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Original Research

Bridging the Contextual Realism Gap: A Learning Analytics Model for STCW-Compliant Maritime English Training

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Abstract

This study addresses a critical gap in online SMCP training, aiming to enhance maritime safety through effective communication, aligned with STCW competency standards. Employing a mixed-methods instrumental case study design, this research involved 60 second-year cadets at an Indonesian maritime university, by purposive sampling. To control for confounding factors, their prior English proficiency was assessed using TOEFL-equivalent baseline scores. Methods: Data were triangulated from four sources: Learning Management System (LMS) logs, STCW-aligned academic transcripts, and a validated 20-item Likert-scale survey (Cronbach's $\alpha = 0.89$), complemented with semi-structured interviews (n=10) to explore cadet perceptions in depth. Analysis involved Pearson correlation assess relationships between engagement metrics and performance, complemented by thematic analysis of qualitative data. Findings reveal a strong positive correlation between radio simulation time and oral proficiency scores (r=0.61). Critically, cadets achieved lower scores in timed radio simulations (M=75%) compared to standard oral tests (M=82%). This discrepancy was explained by thematic analysis, uncovered a fundamental 'contextual realism gap' by which simulations failed to reflect real-life stresses aboard a ship, like engine noise. Moreover, technical barriers such as audio latency prevented 65% of cadets engaged in this manner from transferring their skills across tasks. The contribution of the study is the first data-driven evidence linking online engagement to STCW outcomes through an integrated diagnosis. These findings are critically significant for English for Specific Purposes (ESP) curriculum design, suggesting the use of immersive simulations with stressors and personalized, AI-driven pronunciation feedback to meet STCW operational competency standards.

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1. Introduction

Learning Analytics (LA) has gained considerable attention for its ability to provide beneficial knowledge regarding learning levels and specific behavior to help guide strategies with personalized instruction (Long & Siemens, 2011) in the online context. In Maritime English learning field, this breakthrough is especially important, as the command of Standard Marine Communication Phrases (SMCP) is crucial for secure ship and crew board communication (IMO, 2000, 2016; Yoshida et al., 2020). The SMCP, which serves as the standardized lingua franca in the maritime domain, is a compulsory component of the International Maritime Organization (IMO) Standards of Training, Certification, and Watchkeeping (STCW) to prevent communication failure during critical situations (IMO, 2003). However, a significant gap persists between training and operational readiness. Traditional classroom-based instruction does not translate to the type of real-world communication challenges faced at sea, such as radio static and time-sensitive decision-making (Han, 2022; McLaughlin et al., 2022; Mukasa et al., 2021), and while online platforms have established themselves as flexible solutions, their use as a means of ensuring robust mastery of SMCP remains largely unexplored (Diahyleva et al., 2024).

While earlier research has found weaknesses in cadet SMCP speaking and began evaluating an online learning system, one key and highly complex research gap still exists. Specifically, a literature review reveals three interconnected shortcomings that compromise STCW compliance in digital settings: First, existing research about online platforms usually focuses on general levels of engagement rather than STCW-aligned operational competencies (e.g., measuring login frequency instead of command accuracy in pressure situations). Secondly, these platforms often produce a 'gap of contextual realism' in their inability to replicate the genuine, high-pressure environment of a ship's bridge, which limits the transfer of SMCP skills from a clean, sterile online environment to a real-life setting. For instance, digital simulations often lack essential stress factors in the real-world, such as engine room noise or radio signal interference, which are critical elements of communication at sea. Third, and more crucially, no prior study has leveraged learning analytics as a method of convergence of LMS engagement measures, student academic success, and qualitative user responses to identify these particular pedagogical and technical deficiencies. Studies like Yoshida et al. (2020) identify the errors in mistakes/solutions as SMCP errors but do not connect to specific online learning behaviors.

