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IMPLEMENTING AUGMENTED REALITY (AR) AS AN INTERACTIVE TOOL FOR MASTERING MARITIME ENGLISH IN ENGINEERING TOOLS LEARNING

Alberto[1], Mutmainnah Hasyari[2] ,Muhammad Tri Pujianto[3], Muh. Irsan[4]
[1,2,3]Merchant Marine Polytechnic of Makassar
[4]Ujung Pandang State of Polytechnic
mutmainnah.hassyari1990@gmail.com
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ABSTRACT

Mastering Maritime English, particularly technical terminology related to engine tools, is essential for marine engineering cadets to support effective onboard communication and operational safety. However, traditional instructional methods often fail to help cadets visualize, retain, and accurately pronounce complex technical vocabulary.Despite the growing integration of Augmented Reality (AR) in education, limited studies have specifically explored its application in Maritime English learning for engineering tools. Therefore, this study aimed to design and implement an AR-based interactive learning product to enhance cadets' understanding, engagement, retention, and pronunciation accuracy in Maritime English learning. This study employed a mixed-methods approach involving 25 second-semester Marine Engineering cadets at the Merchant Marine Polytechnic of Makassar selected through purposive sampling. Quantitative data were collected through Likert-scale questionnaires, while qualitative data were obtained through classroom observations and semi-structured interviews exploring cadets' learning experiences, cognitive engagement, and interaction with the AR application. The findings revealed that the AR-based learning product significantly improved cadets' learning experiences and technical vocabulary mastery. The product integrated 3D visualization, audio pronunciation, and interactive features that enabled cadets to better understand and memorize engine tools terminology. Quantitative results showed high average scores in effectiveness and pronunciation accuracy (4.56), retention (4.52), and engagement (4.43). Qualitative findings further demonstrated that AR promoted active participation, self-directed learning, and repeated pronunciation practice through immersive interaction. This study contributes to Maritime English pedagogy by providing an innovative and contextualized AR-based learning approach specifically designed for technical engine tools terminology. The findings suggest that AR can bridge the gap between theoretical Maritime English instruction and practical technical understanding in maritime education.
Keywords: *Augmented Reality, Engine Tools Learning, Maritime English*

INTRODUCTION

Good and effective communication is essential, particularly in the maritime industry. It is needed during onboard procedures. This is particularly important given that the English language is the primary medium of communication in the industry, yet mastering it can be a significant challenge for many maritime professionals. Furthermore, proficiency in maritime English is essential for understanding and operating ship equipment, tools, and components on deck and in the engine room, as these are predominantly provided in English (Trenkner & Cole, 2020). The necessity of having high-quality maritime English, such as mastering engine terminology for the engine seafarers and having good communication in the engine room, is a pivotal thing possessed by seafarers. Maritime English plays a crucial role in ensuring effective communication and safety in the maritime industry. Therefore, its instruction should be carefully designed based on learners' needs and professional requirements (Ahmmed, 2021). Language learning requires active engagement and meaningful interaction, as understanding learners' experiences and participation plays a crucial role in the learning process (Kraus et al., 2024; Tenny et al., 2022). Based on my experience in teaching maritime English in the classroom, I know that learning maritime English often presents challenges for cadets, especially when it involves understanding engine tools and explaining their functions in English. Some of the difficulties arise from the need to master and memorize engine terminology, which may sound unfamiliar. Multimedia learning plays an important role in enhancing students' understanding by integrating visual, audio, and interactive elements. This concept is grounded in the cognitive theory of multimedia learning, which explains how learners process information through dual channels (Mayer, 2009). Recent studies further support this view, showing that multimedia-based learning can significantly improve language acquisition, engagement, and communication skills (Dhivya, 2023; Saraswaty et al., 2024). In addition, the use of multimedia in educational settings has been found to enhance students' motivation and learning outcomes, particularly in higher education contexts (Staneviciene, 2025). Moreover, multimedia resources contribute to more student-centered learning environments by encouraging active participation and interaction (Zhu, 2025). Today, technology plays a crucial role in supporting the learning process, especially in making access easier and enhancing understanding for cadets. With advances in technology, learning methods have become more interactive and accessible, providing a more engaging and efficient experience. AR is a technology that applies digital information, such as images or audio, to the real world. In the maritime industry, the highest demand goes for seafarers who are not only skilled in technical competencies but also have good proficiency in maritime English. The relevance of Maritime English, Augmented Reality (AR), and the global marine industry has become increasingly significant, particularly in the use of engine tools and ship machinery maintenance (Batu et al., 2021). Augmented reality research is broadly used in the education field, but few studies have been applied in the maritime field. Some also applied AR in the maritime field, but the research focuses on how interactive AR-based learning can have an improvement in getting retention, comprehension, and practical application of engine tools terminology, which is still unexplored. Augmented Reality (AR) applications can assist and improve the efficiency, accuracy, and collaboration of the shipbuilding process. Finally, based on those reasons, this paper will investigate the implementation of Augmented Reality as an Interactive Tool for Mastering Maritime English in Engine Tools Learning.

