The Effect of Digital Simulation on Maritime Cadets' English Speaking Skills: A Pre-Experimental Study

Agus Sulistiono[1], Rudi Hartono[2], Sri Wahyuni[3], Jeihn Novita Christanty Budiman[4], Yuniar Ayu Hafita[5]
Universitas Negeri Semarang[1,2, 3], Politeknik Pelayaran Sulawesi Utara[4], Politeknik Pelayaran Sorong[5]
agussulistiono_s3@students.unnes.ac.id, rudi.hartono@mail.unnes.ac.id, sriwahyunifbs@mail.unnes.ac.id, jeihnnovita@poltekpelsulut.ac.id, y.ayuhafita@gmail.com

ABSTRACT

Effective oral communication is a critical competence in maritime operations, where miscommunication may compromise safety and operational efficiency. As English serves as the lingua franca of international shipping, maritime cadets are required to develop adequate speaking skills to meet professional communication demands. However, Maritime English instruction often provides limited opportunities for authentic and contextualized oral practice. This study investigated the effect of digital simulation-based instruction on maritime cadets' English speaking skills. Employing a pre-experimental one-group pre-test–post-test design, the study involved 24 maritime cadets at Politeknik Pelayaran Sulawesi Utara, Indonesia. Speaking performance was assessed using a scenario-based test and an analytic rubric measuring five components: fluency, pronunciation, vocabulary use (including Standard Marine Communication Phrases), grammatical accuracy, and comprehension. Data were analyzed using descriptive statistics, a paired-samples t-test, and effect size calculation. Results revealed a statistically significant improvement in speaking performance following the intervention ($t(23) = 9.47$, $p < .001$), with a large effect size (Cohen's $d = 2.29$). These findings indicate that digital simulation-based instruction can effectively enhance speaking skills in Maritime English contexts.

Keywords: *Maritime English; digital simulation; speaking skills; English for Specific Purposes; maritime education*

1. INTRODUCTION

Effective oral communication is widely recognized as a critical competency in maritime education, particularly in operational contexts such as ship navigation, engine room coordination, and emergency response. In international maritime operations, English functions as the primary language of communication, serving as a lingua franca among multinational crews. Accordingly, maritime cadets are expected to possess adequate speaking proficiency to ensure operational safety, efficiency, and compliance with international maritime regulations (International Maritime Organization [IMO], 2017; Trenkner & Cole, 2010).

Despite its importance, previous studies have consistently reported that many maritime cadets experience difficulties in speaking English fluently and accurately. These challenges are commonly attributed to limited exposure to authentic communicative situations, low confidence in oral interaction, and instructional practices that emphasize theoretical knowledge over communicative use (Bocanegra-Valle, 2015; Kim & Elder, 2009). As a result, cadets often struggle to transfer classroom knowledge to real or simulated maritime operational contexts, revealing a gap between training and professional communication demands (Cole et al., 2007).

Within English for Specific Purposes (ESP), language instruction is expected to be closely aligned with learners' professional needs and workplace realities (Hutchinson & Waters, 1987; Long, 2015). In maritime education, this implies that speaking instruction should simulate authentic shipboard interactions and provide opportunities to practice communication relevant to future occupational roles.

Recent developments in educational technology have highlighted digital simulation as a promising instructional approach to address these pedagogical challenges. Digital simulation enables learners to engage in interactive, scenario-based environments that resemble real-life professional situations, allowing language practice in a safe and controlled setting. Empirical evidence from medicine, aviation, and engineering has demonstrated the potential of simulation-based learning to enhance learners' performance, confidence, and skill transfer (Cook et al., 2013; de Freitas, 2006). However, despite the widespread use of simulators in maritime training, research specifically examining the impact of digital simulation on maritime cadets' English speaking skills remains limited (Radianti et al., 2020; Baldauf et al., 2018).

Therefore, the present study aims to investigate the effect of digital simulation-based instruction on maritime cadets' English speaking skills using a pre-experimental research design. The study addresses the following research question: Is there a significant difference in maritime cadets' English speaking skills before and after instruction using digital simulation?