This study aims to fill these gaps by exploring the use of LA in an Indonesian maritime academy's online Maritime English course. Informed by the theory of English for Specific Purposes (ESP), which promotes the acquisition of a targeted language through context (Hutchinson & Waters, 1987), this study seeks to: (1) examine the manner in which cadets work through SMCP-related assignments in an asynchronous course; (2) identify the extent to which LA can indicate gaps in SMCP proficiency; and (3) assess the relationship between cadets' engagement patterns with the LMS and their practice in IMO-required communication situations. As such, this study presents a number of original contributions to research in Maritime English and in ESP pedagogy. On a theoretical level, it introduces a triangulation model (ESP-informed LA) that seeks to reconnect context-oriented ESP principles with data-oriented LA models to form a new perspective on specialized language assessment. This study is unique not only in its findings but also in its methodological triangulation of quantitative LMS engagement data (e.g., simulation time), STCW-aligned performance data (e.g., oral proficiency scores), and qualitative cadet feedback.

This combination of approaches goes further than simply tracking engagement to diagnose precise learning gaps. Most importantly, this study provides the first data-driven evidence linking specific behaviors in online simulation to STCW competency outcomes, illuminating a 'contextual realism gap' in contemporary digital pedagogy. Empirically, this diagnosis highlights specific pedagogical limitations (lack of oral feedback) and technical barriers (audio latency), addressing a critical safety concern in high-stakes fields such as aviation, medical, and legal English, and providing a practically applicable, systematized, and empirically replicated solution for training institutions worldwide to assess and iterate their online curriculum to meet STCW compliance.

2. Literature Review

2.1 The High-Stakes Setting of Maritime English and the SMCP

As a key branch of English for Specific Purposes (ESP), maritime English is designed to meet the communication demands of the global maritime industry (Hutchinson & Waters, 1987). It draws from the Standard Marine Communication Phrases (SMCP), a vocabulary system standardized by the International Maritime Organization (IMO) that ensures clear and safe communication in shipboard operations (IMO, 2000). The SMCP framework forms part of the Standards of Training, Certification, and Watchkeeping (STCW) covering a wide range of situations from emergency distress signalling to navigational warnings (IMO, 2016).

Therefore, mastering SMCP is not merely an academic requirement but also a regulatory and professional obligation. In accordance with STCW Regulation II/1, every cadet must demonstrate a level of English proficiency that ensures clear, precise, and unambiguous communication in real operational situations. This requirement reinforces the essential role of effective maritime communication in maintaining safety, situational awareness, and coordination aboard vessels (IMO, 2003). However, these regulators have imposed serious conditions; a not well-documented performance in cadets' oral SMCP remains, especially under relatively high-stake environments (Dewan et al., 2023; Sari & Sari, 2022; Shi & Fan, 2021; Yoshida et al., 2020). This body of literature consistently establishes that proficiency in SMCP is a safety-critical competency, framing the assessment of SMCP within the context of high-risk performance, not merely linguistic accuracy.

2.2 The Online Paradigm: Opportunities and Challenges of Training SMCP Online

Some work suggested transforming maritime education into online learning, as it is a flexible and cost-effective option which became hastened ever since the outset of COVID-19 pandemic. At the same time, Learning Analytics (LA) has developed as a game changer in language education, providing data-driven insights for monitoring student engagement and personalizing instruction (Long & Siemens, 2011). In general language learning, LA applications have been successful, ranging from tracking vocabulary gain to writing analysis (Chen, 2024; Crema et al., 2022; Khurana et al., 2022).

However, translating this success to the high-stakes context of Maritime English has exposed significant challenges. Moodle and Blackboard have been shown to be flexible, but they very rarely replicate the true listening and situational needs for extemporaneous shipboard communications including background noise from engines or radio static (Adeyeye et al., 2022; Dias et al., 2020; Flynn et al., 2021; Kumar et al., 2021; Mujalli et al., 2022). For instance, asynchronous forums do not provide the immediacy that practicing time-sensitive distress calls provides, which is a fundamental competency of SMCP (Fatimah et al., 2024). The core challenge synthesized from these studies is a failure of digital platforms to translate pedagogical flexibility into operational fidelity, underscoring the necessity for high-fidelity simulation components in online ESP. A major gap arises where interactive ecosystems expected of the same digital platforms (Nuryanti, 2025) actually prove less able to prepare cadets for real-world application, highlighting a need for tools capable of bridging such gaps.