Therefore, this study addresses the limited exploration of practical applications of engine tools terminology in Maritime English learning by introducing an Augmented Reality (AR)-based interactive approach. The urgency of this research lies in the need for more effective and engaging learning methods that can bridge the gap between theoretical knowledge and real-world application faced by marine engineering cadets. Unlike previous studies that mainly focus on general language learning, this research offers a more specific and contextualized solution by integrating AR technology with engine tools terminology. However, previous studies indicate that there is still a gap between current Maritime English teaching practices and the actual needs of students and the maritime industry, highlighting the need for more innovative and effective learning approaches (Faradillah, 2025). Accordingly, this study aims to design and implement an AR-based interactive learning product to support cadets in mastering Maritime English, while also examining its impact on learning effectiveness, engagement, retention, and pronunciation accuracy.

MATERIALS AND METHODS

MATERIALS

Participants

The participants in this study were 25 second-semester cadets from the Marine Engineering program at the Merchant Marine Polytechnic of Makassar. A purposive sampling technique was employed because the selected cadets met specific criteria relevant to the objectives of the study. The criteria included: (1) cadets who had completed introductory Maritime English courses, (2) cadets who were currently studying engine tools terminology, and (3) cadets who had no prior experience using Augmented Reality (AR) technology in language learning. These criteria were considered important to ensure that the participants could provide relevant insights into the effectiveness of the AR-based learning product in mastering technical Maritime English terminology. All selected cadets participated in both quantitative and qualitative data collection phases.

Instruments

Three primary instruments were used to collect data:

Likert-Scale Questionnaire

Designed to assess cadets' perceptions of the AR learning product in mastering Maritime English terminology related to engine tools. It addressed four key aspects, such as the effectiveness of AR in facilitating technical term acquisition, the Level of engagement during AR-based learning, the Retention of learned material, and the accuracy in pronouncing engine-related terminology. Cadets responded on a 5-point scale (1 = strongly disagree, 5 = strongly agree). The questionnaire was used to gather ordinal yet quantifiable data for statistical analysis.

2. Observation Sheet

Used by the researcher to observe cadets' real-time responses and behavior during the AR sessions. It captured indicators such as excitement, motivation, interaction with AR, and any challenges encountered. This instrument served as direct behavioral evidence of student engagement.

Interview Guide

Semi-structured interviews were conducted to explore cadets' learning experiences, cognitive processes, and interactions while using the AR-based learning tool. The interview questions focused on how cadets understood and retained technical Maritime English terminology, how the AR features supported pronunciation practice and comprehension, and how visual and audio elements influenced their learning engagement. In addition, the interviews explored cadets' interaction patterns with the AR application, the learning strategies they applied during the sessions, challenges encountered during the learning process, and suggestions for improving the AR learning product. This instrument enabled the collection of in-depth qualitative data regarding cadets' learning experiences and cognitive engagement throughout the AR-based learning activities.

