RESEARCH ARTICLE

Enhancing Maritime Cadets' Learning Outcomes through Mobile-Supported E-Mapping in Basic Mathematics: A Classroom Action Research Study

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Abstract: This study aimed to improve cadets' learning activity and outcomes in basic mathematical concepts within the Applied Mathematics course through the implementation of the Electronic Mind Mapping (E-Mapping) method. The research was conducted in the Ship Machinery Study Program and involved 26 cadets who had previously taken the course. A classroom action research approach was employed, consisting of three cycles. Each cycle included a pre-test to assess initial abilities, delivery of instructional material, and task implementation using the E-Mapping method. A post-test was then conducted to evaluate cadets' understanding and learning outcomes. In this study, E-Mapping was facilitated through mobile devices, primarily smartphones, using the SimpleMind and Canva applications. These tools enabled cadets to create, edit, and visualize mind maps in a flexible and interactive manner. The mobile-supported nature of these platforms allowed cadets to access their mind maps anytime and anywhere, enhancing the flexibility, accessibility, and autonomy of their learning. This approach empowered cadets to engage with mathematical concepts beyond the constraints of classroom time, thereby deepening their understanding. The findings revealed that the use of E-Mapping significantly enhanced cadet learning outcomes, as evidenced by increased levels of learning activity and higher average post-test scores. Positive learning activity improved progressively across the cycles: 30.77% in Cycle I, 66.66% in Cycle II, and 82.05% in Cycle III. Similarly, the average post-test score increased from 64.35 in Cycle I to 73.46 in Cycle II, and 82.12 in Cycle III. The study concluded that the E-Mapping method significantly improved both cadet learning activity and outcomes in the *Applied Mathematics* course. This improvement indicated that E-Mapping made a meaningful contribution to strengthening cadets' understanding of fundamental mathematical concepts—such as algebra, trigonometry, and number theory, which are essential for applying mathematics in the field of ship machinery engineering. By enabling the visualization of interconnections among concepts, E-Mapping helped cadets systematically organize and integrate knowledge, thereby facilitating the comprehension of abstract and complex material.

Keywords: E-Mapping, cadet's activity, learning outcomes, basic mathematics

1 Introduction

Basic mathematics in higher education, particularly in vocational institutions such as maritime colleges, continues to face challenges in improving the quality of learning and student outcomes (Karakose at al., 2023; Astriawati, 2020). One of the key courses that plays a significant role in shaping the fundamental abilities of cadets is Applied Mathematics. This course not only teaches mathematical theory but also emphasizes how to apply mathematical concepts to real-world situations—an essential skill for cadets in the Ship Machinery Study Program (Astriawati, 2020). However, despite its importance, many cadets struggle to grasp the complex nature of Applied Mathematics, which requires a more interactive and practical approach to teaching. Education in Indonesia, as mandated in 2003, must ensure equal access to educational opportunities while also providing education that can respond to local, national, and global challenges and demands (Kawuryan et al., 2021). One effort to address these needs is through planned, targeted, and continuous educational reform. Such reform must be implemented across various aspects, especially in teaching and learning practices, to achieve the desired outcomes (Papadakis et al., 2023a; 2023b). For instance, the Regulation of the Head of the Human Resources Development

Agency for Transportation PK.07/BPSDMP-2016 on the curriculum for education and training in the maritime sector must be implemented with close attention to ensure that the curriculum is effectively delivered and aligned with expectations (Wibowo et al., 2019)

However, in practice, the implementation of the curriculum in maritime vocational education faces various issues that hinder the achievement of its intended goals (Emad, 2011). One of the most prominent problems is the lack of preparedness among educators in managing the learning process (Hartanto et al., 2023). This unpreparedness directly affects cadets' understanding of the material, which in turn contributes to poor learning outcomes (Astriawati et al., 2019). The gap between the curriculum's objectives and the results achieved in the field requires serious attention and immediate improvement (Elmore, 2002). Preliminary observations in the Diploma III Ship Machinery Study Program at Yogyakarta Maritime College have revealed several issues in the Applied Mathematics course. The primary problem identified is the low level of cadet engagement during the learning process. This is suspected to stem from the cadets' limited understanding of the subject matter, coupled with their disempowerment due to the continued use of conventional lecture-based teaching methods. In this model, the lecturer dominates as the sole source of information, causing cadets to become passive and disengaged from the learning experience. Such conditions lead to low learning motivation among cadets, which ultimately harms their academic performance.

To address these issues, there is a need for innovation in teaching methods that are more engaging and effective (Papadakis, 2023). One promising solution is the implementation of the E-Mapping method. E-Mapping is a learning approach that utilizes digital technology to organize and visualize information in a more structured and easily comprehensible way (Helwa, 2020). Through E-Mapping, cadets can see the relationships between concepts and more easily recall material by using a combination of text, colours, symbols, and images.

In this digital era, E-Mapping offers opportunities for cadets to participate more actively in the learning process. This active involvement is expected to significantly enhance their understanding of the material and improve learning outcomes. The method also encourages cadets to be more engaged in processing information, which in turn can boost their motivation and academic performance in the Applied Mathematics course, especially in mastering fundamental mathematical concepts. Supporting this, studies on mobile-assisted learning in STEM and vocational education have shown positive impacts on student engagement and comprehension (Lavidas et al., 2024). For example, Khalid et al., (2024) found that mobile learning tools in STEM subjects increased learners' motivation and flexibility, allowing them to access materials anytime and anywhere, which fostered self-directed learning. Similarly, Cherner et al., (2019) emphasized that mobile-friendly educational applications facilitate interactive learning experiences that are crucial for mastering abstract concepts, particularly in vocational settings where practical application is key. Despite some challenges such as device screen size limitations and multitasking constraints, mobile-assisted learning remains a valuable approach to enhance accessibility and learning autonomy among students (Karfa, 2023). Therefore, the integration of e-mind mapping using mobile devices such as smartphones and tablets aligns with current trends in STEM and vocational education by providing flexible, accessible, and engaging learning strategies that can improve cadet understanding and outcomes in basic mathematics (Lavidas et al., 2022).