2.3 The STCW Gap: Where Technology Falls Short of STCW Requirements

An overview of literature highlights a need to explore the critical yet threefold gap in the research between LA, online pedagogy and Maritime English.

Firstly, the use of LA in specific linguistic domains is still not fully investigated. Although LA has been incorporated into technical maritime training orientations such as navigation simulations (Dewan et al., 2023; T. Kim & Lintott, 2022; Krabbel et al., 2025; Munim & Kim, 2023), it appears to be more in its infancy for language training settings for non-native English speakers than the integration of the variables of language skills with slightly generic metrics (e.g., login frequency) (Diahyleva et al., 2024). This synthesis points to a deficit where LA data, crucial for technical competencies, has not been systematically aligned with domain-specific, STCW-based language competencies.

Secondly, there is a persistent 'contextual realism gap' in online maritime education. Research indicates that cadets have difficulty with online exercises specifically because the real-world stressors are absent, suggesting a systemic failure of contemporary digital pedagogy to achieve transferability of skill (Yoshida et al., 2020). Such limitations are usually compounded by pedagogical methods that focus more firmly on exams than on interaction and application (Shi & Fan, 2021). This body of work suggests that while conceptual realism exists (cadets know the phrases), the psychological and physical fidelity required for skill transfer in high-stakes environments remains critically underdeveloped in digital formats.

The third is the apparent methodological gap. For a single exception, Yoshida et al. (2020) had frequent errors in SMCP but failed to relate the errors with LMS engagement data. Crucially, no prior study has systematically triangulated the three essential data pillars (LMS engagement data, STCW competency assessments, and qualitative user feedback) to arrive at a holistic, integrated diagnosis of online SMCP training deficiencies, covering both pedagogical and technical barriers. This methodological shortcoming hinders effective, data-driven curriculum iteration.

2.4 Theoretical Framework and Research Gap

The present study is situated at the intersection of theories of and approaches to ESP, which emphasizes the importance of context in language learning (Hutchinson & Waters, 1987) and approaches to LA, which emphasize the importance of using data for informed decision-making (Long & Siemens, 2011). This research is positioned to fill the identified gaps by integrating these lenses. The main gap in ESP research lies in the absence of authentic, context-driven performance measures, as current learning analytics models fail to reflect real-world operations. This study advances an ESP-informed approach to enhance contextual realism through a mixed-methods design, providing the triangulated evidence lacking in prior research. It offers insights into the challenges and opportunities of online SMCP training and answers the long-standing call for an integrated, evidence-based approach to STCW language training assessment.

3. Method

3.1 Research Design and Rationale

The current study used a mixed-methods instrumental case study design, specifically utilizing a sequential explanatory approach (QUAN → QUAL) (Creswell & Clark, 2017). Within this choice of methods, this approach was intentionally selected, as it has the ability to explore a contemporary phenomenon, such as the implementation of learning analytics for SMCP training, in its real-world context (Sitorus, 2021). The quantitative (QUAN) phase established teh correlation between online engagement (LMS logs) and performance outcomes (STCW scores). The qualitative (QUAL) phase (semi-structured interviews) was then used to explain the unexpected or critical quantitative findings, specifically the discrepancy between simulation and standard test scores, thereby fulfilling the core purpose of the explanatory design. The study has an instrumental case study design because the study is less concerned with the specific group of cadets in this study and more concerned with using this case to shed light on a wider problem: the implementation of LA, its usefulness and associated challenges when conducting STCW-compliant training.

This requires a mixed-methods approach, which was considered appropriate to provide a fuller picture. From an educational and academic facet, a purely quantitative approach may capture engagement trends, relationships, and correlations with performance, as opposed to providing insight into the why behind trends, such as cadet perceptions, technical barriers (Guest & Fleming, 2015). Conversely, a purely qualitative approach might be able to give rich narratives, but would not provide generalizable engagement metrics and statistical evidence connecting learning behaviors to competency outcomes. Thus, this study uses an integrated design (Apc, 2023; Sharma et al., 2023), which means the integration of both data types because of their complementary nature to provide a richer, more holistic, and more powerful analysis.