METHODS

This study employed an applied research approach aimed at developing and implementing an AR-based learning tool for Maritime English instruction. This study employed an applied research approach aimed at developing and implementing an AR-based learning tool for Maritime English instruction. The mixed-methods design integrated both quantitative and qualitative approaches to evaluate the tool's effectiveness. The use of a mixed-methods approach was considered appropriate as it allows for a more comprehensive understanding of the research problem by combining measurable outcomes with in-depth insights. Quantitative data provide objective evidence of learning effectiveness, while qualitative data capture learners' experiences, perceptions, and challenges during the implementation process. This integration enables the study to explain not only the extent of the tool's effectiveness but also how and why it supports learning (Skamagki, 2024; Contreras-Villalobos et al., 2024). The quantitative approach was used to measure the effectiveness of the tool in terms of students' engagement, retention of terminology, and pronunciation accuracy, providing objective evidence of learning outcomes. In contrast, the qualitative approach was applied to explore cadets' learning experiences, including their perceptions, challenges, and suggestions during the use of the AR tool. The combination of these methods was considered appropriate as it allows the study not only to assess the extent of the tool's effectiveness but also to understand the underlying learning processes and user experiences that influence its implementation. The quantitative method focused on measuring perceived effectiveness, student engagement, retention of terminology, and pronunciation accuracy. While the qualitative method aimed to explore cadets' learning experiences, perceived benefits, and challenges, Suggestions for AR tool enhancement. Following Creswell (2020), the integration of both methods allowed for a deeper interpretation of results, particularly in the context of educational innovation and product development.

Data Collection Procedure

All data were collected over several sessions of AR-based learning:

Questionnaires were distributed after the learning sessions.

Observations were conducted during the AR learning implementation.

Interviews were scheduled following the sessions to gather reflective input from cadets.

Data Analysis

Quantitative Analysis

A Likert scale was employed to measure students' responses, as it provides a reliable and structured way to assess participants' perceptions and attitudes (Taherdoost, 2022). The Likert-scale questionnaire responses were analyzed using descriptive statistics in Microsoft Excel. Summary statistics included:

a. Frequencies and percentages
b. Mean scores for each indicator

This analysis helped identify the general level of cadets' agreement with the AR tool's effectiveness and engagement potential.

Qualitative Analysis

Qualitative data were analyzed using a thematic analysis approach to systematically identify, analyze, and report patterns within the data (Braun & Clarke, 2021; Byrne, 2022).

Interview transcripts were analyzed using thematic analysis. The steps included:

a. Identifying meaningful units in cadet responses
b. Coding recurring patterns
c. Grouping codes into overarching themes (e.g., motivation, clarity, technical barriers)

The observation data were also thematically analyzed to identify behavioral patterns consistent with the self-reported data.

Triangulation

To ensure data validity and reliability, methodological triangulation was applied by comparing findings from:

a. Questionnaires
b. Observations
c. Interviews

This triangulation helped confirm consistency or identify divergence across data sources, leading to a more robust interpretation of the AR tool's educational impact.

RESULTS

Questionnaire Results

The questionnaire consisted of 18 Likert-scale statements (1–5 scale) to measure cadets' perceptions of AR-based learning. The focus was on Effectiveness, Engagement, Retention, and Pronunciation Accuracy.

Cadets responded positively across all aspects. Most statements had average scores well above 4.0, indicating high satisfaction. For example, Respondent 2 "strongly agreed" that "the use of AR helped me understand engine tools terminology." The same respondent also agreed that AR made learning "easier and more efficient." Respondent 18 noted increased focus: "I was more focused and concentrated when learning… using AR."

Engagement was another strong area. Cadets stated, "I was actively involved…" and "learning with AR made me more enthusiastic and interested." These reflect how AR's interactivity heightened engagement.