2. LITERATURE REVIEW

2.1 Maritime English and Speaking Skills

Maritime English is a specialized branch of ESP that addresses the communicative needs of maritime professionals in operational contexts such as navigation, engine room communication, and emergency situations (Bocanegra-Valle, 2015; Trenkner & Cole, 2010). Speaking skill constitutes a core component of Maritime English, as oral communication is essential for coordination, safety, and decision-making onboard ships (Pritchard, 2003). Inadequate speaking proficiency has been associated with miscommunication and increased operational risk (Cole et al., 2007). Studies indicate that maritime cadets often demonstrate limited fluency and confidence in spoken English, particularly in authentic or operationally demanding situations (Kim & Elder, 2009).

2.2 Digital Simulation in Language Education

Digital simulation refers to computer-based or technology-enhanced environments designed to replicate real-world situations for instructional purposes (de Freitas, 2006). Research indicates that simulation-based learning provides learners with opportunities for repeated practice, immediate feedback, and engagement in realistic scenarios, making it particularly effective for skill-based learning (Gaba, 2004). The integration of digital simulation into language learning has been associated with improvements in speaking performance, engagement, and confidence (Peterson, 2010; Zheng et al., 2018). Simulation-based environments support key second language acquisition processes, including meaningful input (Krashen, 1985), interaction and negotiation of meaning (Long, 1996), and contextualized spoken output (Swain, 1995).

2.3 Theoretical Framework

This study is grounded in an integrated framework drawing on ESP, Second Language Acquisition (SLA) theories, and experiential learning. The ESP framework emphasizes that effective language learning occurs when instructional content, tasks, and assessment are aligned with real workplace communication demands (Hutchinson & Waters, 1987; Dudley-Evans & St John, 1998). SLA perspectives—specifically the Input Hypothesis (Krashen, 1985), Interaction Hypothesis (Long, 1996), and Output Hypothesis (Swain, 1995)—explain how digital simulation facilitates speaking development through the integration of meaningful input, interaction, and pushed output within contextualized maritime scenarios. Experiential learning theory further supports the use of simulation by emphasizing knowledge construction through active engagement and practice (Kolb, 1984; Cook et al., 2013).

2.4 Research Gap

While previous studies provide support for simulation-based learning in professional education and ESP contexts, there remains a clear need for methodologically rigorous studies that examine the impact of digital simulation specifically on Maritime English speaking performance. Most existing maritime-related studies rely on descriptive or qualitative approaches and rarely employ experimental or pre-experimental designs that measure speaking performance gains. The present study addresses this gap by providing empirical evidence from a pre-experimental design.

3. METHOD

3.1 Research Design

This study employed a pre-experimental one-group pre-test–post-test design. A single group of participants was measured before and after the implementation of an instructional intervention. This design was selected due to practical and institutional constraints that limited the use of random assignment and control groups (Creswell & Creswell, 2018; Fraenkel et al., 2012). Although this design has limitations regarding internal validity, it is considered appropriate for preliminary investigations of instructional effectiveness, particularly when supported by multiple data sources and triangulation (Ary et al., 2019).

3.2 Participants

The participants were 24 maritime cadets enrolled in a Maritime English course at Politeknik Pelayaran Sulawesi Utara, Indonesia. A convenience sampling technique was employed. All participants had prior instruction in general English and introductory Maritime English but had not been exposed to digital simulation-based speaking instruction before the study. Participation was voluntary, and informed consent was obtained from all participants (Creswell & Creswell, 2018).

3.3 Instructional Intervention

The instructional treatment consisted of digital simulation-based speaking activities designed to reflect authentic Maritime English communication contexts, including routine operations, navigational support, and emergency-related communication. The simulations required cadets to perform scenario-based oral communication tasks using appropriate maritime terminology and Standard Marine Communication Phrases (SMCP). The instructional design was grounded in experiential learning theory (Kolb, 1984) and task-based language teaching (Ellis, 2003; Long, 2015).