In particular, implementing a convergent parallel design, the quantitative and qualitative data were collected (and analyzed) separately, but merged at the interpretation stage (Creswell & Clark, 2017; Laban, 2021). This integration aimed at triangulation for validity and complementarity to enhance qualitative findings in greater detail and to clarify statistical results (Soodmand Afshar & Ranjbar, 2023).

3.2 Participants and Setting

The study was also conducted at AMNI Maritime University, a specialized higher education institution in Indonesia with traffic and shipping services. Participants and Setting: 65 second-year cadets in the Transportation Studies program After planning this study with the considerations noted above, it is then used a purposive sampling strategy, where participants were selected based on three inclusion criteria: (1) they had to be enrolled in the online Maritime English course for the 12-week semester; (2) required to have at least completed one semester of English for Seafarers training; and (3) had never held a professional seafaring job.

Of these eligible cadets, 60 agreed to participate and provided informed consent, yielding a final sample size of n = 60 (completion rate = 92%). To control for cadets' prior English proficiency, TOEFL-equivalent baseline scores were obtained to account for possibly confounding variables.

3.3 Data Collection and Instruments

A triangulated dataset This was a triangulated dataset collected over a 12-week period using four distinct instruments.

1). LMS activity logs

Exported engagement data from the built-in analytics module of the Moodle Learning Management System. These logs were filtered to extract the SMCP-related behaviors (i.e., time spent on radio simulations and listening drill attempts) as per the domain-specific analytics recommendations (Diahyleva et al., 2024). Thus, yielding 720 hours of structured engagement data (60 cadets × 12 weeks).

2). STCW-Aligned Assessments

Academic achievement was assessed using three assessments mapped to the STCW Model Course 3.17 (English & Convention, 2015; Martes, 2015): an oral proficiency test, a scenario-based writing assessment, and a timed simulated radio communication. Assessment rubrics were cross-validated by a panel of instructors to ensure reliability of scoring.

3). Likert-Scale Questionnaire

A 20-item questionnaire administered to assess cadet perceptions of relevance of SMCP, LMS functionality, and technical limitations. Content and face validity of the instrument was secured by three senior maritime English teachers to the instrument design. Validity was confirmed through a pilot test with a high Cronbach's alpha (rate of internal reliability) of 0.89.

4). Semi-Structured Interviews

In order to obtain more in-depth descriptions of the learning experience, semi-structured interviews were performed with 10 cadets (stratified based on high, medium & low LMS engagement level). Verbatim transcription was conducted for 10 hours of audio recordings, which were then analyzed.

3.4 Data Analysis

The data analysis process followed the logic of the convergent parallel mixed-methods design. Quantitative and qualitative datasets were first examined independently in order to preserve methodological rigor, and were later brought together during interpretation to generate a comprehensive understanding of cadets' engagement and SMCP performance.

1). Quantitative analysis

Quantitative data were analyzed using SPSS version 27. Descriptive statistics, including means and standard deviations, were calculated to summarize participants' learning engagement and performance profiles. Pearson correlation tests were then conducted at a significance level of $\alpha = 0.05$ to identify relationships between key variables. This approach enabled the examination of associations between learning management system indicators, such as simulation time and listening drill attempts, and standardized SMCP outcomes, such as oral proficiency and radio communication scores. The use of correlation analysis was appropriate because the primary objective was to explore the extent to which LMS engagement patterns were linked to competency-based performance measures..

2). Qualitative analysis

Qualitative data, consisting of interview transcripts and open-ended responses from questionnaires, were analyzed using Braun & Clarke (2006) six-phase thematic analysis framework. The process involved familiarization, coding, theme development, review, refinement, and reporting. To ensure reliability, two researchers independently coded a twenty percent sample of the transcripts, followed by the calculation of inter-rater agreement. A Cohen's Kappa coefficient of 0.87 demonstrated strong agreement, confirming the reliability and consistency of thematic interpretation.