2 Materials and methods

This study was conducted in the Diploma III Ship Machinery Study Program at Yogyakarta Maritime College. The research took place over six months, from August 2024 to February 2025. The procedure in action research involves several stages that must be carried out within a cycle. The study was designed using a classroom action research (CAR) model, in which each cycle required different actions to be implemented compared to the previous one. The focus of the research was on observing cadets' learning activities and improving their learning outcomes as the main variables. Each cycle included the stages of planning, action, observation, and reflection (Nazari, 2022). This working procedure broadly followed the general description of classroom action research as outlined by Nazari (2022). (see in Figure 1)

To determine the cadets' initial abilities, a pre-test was conducted before the intervention in each cycle (Nazari, 2022). At the end of the intervention, a post-test was administered to measure the cadets' learning outcomes (Sagor, 2011). This study observed two main aspects: the improvement of learning outcomes and the technical implementation of lectures through the e-mind mapping method, which was expected to enhance the cadets' academic performance. The intervention in this study followed a classroom action research (CAR) cycle that included:

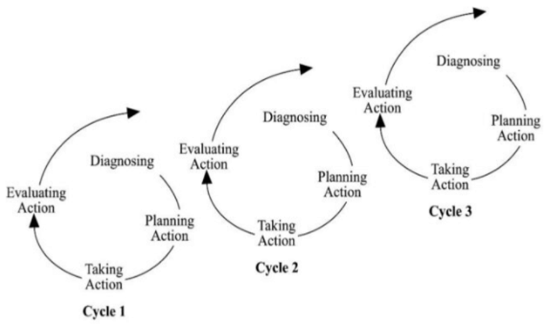

Figure 1 Classroom Action Research Cycle of the Application of Electronic Mind Mapping

2.1 Planning Stage (Plan)

(1) Developed a lecture plan;
(2) Prepared the instructional materials to be taught;
(3) Prepared observation sheets to be used during the classroom intervention;
(4) Determined the learning objectives;
(5) Prepared final test instruments to assess learning outcomes.

2.2 Implementation Stage (Action)

Conducted learning activities by assigning cadets to use electronic mind-mapping methods.

(1) Administered a final test at the end of the intervention to assess the cadets' comprehension;
(2) The detailed steps in the learning process included:
a. Conducting the teaching according to the lesson plan;
b. Administering a pre-test;
c. Conducting a final evaluation through a post-test at the end of the lesson.

2.3 Observation Stage (Observe)

(1) Collected data by observing all cadet activities and learning outcomes during the course;
(2) Closely monitored the learning implementation over time and its impact on learning outcomes.

The instruments used included:
(1) Pre-test and post-test questions;
(2) Observation sheets;
(3) Field notes to collect objective data not captured in the observation sheets.

2.4 Reflection Stage (Reflect)

Engaged in discussions with observers to identify events that occurred before and during the intervention based on observations, field notes, and interviews. Conducted analysis, interpretation, explanation, and conclusion drawing based on the collected data.

This study was carried out through multiple cycles, with each cycle consisting of planning, action, observation, and reflection stages. Each cycle concluded with a reflective stage to evaluate and determine more effective actions for the next cycle (Macintyre, 2012). If the goals were not achieved in the first cycle, the study continued to the second cycle, and so on, until the desired outcomes were achieved. Action research was conducted for a minimum of two consecutive cycles. The information gathered from each previous cycle significantly influenced the planning and implementation of the subsequent cycle. The intervention cycle was concluded once cadets had achieved an understanding of the predetermined indicators.

The success level of this classroom action research was indicated by noticeable improvements in the quality of the Applied Mechanics course in the D3 Ship Machinery Program. The indicators of cadet achievement in this study were the improvement in both learning activity and learning outcomes. The criteria for successful intervention included: Cadets obtaining a minimum score of 66, following the assessment standard set in the syllabus/SLP of Yogyakarta Maritime College. An average score above 66. A minimum of 80% of the 26 cadets who took the Applied Mathematics course achieved mastery. Improved learning activity was also demonstrated by an increase in positive participation. The data analysis techniques used were as follows: For cadet activity observation data. Data were collected through the researcher's observations of cadet activities during class sessions in each cycle. The assessment guidelines for the cadets' learning activity observation sheets in each cycle were based on the following formula:

$$\text{Cadet Activity Percentage} = \frac{\text{Number of Active Cadets}}{\text{Total Number of Cadets xTypes of Activities}} \times 100\% \quad (1)$$

The analysis included calculating the average test scores, gain (improvement) between pre-test and post-test in each cycle, and the percentage of cadets achieving mastery.

$$\text{Learning Mastery Percentage} = \frac{\text{Number of Cadets Who Achieved Mastery}}{\text{Total Number of Cadets}} \times 100\% \quad (2)$$

$$\text{Learning Outcome Improvement Percentage} = \frac{\text{Post Rate} - \text{Base Rate}}{\text{Base Rate}} \times 100\% \quad (3)$$

where, Post Rate = Average score after intervention; Base Rate = Average score before intervention.