3.4 Instruments

Three complementary instruments were employed. First, a scenario-based speaking test was administered as both the pre-test and post-test to measure changes in speaking performance. Pre-test and post-test tasks were constructed as parallel tasks with equivalent structure, complexity, and communicative demand. Second, an analytic speaking assessment rubric evaluated five components: fluency, pronunciation intelligibility, vocabulary use (including SMCP), grammatical accuracy, and comprehension. Content validity was established through expert judgment, and inter-rater reliability analysis yielded a coefficient exceeding the acceptable threshold of 0.70 (Taber, 2018). Third, a classroom observation sheet documented cadets' learning behaviors, interaction patterns, and engagement during simulation activities to provide supporting qualitative evidence.

3.5 Data Collection Procedure

Data collection followed three sequential stages. In Stage 1, cadets completed the pre-test speaking task to establish baseline performance. In Stage 2, cadets participated in the digital simulation-based speaking activities across multiple instructional sessions. In Stage 3, the post-test speaking task was administered using tasks equivalent in structure and difficulty to the pre-test. All speaking performances were independently rated by two trained examiners using the analytic rubric. Observation data were recorded during the instructional sessions.

3.6 Data Analysis

Descriptive statistics (mean and standard deviation) were computed to summarize speaking scores. A paired-samples t-test was conducted to determine statistical significance ($\alpha = .05$), given that the same participants were measured at two time points (Field, 2018). Effect size was calculated using Cohen's d to assess the practical magnitude of the instructional effect, following recommendations for educational research reporting (Cohen, 1988; Plonsky & Oswald, 2014). Observation data provided triangulated qualitative support.

4. RESULTS

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics of maritime cadets' speaking scores from the pre-test and post-test assessments.

Table 1

Descriptive Statistics of Pre-test and Post-test Speaking Scores (N = 24)

Test	N	M	SD
Pre-test	24	66.54	6.12
Post-test	24	79.83	5.48

As shown in Table 1, the mean post-test score ($M = 79.83$, $SD = 5.48$) was substantially higher than the mean pre-test score ($M = 66.54$, $SD = 6.12$), indicating an overall improvement of 13.29 points in cadets' English speaking performance following the digital simulation-based instruction.

4.2 Paired-Samples t-Test

Table 2 presents the results of the paired-samples t-test comparing pre-test and post-test speaking scores.

Table 2

Paired-Samples t-Test Results (N = 24)

Comparison	Mean Diff.	SD	t	df	p
Post-test – Pre-test	13.29	5.80	9.47	23	< .001

The paired-samples t-test revealed a statistically significant difference between pre-test and post-test speaking scores, t(23) = 9.47, p < .001. This finding indicates that the digital simulation-based instruction had a significant effect on cadets' English speaking skills. Accordingly, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_1) was accepted.

4.3 Effect Size

Table 3 presents the effect size analysis to assess the practical significance of the instructional effect.

Table 3

Effect Size of Digital Simulation-Based Instruction

Comparison	Mean Diff.	SD (Pooled)	Cohen's d	Interpretation
Post-test – Pre-test	13.29	5.80	2.29	Large

The calculated effect size (Cohen's d = 2.29) indicates a large effect, suggesting that digital simulation-based instruction had a substantial and practically meaningful impact on cadets' speaking performance. This exceeds the conventional threshold for a large effect (d > 0.80; Cohen, 1988; Plonsky & Oswald, 2014).

5. DISCUSSION

5.1 Effect of Digital Simulation on Speaking Skills

The findings of this study demonstrate that digital simulation-based instruction significantly improved maritime cadets' English speaking skills. The substantial increase in post-test scores, supported by a large effect size (d = 2.29), suggests that the instructional intervention was not only statistically significant but also pedagogically meaningful. This result is consistent with previous research indicating that simulation-based learning enhances professional communication skills through contextualized practice (Cook et al., 2013; de Freitas, 2006; Peterson, 2010; Zheng et al., 2018).

