24	.647
Reflection (Exp)	.040	.676	.135	-.239	.319	.296	24	.770
Know the problem (Co)	1.040	.841	.168	.693	1.387	6.186	24	.000
Drawing up a plan (Co)	1.000	.577	.115	.762	1.238	8.660	24	.000
Execute the plan (Co)	.840	.800	.160	.510	1.170	5.250	24	.000
Reflections (Co)	.920	.702	.140	.630	1.210	6.549	24	.000

Finally, the researcher ran a one-way MANCOVA to investigate differences between the maritime students' post-test on the four aspects of problem-solving skills of the two groups. This test also aims to eliminate the effects of the pre-test session. Table 11 shows the results of the one-way MANCOVA test, which showed a significant difference between the post-tests of the maritime students in the four aspects of problem-solving skills.

Table 11. Tests of Between-Subjects Effects (Posttest on Experiment Class)

Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Know the problem	19.220[a]	1	19.220	41.186	.000
Plan	24.500[b]	1	24.500	104.255	.000
Carry out the plan	24.500[c]	1	24.500	56.757	.000
Reflection	16.820[d]	1	16.820	55.451	.000

Results of Interview Analysis (Qualitative Phase)

As stated in the previous method section, there are two stages of the method in this study. The second phase is the analysis of the interview data (qualitative phase), which aims to explain and clarify the previous quantitative findings. In this phase, the researcher interviewed maritime students from the experimental class to explore their perceptions and attitudes towards implementing the flipped classroom model. This data analysis uses thematic analysis techniques to find the main themes in the learning process with the FC model. Several themes from the attitudes and perceptions of cadets towards applying the FC model are presented in Table 12.

Table 12. The Themes From the Results of the Interview Data Analysis

No	Themes
1.	Flexible in learning (out class session)
2.	Feel more ready to learn in an offline setting
3.	Self-confidence increases
4.	Learning performance increases (by collaborating)

From Table 12, the cadets showed positive attitudes and perceptions of applying the FC model in learning. Four main themes emerge from the results of this interview analysis, namely: (a) maritime students feel flexible in learning, (b) maritime students feel more prepared to face offline learning, (c) there is an increase in self-confidence, and (d) better learning performance increase. Thus, the maritime students considered that the FC model positively impacted the learning process they experienced.

The first central theme that emerged in the interviews with the maritime student was the ease of learning in the FC model. The maritime students considered that the out-class session made them more flexible in determining the time to study. This flexibility makes the learning process outside the classroom feel more comfortable for maritime students. Differences in the learning styles of maritime students (Gen Z) make learning trends more flexible and unrestricted. C-5 and C-10 state that:

> Sharing material before class is beneficial in mastering the initial concepts. I am more free to determine when I have to read the material as I wish.
>
> I like flexible learning. Since I tend to like studying at night, distributing material before class sessions makes it easier for me to master it.

Another theme that emerged from the interview results was the better learning readiness of the maritime students after they studied in the out-of-class session. Sharing material via Google Drive or the WhatApps Group application familiarizes maritime students with learning the material as an initial understanding before continuing to offline learning. Thus, the maritime students feel that they have more mature preparation when compared to conventional learning concepts. Two of the maritime students (C-17 and C-6) expressed their perspective as follows.

> I am prepared to face learning in class with the material that has been shared. At least I know what content will be studied tomorrow in class.
>
> Studying the material at home makes me feel better prepared to learn in class. At least I have obtained an initial picture of what will be known tomorrow in class.

The maritime students also claim that they have a better confidence level when learning using the FC model. Learning with the FC model can foster self-confidence when they convey their perspectives and arguments related to their tasks. Learning content through videos and peer-to-peer interactions can boost self-confidence. Two maritime students (C-14 and C-21) stated their perceptions of this.

> After discussing with my group mates, I feel more confident in carrying out various learning activities, such as when I present the results of our group discussions in class.
>
> My confidence has increased after studying material through videos and social media. I understand the material more quickly if I watch it through videos or social media such as YouTube, Instagram and TikTok.

In addition to the self-confidence aspect, the maritime students claim that learning using the FC model has great potential to improve learning outcomes. They believe that the FC model has an impact on the achievement of learning outcomes and also problem-solving skills. The maritime students believe collaborative activities or project-based learning to encourage these academic achievements. The maritime students became more enthusiastic about learning the material to understand it more easily. Two of the cadets (C-13 and C-9) support this in the following statement.

> Learning with a system like this makes it easier for me to understand the material. I found answering some of the lecturer's questions in the discussion session easier.

I am comfortable studying with the FC model so that it impacts the test scores I achieve. I got a satisfactory grade in the Electronics course.

Discussion

In general, this study aimed to investigate the effect of the flipped classroom model and the conventional model on problem-solving skills for maritime students. In addition, this study also aims to obtain an overall picture of the perspectives and attitudes of maritime students towards learning using the flipped classroom model. The results of the study showed that the class with the flipped classroom model (experimental group) outperformed the class with the conventional model (control group) in improving the problem-solving skills of maritime students. The cadets also positively responded to using the flipped classroom model in their learning.