3 Results

This study was an effort to improve cadets' learning outcomes in mastering basic mathematics theory before advancing to applied mathematics, through the implementation of the e-mind mapping method in the D3 Ship Machinery Program at Yogyakarta Maritime College. The study was conducted in three cycles, with each cycle comprising the stages of action planning, action implementation, observation, and reflection. Research data were obtained through observations of the lecture process to evaluate the cadets' learning activities as well as the development of their learning outcomes throughout the implementation of the intervention.

3.1 Cycle I

The research in Cycle I was carried out through the following steps:

(1) Identifying issues related to the teaching materials and teaching strategies to be used in the lectures;

(2) Presenting the lecture materials, including preparing teaching materials and presentations related to the e-mind mapping method;

(3) Observing the cadets' activities to assess the impact of the e-mind mapping approach;

(4) Preparing evaluation tools in the form of questions for the pre-test and post-test to measure the improvement of cadets' learning outcomes through e-mind mapping-based learning.

3.1.1 Preliminary Study

The lecture activities at Yogyakarta Maritime College showed that 84.6% of instructors still used the conventional teaching model, including lectures, question-and-answer sessions, and assignment-giving. In the learning process, the approach remained teacher-centred. The instructors provided limited motivation, which led to suboptimal cadet learning activities during the lectures. Based on the instructors' experiences in teaching Applied Mathematics with fundamental concepts, several classroom issues were identified that needed to be addressed to improve cadet learning outcomes, particularly in the teaching of theory related to numbers and trigonometry. The issues identified in the Applied Mathematics class were: Cadets still faced difficulties in understanding and retaining the material presented by the instructor, even though note-taking was encouraged; Cadets' active participation in learning was still low, with many cadets feeling shy or afraid to ask questions, even though the instructors encouraged them to inquire about material they had not yet understood; Cadets' participation in expressing ideas remained very limited; The use of information technology in learning was still limited. Based on these issues, to improve cadets' learning activities and outcomes in the Basic Mathematics course, action research was planned by applying the e-mind mapping method as a solution to address the problems.

3.1.2 Action Planning

To address the low learning outcomes of cadets, meticulous planning was required to enhance their active participation in the lecture process, achieved through the implementation of the e-mind mapping method. In this approach, the Basic Mathematics instructor asked the cadets to pay attention to the material presented, then to take notes and organize the content according to their mental maps using the e-mind mapping approach. The planned actions included the implementation of the e-mind mapping method was outlined and realized in the form of the Semester Learning Plan (SLP). The SLP was collaboratively developed, encompassing:

competency standards, learning outcomes, planned final competencies, success indicators for cadets, core materials, teaching methods, assessment (types and criteria), and references. The SLP was developed based on the syllabus that had been prepared, with an information technology-based learning approach through e-mind mapping. The researcher collaborated with the Basic Mathematics lecturer to develop pre-test and post-test questions to measure the achievement of cadet learning outcomes before and after the intervention.

3.1.3 Implementation of Actions

The classroom action in Cycle I was conducted using e-mind mapping-based learning media. A total of 23 cadets attended out of 26 enrolled. In this study, the Basic Mathematics instructor acted as the facilitator. The steps taken during this phase included: Conducting the Learning Activities: The instructor implemented the learning activities following the Semester Learning Plan. The material presented in Cycle I focused on number theory. Initial Activities: At the beginning of the session, the instructor communicated the learning objectives, and the competencies to be achieved, and administered a pre-test to the 23 cadets. Core Activities: The instructor delivered the material on number theory. Following the presentation, the cadets were assigned to create e-mind maps based on the topics covered. They were given the freedom to use any available free e-mind mapping applications, as previously discussed. Closing Activities: The cadets completed a post-test to assess the improvement in their learning outcomes.

3.1.4 Observation

Data collection was carried out during the course sessions. At the beginning of the lesson, observations were made of the cadets during the introductory activity, followed by the pre-test, the core activities, and concluding with the post-test. The observed learning activity of the cadets during the lesson was their positive activity. In Cycle I, it was concluded that cadet-positive activity was still relatively low. Observations of cadet learning activities showed that during the presentation session, only one cadet actively asked questions. This low activity was attributed to the habit of cadets being more passive, primarily receiving information from the lecturer. During the presentation, the number of cadets answering questions from the lecturer or other cadets was also just one, and the responses given were still somewhat incorrect. Cadet participation in expressing ideas or responses during discussions was still very low. This was influenced by the cadets' unfamiliarity with using the e-mind mapping method applied in the Applied Mathematics course, which covered basic mathematics topics. The following are the results of the observation of cadet learning activity in Cycle I. (see in Table 1)

Table 1 Results of Cadet Learning Activity Observation in Cycle I

No	Activity	No. of Cadet
1	Listening activities	23
2	Emotional activities	0
3	Desain activities	1
Total		24

$$\begin{aligned}\text{Cadet Activity Percentage} &= \frac{\text{Number of Active Cadets}}{\text{Total Number of Cadets xTypes of Activities}} \times 100\% \\ &= \frac{24}{26 \times 3} \times 100 = 30.77\%\end{aligned} \tag{4}$$

Based on the calculations above, the cadet learning activity in Cycle I is still considered very low. Therefore, action planning is required for Cycle II to improve cadet activity through the application of the e-mind mapping method in the learning process. (see in Table 2)