Retention was also positively perceived. Cadet 2 stated, "AR helped me retain the names and functions… over time." Respondent 18 noted, "Visualizations through AR improved my memory retention." AR's audio features supported pronunciation practice. For instance: "I was able to imitate the pronunciation… after listening to the audio" and "The audio feature helped me recognize and correct mispronunciations."

Another cadet said: "I repeated the pronunciation… until I could pronounce them fluently." This indicates that AR encouraged repeated, self-guided practice.

Summary of average scores:

Effectiveness: 4.56

Pronunciation Accuracy: 4.56

Retention: 4.52

Engagement: 4.43

These high scores suggest that AR improved understanding, interest, vocabulary retention, and pronunciation. The audio-visual integration aligned with Mayer's multimedia learning theory, allowing cadets to see, hear, and recall terms more effectively.

Observation Results

To support the self-reported data, two observers assessed cadets during AR-enhanced lessons using a 15-indicator sheet (rated 1–5). Indicators covered effectiveness, engagement, retention behaviors, and pronunciation practice.

Observations revealed high levels of active participation. For example, Cadet C5 received a score of 5 for recalling and explaining engine tool info. Cadet C10 scored 5 for fully interacting with AR content. Cadet C17 also scored 5 for note-taking, demonstrating a strong retention strategy.

These scores indicated that cadets were not passive recipients. They manipulated the AR app, repeated terms aloud, and took notes—achieving learning objectives actively.

Observers rated most cadets in the 4–5 range across indicators. Consistency between observers was strong. For example:

C5: Avg. score = 4.03 (Obs.1 = 3.93; Obs.2 = 4.13)

C10: Avg. score = 4.27 (exact agreement)

C17: Avg. score = 4.20 (exact agreement)

Inter-rater reliability (IRR) measured by Cohen's Kappa averaged 0.72, interpreted as "substantial agreement." Several indicators had Kappa > 0.80 (e.g., Indicator 12 = 0.93), showing nearly perfect agreement.

The consistency confirmed that learning behaviors were observable and objectively rated. For instance, cadets pointed at virtual tools, asked questions, and verbalized terminology during sessions.

Spontaneous pronunciation practice was commonly observed: cadets repeated terms aloud after hearing them through AR. This behavior indicates immediate feedback and repetition—an important part of language acquisition.

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Note-taking and sketching also occurred, showing self-directed behavior. Cadets were seen writing down tool names and making diagrams, indicating serious engagement.

Observers reported minimal off-task behavior. Cadets showed enjoyment—smiling, nodding, and engaging with the material throughout. These behaviors indicate that AR lessons were effective, enjoyable, and motivating.

Overall, observations confirmed questionnaire results: AR enhanced focus, active learning, and behavior conducive to vocabulary retention and pronunciation improvement. The strong inter-observer agreement (κ = 0.72) supported the credibility of the findings.

Interview Results

Open-ended interviews were conducted with all 25 cadets. Questions focused on the four learning aspects and any challenges encountered.

Effectiveness

Almost all cadets stated that AR helped them understand engine tools better. Cadet 10 said: “I understood the function… because I could visualize the shape and working mechanism.” AR made complex content more concrete, confirming high questionnaire ratings.

Retention

Cadets said that AR helped them remember terms. Cadet 10 stated: “Terms were easier to remember because I could see and hear them.” Cadet 6 added: “AR was very helpful because I could directly imitate the pronunciation.” Visuals and audio provided dual channels for memory.

Cadets mentioned they kept practicing after sessions—e.g., repeating terms later—which indicated long-term learning motivation.

Pronunciation Accuracy

Several cadets noted that before using AR, they weren’t sure how to pronounce terms correctly. Cadet 21 said: “After using AR, I realized my pronunciation was incorrect.” Cadet 24 noted: “Listening to pronunciation… helped me become more accurate.” These results support the role of AR in offering real-time feedback.

Terms like “practice,” “imitate,” and “repeat” were frequent in responses. Cadets engaged in repetition-based learning, reinforcing correct pronunciation—aligning with Skinner’s behaviorist theory.