The findings of this study align with previous studies that state that the use of flipped classrooms has an impact on improving student problem-solving skills. Several previous studies have claimed that the flipped classroom method can potentially develop students' problem-solving skills (Gao & Hew, 2021; Park & Han, 2018; Rohmatulloh et al., 2022; Wright, 2015). In addition, other studies also found evidence that the flipped classroom model can improve problem-solving skills even in various subjects, such as mathematics, biology, computers, and others (Hew & Lo, 2018; Jiang et al., 2022; Lo et al., 2017; Nicholes, 2020). The findings of these previous studies confirm that the FC model has great potential to improve students' problem-solving skills even though it is integrated into various subjects. Many factors can encourage the development of problem-solving skills for maritime students through the flipped classroom model. One of them is the design model of flipped classroom that implements the system inside and outside the classroom. In other words, learning activities at home independently and in class are one of the advantages of the flipped classroom model. The use of these two different systems can encourage maritime students to brainstorm and collaborate to learn complex materials (Fernandez-Martin et al., 2020). With the flipped classroom model, maritime students can learn the material through teaching materials distributed by the teacher before learning in class. Under these conditions, Bhagat et al. (2016) believe that using the FC model provides students with more study time allocation and is more flexible. Maritime students can adjust their study time based on understanding, learning speed, and psychological condition.

The potential of the flipped classroom model to improve problem-solving skills can also be identified from the variety of teaching materials prepared by the instructor. Before learning in class, the teacher provides learning videos, teaching modules like e-books, learning simulations, learning links through social media, and others. With a variety of teaching materials, it can train students' independence in developing their knowledge so that they can understand the material while studying in class (Lee et al., 2022). This condition certainly equips students with the material concepts they have learned before. Thus, brainstorming activities in the classroom become smooth and dynamic because students understand the material. The condition of students who have mastered the concept of material through independent learning in the out-of-class phase can encourage and practice problem-solving skills more optimally. McLean et al. (2016) support this fact by providing evidence that finding and completing assignments in the “before class” session allows students to interact with learning materials more meaningfully.

In addition, Alias et al. (2020) also stated that the flipped classroom method modified with a problem-based learning approach impacted maritime students' problem-solving skills. According to the study, student learning outcomes increased because they felt comfortable and confident after watching the learning videos. Independent learning activities at home through videos provide initial knowledge for students. Thus, they will be actively involved in learning and interact more intensely with their colleagues and instructors (Bergmann & Sams, 2012). The urgency of using video in supporting the learning process has also been published previously by researchers. In essence, students of generations Z and A like learning by using media in videos to improve their learning outcomes (Malto et al., 2018; Sezer, 2017; Sirakaya & Ozdemir, 2018).

The flipped classroom model is a form of constructivism theory. In solving problems, students actively develop knowledge and all the concepts they master. One way to practice problem-solving is to use the collaborative strategy found in the flipped classroom model. Various studies claim that collaborating with colleagues can improve problem-solving skills more than with conventional passive models. Furthermore, the flipped classroom model that uses a variety of technology and information products has great potential in helping to increase knowledge and provide examples of problem-solving.

Conclusion

In meeting the demands of the world of work, one of the skills that maritime students must master is problem-solving skills. These skills play an essential role in shaping maritime students to become confident, creative, and solutive individuals to all the problems they face. The results of this study indicate that the flipped classroom model can improve maritime students’ problem-solving skills. Combining learning activities at home and in the classroom makes learning more flexible, and maritime students can develop problem-solving skills well. In addition, other findings state that students have a positive attitude towards using the flipped classroom model in learning. In other words, most maritime students think the FC model can motivate them to study better. Thus, the interview analysis's qualitative findings support previous quantitative results about an increase in maritime students' problem-solving skills using the FC model.

Recommendations

In general, the findings of this study contribute significantly to the theory of constructivism, which states that the flipped classroom model can encourage students' ability to construct their knowledge independently and together. For practical aspects, teachers can select and use the flipped classroom model to improve problem-solving skills. Researchers suggest that further research can elaborate qualitatively and quantitatively between online and offline platforms. This means that teachers can use various learning applications or social media integrated into the FC model in addition to the WhatsApp application used in this study, such as Telegram, WeChat, Facebook Group, and others. In addition, further studies can also integrate the flipped classroom model with other approaches such as problem-based learning, project-based learning, collaborative learning and others. In the future, further research can also explore using the flipped classroom model to develop other aspects, such as critical thinking and creative thinking.

Limitations

All research has limitations. In this study, the limitations of the research were evident from the use of a limited sample, namely 50 cadets divided into two classes. Thus, there is a need for further trials involving many students from other study programs or other shipping campuses. The existence of further trials will comprehensively support findings about the impact of using the flipped classroom model on the problem-solving skills of maritime students. Another limitation is still related to the participants involved in the interview session, who are only from the experimental group. Further research can be carried out by also involving participants from the control class so that findings can be obtained that distinguish between the flipped classroom model and the conventional model.

Acknowledgements

The author would like to express his deepest gratitude to all the leaders of the Maritime Sciences Polytechnic (MSP) Makassar, South Sulawesi, Indonesia, who have provided the opportunity to support the implementation of this research. Furthermore, the researchers also gave their highest appreciation to the MSP Makassar cadets who had participated in this research.

Conflict of Interest

The authors declare no conflict of interest

Authorship Contribution Statement

Ivan: Conceptualization, data acquisition, and drafting manuscript. Ulfah and Awalludin: Data analysis, translate the manuscript, and editing/reviewing. Novarita and Nilawijaya: Editing/reviewing, supervision, and critical revision manuscript.

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