Table 2 Test Results of Learning Outcomes in Cycle I

Description/Score	Cycle I		
	Pre-test	Post-test	Improvement
No. of Test Participants	23	23	-
Average	53.26	64.35	11.09
Σ Score $\geq$ 66	3	10	7

$$\begin{aligned}\text{Learning Mastery Percentage} &= \frac{\text{Number of Cadets Who Achieved Mastery}}{\text{Total Number of Cadets}} \times 100\% \\ &= \frac{64.35 - 53.26}{53.26} \times 100\% = 20.82\%\end{aligned} \tag{5}$$

$$\begin{aligned}\text{Learning Outcome Improvement Percentage} &= \frac{\text{Post Rate} - \text{Base Rate}}{\text{Base Rate}} \times 100\% \\ &= \frac{10}{23} \times 100\% = 43.48\%\end{aligned} \tag{6}$$

From Table 2, it can be seen that the average post-test score of the cadets in Cycle I was 64.35, which represents an improvement of 20.82%. Meanwhile, the number of cadets who scored $\geq$ 66 (the number of cadets who met the passing score) in the final test of Cycle I was 10, resulting in a learning mastery percentage of only 43.48%.

3.1.5 Reflection

In the first cycle, no issues were found in the formulation of the Semester Learning Plan (SLP). The learning schedule had been arranged with consideration of the need for effective teaching. However, during the implementation phase, several important findings emerged: the task of creating e-mind mapping took a considerable amount of time. This was due to the cadets' lack of familiarity with creating e-mind maps and their adaptation to the use of the technology. Most of the cadets experienced delays in completing their learning activities. The course that used e-mind mapping provided new experiences for both the lecturer and the cadets. This method offered opportunities for both parties to become more involved in the learning process. The application of the e-mind mapping method proved to enhance cadet learning activity and outcomes, especially in the lectures. Although there were challenges in the initial adaptation, the results obtained showed positive potential in increasing engagement and understanding of the material by the cadets.

The conclusions drawn from Cycle I regarding the learning process were as follows: The planning process ran smoothly and was in line with the plans outlined in the SLP. The implementation process proceeded as planned and following the prepared SLP. The application of the e-mind mapping method created a more dynamic classroom environment. Using the e-mind mapping was a new experience for both the cadets and the lecturer. The use of the e-mind mapping method provided benefits for both cadets and the lecturer, including facilitating cadets' understanding of Basic Mathematics, increasing their enthusiasm for learning, and making it easier for the lecturer to explain the material. The assessment process showed that the use of the e-mind mapping method significantly improved cadet activity and learning outcomes in Basic Mathematics.

3.2 Cycle II

3.2.1 Action Planning

Based on the reflection of the lecturer's activities and cadet learning activities in Cycle I, it was found that the improvement in cadet learning activity and outcomes had not yet met the success indicators. Therefore, Cycle II was carried out as a basis for improvement and enhancement from Cycle I. In Cycle II, the material presented was Trigonometry. The improvements made by the lecturer, who was also the researcher, in Cycle II aimed to encourage cadets to be more active and familiar with the e-mind mapping method integrated with digital media. It was expected that this method could help cadets understand and master the material more easily. Before the learning began, the study underwent several preparation stages, including The application of the e-mind mapping method was outlined and realized in the form of the Semester Learning Plan (SLP). The SLP was developed collaboratively between the researcher and the lecturer of the Basic Mathematics course. The SLP contained competency standards, basic competencies, learning outcome indicators, learning objectives, learning steps in applying the e-mind mapping method, and the assessment rubric used to determine the success indicators of the learning process. The researcher and the Basic Mathematics lecturer also collaborated to create relevant pre-test and post-test questions. The planning for Cycle II included the implementation time, lesson material, and teaching methods. The steps of the activity and the assessment were also included.

3.2.2 Action Implementation

The steps taken in this stage involve the lecturer carrying out the class activities according to the SLP, which includes introductory activities, pre-tests, core activities, closing activities, and post-tests. In Cycle II, the material taught was Trigonometry. The lecture in Cycle II using the e-mind mapping method was an improvement from Cycle I, addressing the shortcomings identified in the class action implementation of Cycle I, which the lecturer and researcher worked on for Cycle II. The initial activity began with the lecturer taking attendance and preparing the cadets for the lesson. Then, the lecture objectives were presented. Next, a pre-test was conducted to assess the cadets' initial abilities. The pre-test was given 50 minutes. In the core activity, the lecturer presented some material on Trigonometry to the cadets. After the material was presented, it was uploaded to the provided platform. The lecturer then assigned a task to be completed during the session, which was to create an e-mind mapping with the theme of the material presented and uploaded. In the closing activity, the cadets worked on a post-test, which was also uploaded to the same platform, with a time limit of 50 minutes.

3.2.3 Observation

Data collection was carried out by an observer during the learning process. In Cycle II, the observation of cadet learning activities at the beginning of the lecture can be seen in Table 3.