4). Data Integration:

Following the separate analyses, the quantitative results and qualitative themes were integrated through methodological triangulation. This step allowed for systematic comparison between statistical findings and lived experiences reported by cadets. The purpose of this integration was to identify points of convergence, complementarity, and divergence across the two datasets, supporting a richer and more nuanced interpretation of how online SMCP engagement translated into operational communication competence (Creswell & Clark, 2017).

3.5 Ethical Considerations

This research was conducted in accordance with ethical standards. Prior to data collection, informed consent was obtained from all participants. All data (LMS logs, assessment scores, and interview transcripts) was anonymized and participant identifiers were replaced with numerical codes to maintain confidentiality and anonymity.

4. Results

The mixed-methods analysis results are provided in this section, in order to answer the research questions about cadet engagement, learning gaps, and the relationship between cadet online behavior and STCW-aligned competency. Consistent with the mixed-methods design, the findings are presented in two phases: quantitative results from LMS logs and academic tests, followed by qualitative results from questionnaires and interviews, which provide the explanatory context for the numerical data.

4.1 Quantitative Data Results

Table 4.1 SMCP-Specific LMS Engagement Metrics

Metric	Mean (SD)	Interpretation
SMCP Listening Drill Attempts/Week	5.1 (±1.8)	High engagement with auditory training for distress signals
Radio Simulation Time (minutes/week)	85 (±30)	Moderate time spent on SMCP role-plays (e.g., Mayday calls).
SMCP Vocabulary Quiz Attempts/Week	3.5 (±1.2)	Active practice of IMO-mandated terminology.
Forum Posts on SMCP Scenarios/Week	2.8 (±1.5)	Limited participation in SMCP-focused discussions.

LMS data analysis in Table 4.1 showed different patterns of cadets' work on SMCP-specific tasks (Table 1). SMCP Listening Drills were also the most engaging, with cadets attempting them, on average, 5.1 times per week (SD = 1.8). Much time was also spent on Radio Simulations which averaged 85 minutes per week (SD = 30). By contrast, the mean number of asynchronous Forum Posts on SMCP Scenarios was low (M = 2.8 posts/week, SD = 1.5).

Table 4.2 STCW-Aligned Academic Performance

Assessment Type	Mean Score (%)	SD (%)	Interpretation
SMCP Oral Proficiency Test	82	±6	High competency in real-time communication (e.g., navigational warnings).
SMCP Writing Assignments	78	±7	Accurate use of SMCP phrases in written scenarios.
Radio Communication Simulation	75	±9	Moderate performance under time pressure.

As displayed in Table 2, the cadets performed well on the SMCP Oral Proficiency Test with a high mean score (M = 82%, SD = 6%). Results indicated somewhat lower performance on SMCP Writing Assignments (M = 78%, SD = 7%) and significantly lower performance on the Radio Communication Simulation (M = 75%, SD = 9%).

Table 4.3 Pearson Correlation Analysis

LMS Metric	SMCP Oral Test	SMCP Writing	Radio Simulation
SMCP Listening Drill Attempts	0.52	0.34	0.28
Radio Simulation Time	0.61	0.22	0.67
SMCP Vocabulary Quiz Attempts	0.45	0.55	0.19

*Significance Levels: p<0.05, **p<0.01*, **p<0.001*

A Pearson correlation analysis was conducted to determine the relationship between LMS upper division engagement and academic performance (Table 3). Radio Simulation Time was also strongly, positively and statistically significantly correlated with the scores of the subjects on the SMCP Oral Test (r = 0.61, p < ·). 01), along with the Radio Simulation evaluation (r = 0.67, p <. 01). Similarly, the oral test had a moderate positive association with SMCP Listening Drill Attempts (r =.52, p <. 05). In contrast, writing scores were more strongly related to SMCP Vocabulary Quiz Attempts (r = 0.55, p <. 05) more than with oral or simulation performance.

4.2 Qualitative Findings

Table 4.4 Cadet Perceptions of SMCP Training

Perception Category	Agreement (%)	Interpretation
SMCP Relevance to Career Goals	90	Strong belief in SMCP's applicability to shipboard communication.
LMS Usability for SMCP Drills	75	Technical limitations noted (e.g., lack of noise simulation).
Technical Issues (e.g., audio lag)	65	Connectivity/audio delays hindered listening exercises (Fatimah et al., 2024).