Engagement

Cadets described the AR lessons as interesting and motivating. Cadet 22 said: “I became more active in asking questions and taking notes.” Some found it more exciting than traditional classes. This suggests AR increased intrinsic motivation.

Cadets smiled and expressed enthusiasm during interviews, indicating enjoyment. AR appeared to satisfy autonomy and competence needs, supporting engagement through self-directed learning.

Challenges

A few cadets mentioned technical problems like lag or unclear audio. Some found AR difficult to use initially, but adapted quickly. Device compatibility was a minor concern. However, cadets stated that these issues did not outweigh the benefits. Suggestions included clearer audio and more content variety.

Thematic Summary

Thematic coding of interviews revealed four dominant categories:

Effectiveness: “Easy to understand and remember”

Engagement: “Enthusiasm and self-confidence”

Retention: “Long-term memory”

Pronunciation Accuracy: “Improved technical pronunciation”

Representative quotes matched these themes and validated the earlier findings from observations and questionnaires. Cadets’ feedback echoed key learning theories—multimedia learning, dual coding, behaviorism, and self-determined learning—strengthening the overall conclusion.

DISCUSSION

This research involved 25 second-semester cadets from the Marine Engineering Department at the Merchant Marine Polytechnic of Makassar. These cadets were involved in Maritime English lessons integrated with an Augmented Reality (AR) learning tool focused on engine room equipment terminology. Most cadets had limited engagement with technical English and had never used AR for learning, making this a novel educational experience. Any observed improvements may be attributed to AR, as it introduced a new learning method.

Cadets responded positively to the AR learning experience. One cadet "strongly agreed" that AR helped him understand engine tools terminology. Another stated, "AR made learning Maritime English, particularly engine tools, easier and more efficient." These responses showed that AR improved understanding of technical terms.

Cadets also reported increased focus: "I was more focused and concentrated when learning Maritime English, especially engine tools, using AR." Others noted motivation and involvement: "I was actively involved in learning using AR," and "learning with AR made me more enthusiastic and interested." AR's interactive nature enhanced interest in the subject matter.

Importantly, cadets viewed AR as useful for long-term learning and pronunciation. Many agreed that AR helped retain the names and functions of engine tools. "Visualizations through AR improved my memory retention," one cadet said. Cadets practiced pronunciation using AR's audio. One "strongly agreed" that

he could imitate pronunciation after listening to the audio. Others noted: "I repeated the pronunciation… until I could pronounce them fluently."

The audio-visual multisensory experience of AR reinforced learning. Cadets could see the 3D model, read the name, and hear pronunciation—strengthening memory and understanding. This supports Mayer's multimedia learning principle: combining visual and auditory input enhances comprehension and recall. Cadets confirmed that seeing and hearing the terms simultaneously made them easier to remember, showing the benefit of dual channels in vocabulary learning.

To gain deeper insight into cadets' experiences, interviews were conducted. Nearly all cadets said that seeing the 3D models made technical terms much clearer. Cadet 10 said he better understood tool functions "because I could visualize the shape and working mechanism." AR turned abstract terms into concrete objects.

Cadets could describe engine tools in detail and remarked that the visual component was key to understanding.

Cadets overwhelmingly felt that AR helped them remember terminology more easily and for longer. One stated: “The technical terms were easier to remember because I could see and hear them.” Another noted: “AR was very helpful because I could directly imitate the pronunciation.” This aligns with Paivio’s Dual Coding Theory: when learners both see and hear terms, they encode information more effectively.

Cadets also reported substantial improvements in pronunciation. Before using AR, many were uncertain about how to pronounce technical terms. Cadet 21 said: “After using AR, I realized that my pronunciation was incorrect.” He adjusted based on AR’s model. Cadet 24 said: “I felt my pronunciation become more accurate.” This shows how hearing correct pronunciation and imitating it with repetition helped shape more accurate speech patterns—consistent with Skinner’s Behaviorist Theory.