Table 3 Results of Cadet Learning Activity Observation in Cycle II

No	Activity	No. of Cadet
1	Listening activities	26
2	Emotional activities	18
3	Desain activities	8
Total		24

$$\begin{aligned}\text{Padet Activity Percentage} &= \frac{\text{Number of Active Cadets}}{\text{Total Number of Cadets xTypes of Activities}} \times 100\% \\ &= \frac{52}{26 \times 3} \times 100 = 66.66\%\end{aligned} \tag{7}$$

From the calculations above, it is observed that the cadet learning activity in Cycle II showed improvement. Listening activities involved 26 cadets, emotional activities involved 18 cadets, and design activities were completed by 8 cadets. Therefore, the activity percentage in Cycle II was 66.66%, showing an improvement of 35.89% compared to Cycle I. (see in Table 4)

Table 4 Test Results of Learning Outcomes in Cycle II

Description/Score	Cycle I		
	Pre-test	Post-test	Improvement
No. of Test Participants	26	26	-
Average	60.58	73.46	12.69
Σ Score $\geq$ 66	9	19	10

$$\begin{aligned}\text{PLearning Mastery Percentage} &= \frac{\text{Number of Cadets Who Achieved Mastery}}{\text{Total Number of Cadets}} \times 100\% \\ &= \frac{73.46 - 60.58}{60.58} \times 100\% = 21.27\%\end{aligned} \tag{8}$$

$$\begin{aligned}\text{Learning Outcome Improvement Percentage} &= \frac{\text{Post Rate} - \text{Base Rate}}{\text{Base Rate}} \times 100\% \\ &= \frac{19}{26} \times 100\% = 73.08\%\end{aligned} \tag{9}$$

From Table 4, it can be seen that the average score of the final test for the cadets in Cycle II was 73.46, which represents an improvement of 21.27%. Meanwhile, the number of cadets who scored $\geq$ 66 (those who met the passing criteria) in the final test of this cycle was 19, resulting in a learning completion percentage of only 73.08%.

3.2.4 Reflection

In the first cycle, no issues were found in the formulation of the Semester Learning Plan (SLP). The implementation phase showed that: (1) The time needed by the cadets to complete the e-mind mapping method was following the time allocated, as they had started to get used to creating and adapting to the method. Therefore, the following conclusions were drawn: (1) The planning process went smoothly, following the plan developed collaboratively between the lecturer and the researcher, which was included in the SLP; (2) The implementation process went smoothly, in line with the SLP; (3) The use of the e-mind mapping method made the classroom atmosphere more dynamic; (4) The e-mind mapping method benefited both the cadets and the lecturer by helping the cadets easily recall the material, gain experience using various applications, and assisting the lecturer in explaining the course material; (5) During the assessment process, the e-mind mapping method proved to enhance the learning activities and results of the cadets, especially in memorizing the Trigonometry material.

3.3 Cycle III

3.3.1 Action Planning

Based on the reflection of the lecturer's activities and the cadets' learning activities in Cycle II, the increase in activity and learning outcomes had not yet reached the success indicators, and there were still weaknesses. Therefore, Cycle III was conducted as a means of improvement and enhancement from Cycle II. The improvements made by the lecturer and researcher in Cycle III included preparing evaluation tools, such as questions for the pre-test and post-test, to measure the improvement in learning outcomes of the cadets with the e-mind mapping teaching method. The planning for Cycle III included several aspects: the timing of implementation, lesson material, teaching methods, the steps of activities, and the assessments that would be used to measure success in increasing cadet activity and learning outcomes.

3.3.2 Action Implementation

The steps taken at this stage involved the lecturer conducting lessons according to the SLP, which included introductory activities, a pre-test to assess the cadets' initial abilities, the core activities, and closing activities. A post-test was conducted at the end of the session. The class actions in Cycle III were an improvement over Cycle II, with corrections made to the weaknesses of the class action in Cycle II. These corrections were applied by the lecturer and researcher in Cycle III. The initial activities began with the lecturer preparing the cadets to be ready to learn, followed by communicating the learning objectives. Afterwards, a pre-test was conducted to assess the cadets' initial knowledge. In the core activities, the lecturer presented a brief lesson on Plane Geometry and Solid Geometry. Once the material was delivered, it was uploaded, and the lecturer assigned a task that had to be completed during the session, which was to create a mind map or e-mind map based on the material provided. The closing activity involved the cadets completing a post-test, which was also uploaded.

3.3.3 Observation

Data collection was conducted by the observer during the lesson in Cycle III, with a focus on observing the cadets' learning activities. The results of the observation showed a significant improvement compared to Cycle II. The cadets were now more accustomed to using the e-mind mapping method and demonstrated better readiness to implement the technique. In terms of questioning activity, twenty-two cadets actively asked questions, while fifteen cadets were able to answer correctly from the four questions posed by the lecturer. Overall, the application of the e-mind mapping method successfully increased the activity and engagement of the cadets in the learning process. (see in Table 5)

Table 5 Observation Results of Cadet Learning Activities in Cycle III

No	Activity	No. of Cadet
1	Listening activities	26
2	Emotional activities	20
3	Desain activities	18
Total		24

$$\begin{aligned}\text{Cadet Activity Percentage} &= \frac{\text{Number of Active Cadets}}{\text{Total Number of Cadets xTypes of Activities}} \times 100\% \\ &= \frac{64}{26 \times 3} \times 100 = 82.05\%\end{aligned} \tag{10}$$

Based on the calculations above, cadet learning activity in Cycle III showed significant improvement compared to Cycle II. In Cycle III, there were 26 cadets engaged in listening activities, 20 cadets participated in emotional activities, 4 cadets experienced delays or showed a lack of interest, and 1 cadet did not submit their assignment. For design activities, 18 cadets participated as expected. As a result, the overall percentage of cadet activity in Cycle III reached 82.05%, which is an increase of 16.05% from Cycle II. This increase in participation and engagement demonstrates the effectiveness of the e-mind mapping method in improving cadet activity during the learning process. (see in Table 6)

$$\begin{aligned}\text{PLearning Mastery Percentage} &= \frac{\text{Number of Cadets Who Achieved Mastery}}{\text{Total Number of Cadets}} \times 100\% \\ &= \frac{82.12 - 67.12}{67.12} \times 100\% = 22.35\%\end{aligned} \tag{11}$$