Qualitative data from questionnaires and interviews provided context for the quantitative results. As shown in Table 4, a vast majority of cadets (90%) reported that they believed SMCP was highly relevant to their future careers. However, a significant portion reported challenges with the online learning environment; 75% noted usability limitations, and 65% specifically identified technical issues like audio lag as a barrier that hindered their learning.

Table 4.5 Instructor Observations

Observation Category	Noted (%)	Interpretation
Correct SMCP Phrase Usage	78	High adherence to IMO protocols during role-plays.
Engagement with SMCP Feedback	82	Active revision of errors post-feedback.
Use of Supplementary SMCP Guides	55	Underutilization of IMO Model Course 3.17 materials (Diahyleva et al., 2024; English & Convention, 2015; Martes, 2015).

Instructors observed high adherence to IMO protocols during SMCP role-plays, with 78% of cadets accurately using standardized phrases such as "Mayday" and "Alter course to port" in simulations. This reflects effective training in structured scenarios. However, instructors noted that cadets occasionally reused incorrect phrases in unstructured exercises, suggesting over-reliance on memorization rather than contextual understanding. The primary observation was that automated LMS feedback predominantly addressed written errors, leaving critical gaps in oral proficiency correction, a limitation echoed by cadets in qualitative interviews. 82% of cadets actively revised errors after receiving feedback on SMCP tasks, highlighting the value of iterative learning in improving compliance with STCW communication standards. This aligns with Shi and Fan's (2021) advocacy for timely feedback in maritime education (Shi & Fan, 2021). However, instructors emphasized that automated LMS feedback primarily addressed written errors, leaving gaps in oral proficiency correction, a limitation echoed by cadets in qualitative interviews. Notably, only 55% of cadets utilized supplementary SMCP resources such as the IMO Model Course 3.17 materials. For instance, embedding SMCP guides directly into simulation interfaces could enhance accessibility and relevance during training.

Thematic analysis of the semi-structured interviews produced three overarching themes. The first theme, The Centrality of Immersive Practice reflects what all cadets shared was the most beneficial aspect of the course. One high-engagement cadet stated: *"Buat saya latihan radio itu bagian yang paling berguna. Saya sampai mengulang frasa-frasa tertentu yang buat saya ga begitu paham. Cuma, gimana ya, ini simulasi kan.. rasanya ga sama dengan keadaan yang sebenarnya."* (C5-H, High-Engagement Cadet)

The second, the 'contextual realism gap', became a direct rationale for the observed performance decline during timed simulations. Cadets expressed an unmistakable disparity between the antiseptic realm of the Internet and the expected landfall of a ship's bridge. Another participant elaborated: *"Situasi simulasinya beda sama dengan aslinya, di ruang mesin pastinya lebih bising, di sini ga ada suara mesin, ga ada suara radio, dan lain-lain lah."* (C9-M, Medium-Engagement Cadet)

The Feedback Effectiveness Dilemma, the third theme, showcased that cadets had both positive and negative experiences. Although they found automated feedback on vocabulary quizzes useful for written tasks, they felt that they received no feedback on their oral performance, as one cadet commented: *"Kuis yang kosa kata itu, buat saya cukup ngebantu, langsung dikoreksi, langsung tahu salahnya. Cuma pas buat speaking saya ga tahu pengucapan saya salah apa benar."* (C2-L, Low-Engagement Cadet)