5.2 Speaking Skill Components and Simulation

The improvement in speaking performance can be attributed to several characteristics of digital simulation-based instruction. First, scenario-based tasks engaging cadets in authentic maritime communication—such as routine operational reporting and emergency response—closely resembled real shipboard communication demands, supporting the ESP principle that effective instruction should be aligned with workplace communication (Hutchinson & Waters, 1987; Trenkner & Cole, 2010). Second, the opportunity for repeated practice and interaction within simulated environments contributed to improvements in fluency and pronunciation, as cadets became more familiar with task structures and communicative expectations. Third, the systematic integration of Standard Marine Communication Phrases (SMCP) within simulation tasks supported the development of accurate and appropriate maritime vocabulary use, reflecting the standardized communication principles promoted by IMO (2017).

5.3 SLA Theoretical Interpretation

From a second language acquisition perspective, the findings can be interpreted through established theoretical frameworks. The simulation-based activities provided meaningful input aligned with Krashen's (1985) Input Hypothesis, while the interactive nature of the simulations encouraged negotiation of meaning consistent with Long's (1996) Interaction Hypothesis. Furthermore, the requirement to produce spoken output in operational scenarios supported Swain's (1995) Output Hypothesis by prompting cadets to notice gaps in linguistic knowledge and refine speaking accuracy. The integration of input, interaction, and output processes within contextualized maritime scenarios thus explains the significant gains in speaking performance (Ellis, 2003).

5.4 Observation Data

The classroom observation data provided triangulated qualitative support for the quantitative findings, revealing increased learner engagement, participation, and confidence during simulation-based activities. Observers noted that cadets became progressively more responsive to instructions and more willing to communicate orally across sessions. These behavioral changes help explain the significant improvement observed in the speaking test scores and reinforce the pedagogical value of digital simulation as a learning medium.

5.5 Limitations

Despite the positive findings, this study has limitations that warrant consideration. First, the absence of a control group limits the ability to attribute improvements solely to the instructional intervention, as other variables may have contributed to the observed changes. Second, the relatively small sample size ($N = 24$) from a single institution may limit the generalizability of the findings to broader maritime education contexts. Third, the study focused on overall speaking performance rather than analyzing the differential effects on individual speaking components.

6. CONCLUSION

This study investigated the effect of digital simulation-based instruction on maritime cadets' English speaking skills using a pre-experimental one-group pre-test–post-test design. The findings demonstrated a statistically significant improvement in cadets' speaking performance following the instructional intervention ($t(23) = 9.47$, $p < .001$), with a large effect size (Cohen's $d = 2.29$), indicating a substantial and meaningful impact on oral communication ability in Maritime English contexts.

The results suggest that digital simulation effectively facilitated the development of key speaking components, including fluency, pronunciation intelligibility, vocabulary use (particularly SMCP), grammatical accuracy, and comprehension. By engaging cadets in scenario-based communication tasks reflecting authentic maritime operations, the approach enabled learners to practice language use in contextually relevant and professionally meaningful situations. Classroom observation data further supported these findings by revealing increased learner engagement and confidence during simulation activities.

These findings have important pedagogical implications. Maritime English instructors are encouraged to integrate digital simulation-based speaking tasks into regular instruction, as simulations provide safe, controlled environments for authentic oral practice. Maritime training institutions should utilize simulation facilities for language skill development in addition to technical training. Curriculum designers should align Maritime English courses with simulation-based learning principles, and instructors should receive professional development in designing and assessing simulation-based language activities.

Future research should address this study's limitations by employing quasi-experimental or experimental designs with control groups, involving larger and more diverse samples across multiple institutions, and investigating the long-term retention of speaking skills following simulation-based instruction. Further studies may also examine the differential effects of digital simulation on specific speaking components and explore the integration of more immersive technologies, such as virtual reality, to enhance authenticity in Maritime English instruction.

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