Table 6 Test Results of Learning Outcomes in Cycle III

Description/Score	Cycle I		
	Pre-test	Post-test	Improvement
Number of Test Participants	26	26	-
Average	67.12	82.12	15
Σ Score $\geq$ 66	15	21	6

$$\begin{aligned}\text{Learning Outcome Improvement Percentage} &= \frac{\text{Post Rate} - \text{Base Rate}}{\text{Base Rate}} \times 100\% \\ &= \frac{21}{26} \times 100\% = 80.71\%\end{aligned} \tag{12}$$

From Table 6, it can be seen that the average final test score of the cadets in Cycle III was 82.12, showing an increase of 22.35%. Meanwhile, the number of cadets who scored $\geq$ 66 (cadets who met the required score) in the final test of this cycle was 21 cadets, resulting in a learning completion percentage of 80.71%.

3.3.4 Reflection

The cadets were able to learn more actively and dynamically through the teaching pattern applied, which sparked enthusiasm and motivation in the learning process. The improvement in the activity and learning outcomes of the cadets was evident from Cycle I to Cycle III. The use of the e-mind mapping method proved effective in improving the quality of learning in the Applied Basic Mathematics Concepts course. In Cycle III, the cadets' learning outcomes showed significant progress. The average post-test score increased from 64.35 in Cycle I to 73.46 in Cycle II and reached 82.12 in Cycle III. Additionally, the percentage of cadets who completed the learning also increased, from 43.48% in Cycle I to 73.08% in Cycle II, and 80.71% in Cycle III. Therefore, it can be concluded that the Applied Basic Mathematics Concepts course, with the application of the e-mind mapping method, successfully optimized the improvement of cadet activity and learning outcomes. The success indicators and action hypothesis were achieved, meaning this research ended in Cycle III. Some examples of the e-mind mapping works were as follows. (see in Figure 2)

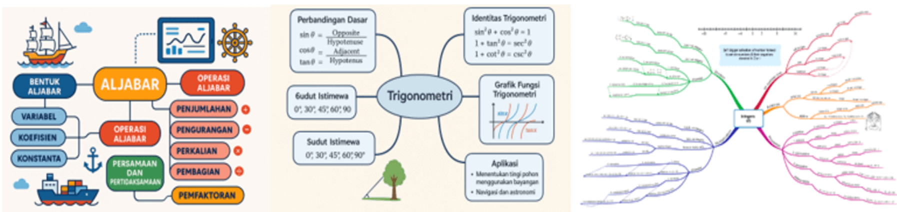

Figure 2 Cadets' e-Mind Mapping Works

4 Discussion

This study aimed to improve the learning outcomes of cadets in basic mathematics before they advanced to applied mathematics by using the e-mind mapping method in the Ship Machinery Study Program at Yogyakarta Maritime College. This research was conducted using a Classroom Action Research (CAR) approach, carried out in three cycles, each consisting of planning, implementation, observation, and reflection stages.

4.1 Cycle I

In the first cycle, the initial step was identifying issues that arose in the basic mathematics learning process. The preliminary observation showed that the conventional methods still widely applied by the lecturer, such as lectures and assignments, made most cadets passive in their learning. The lack of engagement and difficulty in understanding basic mathematics material, such as numbers and trigonometry, were the main problems. The application of the e-mind mapping method began with a pre-test to assess the initial understanding of the cadets and involve them in creating digital mind maps based on the material covered. Most cadets used smartphones, the SimpleMind and canva app to create their mind maps, enabling them to work flexibly outside the classroom. The mobile-friendly nature of the apps allowed cadets to revise and access their mind maps anytime, including during practice sessions or self-study, fostering greater autonomy and accessibility in learning. However, some cadets faced challenges such as small screen sizes and multitasking limitations on mobile devices, which occasionally hindered their ability to manage complex maps efficiently. The results of the observation showed that cadet learning activity in Cycle I was still low, with only 30.77% positive activity. However, the final test showed an improvement in learning outcomes, with the average final test score reaching 64.35, an increase of 20.82% from the initial test score. However, the learning mastery rate of the cadets was only 43.48%, indicating the need for further improvements in the next cycle.

4.2 Cycle II

In the second cycle, improvements were made based on the reflection from Cycle I. The focus of improvement was on reinforcing the use of e-mind mapping and increasing cadet involvement in the learning process. The material taught in Cycle II was Trigonometry. In this cycle, observations of cadet activity showed a significant improvement, with positive activity reaching 66.66%. This indicated a better adaptation of the cadets to using the e-mind mapping method. The mobile-based nature of the mind mapping applications supported cadets in engaging with the material beyond classroom hours, allowing continuous learning and iterative refinement of their maps. This flexibility increased motivation and sustained engagement. However, some limitations of mobile devices remained, such as limited screen space that sometimes required zooming and scrolling, slightly affecting work. The average final test score in Cycle II reached 73.46, a 21.27% improvement from the initial test score, and the learning mastery rate increased to 73.08%. This improvement suggests that the use of the e-mind mapping method in basic mathematics learning positively impacted cadets' understanding of the material and increased their engagement in the learning process.