Cadets frequently used terms like “practice,” “imitate,” and “repeat” when discussing pronunciation, indicating drill-like learning behaviors. As Li et al. (2025) and Burhanuddin et al. (2021) note, immediate feedback and repetition are essential for developing correct language habits. Cadets became more confident in their pronunciation of technical terms, improving future professional communication.

The interactive and immersive nature of AR also boosted motivation. Many cadets said AR sessions were more interesting than traditional lessons. Cadet 22 stated: “I became more active in asking questions and taking notes when learning with AR.” This shows both mental and behavioral engagement. Cadets found learning enjoyable, which is vital to foster sustained interest.

Self-Determination Theory explains this engagement: AR helped meet needs for autonomy (exploring at their own pace) and competence (mastering difficult content). Though not the primary theoretical framework here, student behaviors—initiative, curiosity, and motivation—reflect its principles. AR not only helped teach content, but also encouraged cadets to be more eager and independent learners.

Despite its advantages, cadets also noted challenges. Some reported technical issues like lag or unclear audio. These minor issues, while not frequent, could temporarily hinder learning. Access to devices and familiarity with the technology also affected ease of use. A few cadets initially struggled with scanning AR markers or navigating the interface but adapted quickly.

Pedagogically, the AR app required a short adjustment period, especially for those unfamiliar with digital tools. Still, cadets found the interface user-friendly after brief orientation. No cadet reported that the challenges outweighed the benefits. Suggestions for improvement included clearer audio and broader content coverage.

Thematic analysis of interviews yielded four key themes: Effectiveness, Engagement, Retention, and Pronunciation Accuracy—aligned with the research focus.

Effectiveness: Cadets felt learning was easier and content was clearer with AR.

Engagement: Cadets reported feeling enthusiastic and confident. One said, “I became more active in asking questions and taking notes.”

Retention: “The image and sound made it easier to remember,” said Cadet 17.

Pronunciation Accuracy: Cadet 24 shared: “I listened to the pronunciation and felt mine become more accurate.”

In summary, cadets not only rated the AR experience positively but also explained in detail how AR helped them learn. They identified the app’s strengths—visualization, interactivity, and audio feedback—as central to their improved performance. These reflections validated the theoretical principles applied in the study and showed that the AR tool meaningfully improved their Maritime English learning.

CONCLUSION

This study demonstrated that the integration of Augmented Reality (AR) in Maritime English learning significantly enhanced cadets’ understanding, engagement, retention, and pronunciation accuracy when studying technical engine tools terminology. The findings from the questionnaire, observation, and interview data consistently indicated that AR served as an effective and interactive learning tool. Cadets found the AR-based product beneficial in visualizing and memorizing technical terms, while the multisensory experience—combining 3D models, text labels, and audio pronunciation—supported deeper learning. The results aligned with key educational theories, including Mayer's Cognitive Theory of Multimedia Learning, Paivio's Dual Coding Theory, Skinner's Behaviorist Theory, and Knowles' Self-Directed Learning framework. These theories helped explain the learning improvements observed in the cadets. The triangulated data confirmed that AR facilitated active participation, motivated learners, and supported the development of correct pronunciation through immediate feedback and repetition.

Overall, this study provides practical evidence that AR can serve as an effective pedagogical tool for improving Maritime English learning, particularly in mastering technical engine tools terminology among marine engineering cadets. The integration of 3D visualization and audio pronunciation features helped cadets better understand, retain, and accurately pronounce technical vocabulary commonly used in engine room communication. In addition, the AR-based learning approach supported cadets' active engagement and self-directed practice in learning technical Maritime English terminology within a maritime training context. These findings suggest that maritime institutions may integrate AR-based learning resources into Maritime English instruction to strengthen cadets' technical vocabulary comprehension and communication competencies required in real maritime operations. These findings suggest that maritime institutions should consider adopting AR-based resources to modernize their teaching methods and support cadet learning more effectively.

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