4.3 Cycle III

In the third cycle, further improvements were made based on the reflection from Cycle II. The material taught in this cycle was Plane Geometry and Solid Geometry. In Cycle III, the cadets were more accustomed to using e-mind mapping as a tool to understand the learning material. Observations showed a significant increase in cadet learning activity, with more cadets actively asking questions, participating in discussions, and expressing their ideas. The final test results showed an average score of 80.75, an increase of 22.98% compared to the initial test, indicating the success of the e-mind mapping method in improving cadet learning outcomes. The learning mastery rate in Cycle III reached 84.62%, showing that most cadets had achieved the expected competency standards. The continuous access to mobile-supported e-mind mapping tools like SimpleMind and Canva allowed cadets to organize complex concepts visually and efficiently, promoting deeper understanding. The portability of these tools enabled learning in various contexts, supporting self-paced and flexible study habits. Although the limitations of mobile devices, such as screen size constraints, persisted, cadets adapted well by using zoom and navigation features.

This study demonstrates that the application of the e-mind mapping method can improve cadet learning outcomes in the Basic Mathematics course in the Ship Machinery Study Program at Yogyakarta Maritime College. As a technology-based learning method, e-mind mapping allows cadets to organize learning materials in a more structured and visual manner. This aligns with the theory put forward by Alderbashi (2024) who stated that mind mapping, especially when done electronically (e-mind mapping), can help simplify the understanding of complex materials and improve memory retention. In the first cycle, although the implementation of e-mind mapping faced challenges, such as the time required to familiarize the cadets with this technique, the observation results showed improvements, although still low. This aligns with research by Chang et al., (2023) which noted that initial adoption of technology-based learning methods, such as mind mapping, requires adaptation but provides long-term positive effects on understanding and student engagement.

The application of the e-mind mapping method in Cycle II showed significant improvement in cadet learning activity. According to Narawang and Phusawisot (2023) the improvement in learning outcomes obtained through the use of visual techniques, such as e-mind mapping, can enhance working memory capacity and enable deeper understanding. This was evident in the increase in average test scores and higher learning mastery rates in Cycle II, with 73.08% of cadets achieving the minimum required score. In Cycle III, the cadets showed a better understanding and readiness to use the e-mind mapping method independently. This experience aligns with the theory proposed by Rahimi and Allahyari (2019) who explained that multimedia-based learning that combines text and visuals enhances the learning process because it engages multiple memory channels.

Overall, the application of e-mind mapping in the Basic Mathematics learning process has shown positive potential in increasing cadet engagement and learning outcomes, especially in learning abstract and complex mathematical concepts. Despite some challenges in the initial adaptation phase, the results from Cycles II and III show that this method is effective in enhancing cadets' understanding and learning achievements.

5 Conclusion

This study demonstrates significant progress in cadet learning outcomes through the application of the electronic mind mapping (E-Mapping) method in basic mathematics instruction. In the first cycle, although there was an increase in the average final test score by 20.82%, the level of mastery remained low at 43.48%, indicating that initial implementation faced challenges in optimizing the method. In the second cycle, adjustments based on reflections from the first cycle led to a substantial improvement, with the average final test score increasing by 21.27% and mastery reaching 73.08%. Despite these gains, further refinement was still necessary. In the third cycle, even more significant progress was achieved, with the average score rising to 82.12 and learning mastery reaching 80.71%. These results indicate that the E-Mapping method not only enhanced learning outcomes quantitatively but also increased cadets' active engagement in the learning process. The integration of technology through mobile-supported E-Mapping empowered cadets to better understand and structure complex mathematical concepts. By utilizing mobile applications such as SimpleMind and Canva, cadets could flexibly create, revise, and access their mind maps anytime and anywhere, thereby fostering independent learning and sustained motivation. Overall, this study confirms that the application of mobile-based E-Mapping is an effective and innovative instructional strategy to improve cadets' comprehension in basic mathematics within maritime vocational education. As cadets become increasingly familiar with this method, they are expected to more confidently approach advanced mathematical applications in subsequent courses. The predetermined success indicators improvement in both learning activities and learning outcomes—were met in the third cycle, validating the effectiveness of this approach. Thus, the study can be considered complete, with meaningful implications for enhancing technology-assisted learning in vocational maritime education.

Conflicts of interest

The authors declare that they have no conflict of interest.

References

Alderbashi, K. Y. (2024). Assessing the Efficacy of E-Mind Mapping on Academic Performance: A Meta-Analysis of Empirical Research. Artificial Intelligence in Education: The Power and Dangers of ChatGPT in the Classroom, 351–364.
https://doi.org/10.1007/978-3-031-52280-2_22

Astriawati, N. (2020). Development of interactive media based on videoscribe with realistic mathematics education approach to navigation. Math Didactic: Jurnal Pendidikan Matematika, 6(3), 321–333.
https://doi.org/10.33654/math.v6i3.1063

Astriawati, N., & Setiyantara, Y. (2019). Pengaruh Pendekatan Realistic Mathematics Education Bidang Teknika Pelayaran Dalam Meningkatkan Minat Belajar Taruna. Majalah Ilmiah Bahari Jogja, 17(1), 63–70.
https://doi.org/10.33489/mibj.v17i1.186

Astriawati, N., Wibowo, W., & Pratama, W. (2019). Developing Mathematics Learning Materials Based on CO-PROL to Improve Cadets' Learning Outcomes. Journal of Physics: Conference Series, 1315(1), 012059.
https://doi.org/10.1088/1742-6596/1315/1/012059

Chang, C. C., Hwang, G. J., & Tu, Y. F. (2022). Roles, applications, and trends of concept map-supported learning: a systematic review and bibliometric analysis of publications from 1992 to 2020 in selected educational technology journals. Interactive Learning Environments, 31(9), 5995–6016.
https://doi.org/10.1080/10494820.2022.2027457

Cherner, Y., Witus, G., Uhomoibhi, J., Cherner, T., Van Dyke, B., Popova, I., & Wang, H. (2019). Interactive and Adaptable Mobile-Friendly e-Learning Environments for K-12 and Higher STEM Education and Skills Training. Mobile Technologies and Applications for the Internet of Things, 235–247.
https://doi.org/10.1007/978-3-030-11434-3_27

Elmore, R. F. (2002). Bridging the gap between standards and achievement: The imperative for professional development in education. Secondary Lenses on Learning Participant Book: Team Leadership for Mathematics in Middle and High Schools, 313–344.

Emad, G. R. (2011). Rethinking adult and vocational education: hauling in from maritime domain (Doctoral dissertation).

Hartanto, B., Astriawati, N., Wibowo, W., Santosa, P. S., & Widyanto, H. (2023). Development of maritime school management as a center of excellent in supporting the learning process. Journal of Community Service and Empowerment, 4(1), 104–110.

Helwa, S. A. H. A. (2020). Integrating Telegram application into digital mind map** to develop student teachers' EFL critical reading and writing skills.Journal of the Faculty of Education, 31(121), 1-54. https://doi.org/10.21608/jfeb.2020.121389

Karakose, T., Polat, H., Yirci, R., Tülübaş, T., Papadakis, S., Ozdemir, T. Y., & Demirkol, M. (2023). Assessment of the Relationships between Prospective Mathematics Teachers' Classroom Management Anxiety, Academic Self-Efficacy Beliefs, Academic Amotivation and Attitudes toward the Teaching Profession Using Structural Equation Modelling. Mathematics, 11(2), 449. https://doi.org/10.3390/math11020449

Karfa, A. (2023). Exploring Teachers' and Learners' Perceptions towards the Use of Technology-Based Instruction in Promoting Learners' Autonomy The Case of Third-Year Students of English at Biskra University.

Kawuryan, S. P., Sayuti, S. A., Aman, A., & Dwiningrum, S. I. A. (2021). Teachers Quality and Educational Equality Achievements in Indonesia. International Journal of Instruction, 14(2), 811–830. https://doi.org/10.29333/iji.2021.14245a

Khalid, I. L., Abdullah, M. N. S., & Mohd Fadzil, H. (2024). A Systematic Review: Digital Learning in STEM Education. Journal of Advanced Research in Applied Sciences and Engineering Technology, 51(1), 98–115. https://doi.org/10.37934/araset.51.1.98115

Lavidas, K., Papadakis, S., Manesis, D., Grigoriadou, A. S., & Gialamas, V. (2022). The Effects of Social Desirability on Students' Self-Reports in Two Social Contexts: Lectures vs. Lectures and Lab Classes. Information, 13(10), 491. https://doi.org/10.3390/info13100491

Lavidas, K., Voulgari, I., Papadakis, S., Athanassopoulos, S., Anastasiou, A., Filippidi, A., Komis, V., & Karacapilidis, N. (2024). Determinants of Humanities and Social Sciences Students' Intentions to Use Artificial Intelligence Applications for Academic Purposes. Information, 15(6), 314. https://doi.org/10.3390/info15060314

MacIntyre, C. (2012). The Art of Action Research in the Classroom. David Fulton Publishers. https://doi.org/10.4324/9780203065228

Narawang, C., & Phusawisot, P. (2023). Using E-Mind Mapping in Improving Reading Comprehension of Thai EFL Seventh Graders. Mahasarakham University.

Nazari, M. (2021). Plan, Act, Observe, Reflect, Identity: Exploring Teacher Identity Construction across the Stages of Action Research. RELC Journal, 53(3), 672–685. https://doi.org/10.1177/0033688220972456

Papadakis, S. (2023). MOOCs 2012-2022: An overview. Advances in Mobile Learning Educational Research, 3(1), 682–693. https://doi.org/10.25082/amler.2023.01.017

Papadakis, S., Kiv, A. E., Kravtsov, H. M., Osadchyi, V. V., Marienko, M. V., Pinchuk, O. P., ... & Striuk, A. M. (2023b). Unlocking the power of synergy: The joint force of cloud technologies and augmented reality in education. In Joint Proceedings of the 10th Workshop on Cloud Technologies in Education (CTE 2021) and 5th International Workshop on Augmented Reality in Education (AREdu 2022), Kryvyi Rih, Ukraine, May 23, 2022. CEUR Workshop Proceedings.

Papadakis, S., Kravtsov, H. M., Osadchyi, V. V., Marienko, M. V., Pinchuk, O. P., Shyshkina, M. P., ... & Striuk, A. M. (2023). ACNS conference on cloud and immersive technologies in education: Report. CTE Workshop Proceedings, 10, 1–44. https://doi.org/10.55056/cte.544

Rahimi, M., & Allahyari, A. (2019). Effects of Multimedia Learning Combined With Strategy-Based Instruction on Vocabulary Learning and Strategy Use. Sage Open, 9(2). https://doi.org/10.1177/2158244019844081

Sagor, R. (2011). The action research guidebook: A four-stage process for educators and school teams. Corwin Press.