Table 4.6 Combined View of Triangulated Data on SMCP Online Training Experiences

Key Findings (Themes)	**Quantitative Evidence (from LMS & Assessment)**	**Qualitative Data (from Interviews)**	**Integrated Interpretation**
The Centrality of Immersive Practice	Time spent in radio simulations showed a strong positive correlation with verbal proficiency scores ($r=0.61, p<0.01$). Cadets spend an average of 85 minutes per week in simulations.	"*Buat saya latihan radio itu bagian yang paling berguna. Saya sampai mengulang frasa-frasa tertentu yang buat saya ga begitu paham. Cuma, gimana ya, ini simulasi kan.. rasanya ga sama dengan keadaan yang sebenarnya."* (Cadets 5, high achievers).	The statistical relationship between training and performance was validated by the cadets' testimonials. Data converged to show that cadets who invested more time in active scenario-based simulations performed much better, confirming the value of this pedagogical tool.
The 'Contextual Realism' Gap	Cadets scored lower in simulated timed radio communication (M=75%) compared to indefinite oral tests (M=82%). 65% of cadets reported technical issues (e.g., audio pauses) hindering training. [1]	"*Situasi simulasinya beda sama dengan aslinya, di ruang mesin pastinya lebih bising, di sini ga ada suara mesin, ga ada suara radio, dan lain-lain lah*." (Cadet 9). "*Kadang suaranya nge-lag, Saya sering ketinggalan, bikin stress*." (Cadet 7).	The decline in quantitative performance under pressure and reported technical problems is explained by the qualitative findings that the online environment is too "sterile". This environment lacks the authentic auditory stress triggers and technical imperfections of real onboard communication, which hinders skill transferability.
The Feedback Effectiveness Dilemma	82% of cadets reported actively using feedback on SMCP tasks. Vocabulary quiz efforts (M=3.5/week) correlated with writing scores (r=0.55) but less	"*Kuis yang kosa kata itu, buat saya cukup ngebantu, langsung dikoreksi, langsung tahu salahnya, Cuma pas buat speaking saya gat ahu pengucapan saya salah apa benar*." (Cadet 2).	Cadets appreciate and take advantage of the automated text-based feedback from the LMS, which increases their use of written SMCPs. However, there are feedback gaps

Key Findings (Themes)	Quantitative Evidence (from LMS & Assessment)	Qualitative Data (from Interviews)	Integrated Interpretation
	correlated with verbal scores. [1]		critical to oral proficiency, a cornerstone of STCW's communication standards, that cannot be addressed by current automated tools.

In conclusion, the results show two key outcomes: 1) a strong positive correlation between time spent on practical simulation and oral proficiency, and 2) a significant performance discrepancy and reported technical barriers in timed simulations. The qualitative data contextualized these figures, revealing the 'contextual realism gap' and the critical absence of oral feedback as overarching challenges faced by the cadets, which necessitate further interpretation in the Discussion section.

5. Discussion

This study's investigation into the use of Learning Analytics (LA) for online Standard Marine Communication Phrases (SMCP) training provides critical insights into the intersection of educational technology, specialized language pedagogy, and international maritime safety standards. By employing a mixed-methods approach, this research moves beyond surface-level engagement metrics to uncover the nuanced realities of how maritime cadets interact with digital learning tools, the challenges they face, and the pedagogical adaptations required to align online training with the stringent, competency-based framework of the International Maritime Organization's (IMO) Standards of Training, Certification, and Watchkeeping (STCW). The findings reveal a complex landscape where the promise of flexible, technology-driven education is often constrained by a deficit in contextual realism, persistent technical barriers, and the limitations of automated feedback systems. This discussion will interpret these findings by situating them within the broader literature on English for Specific Purposes (ESP), simulation-based training, and the digital divide, ultimately proposing a series of actionable recommendations for pedagogy, policy, and future research aimed at enhancing the efficacy of online maritime education.

The use of Learning Analytics (LA) in conducting the online Standard Marine Communication Phrases (SMCP) training in the current study offers important pedagogical implications for the broader niche of educational technology in maritime education, specialized language education, and international maritime transportation and safety regulating standards. The results point to a key paradox: whilst cadets are instrumentally motivated to seek out situations that approximate genuine professional practice, the prevailing digital learning landscape fails to nurture genuine, real-world competence due to a pernicious 'contextual realism deficit' and an enduring technical barrier. This discussion contextualizes these results in the larger literature and provides implications for pedagogy and policy.

5.1 Cadet Engagement and the Primacy of Authentic Practice

The strong positive correlation (r = 0.61) between time spent on radio communication simulation and oral proficiency scores directly validates a core principle of English for Specific Purposes (ESP): language mastery is intrinsically linked to its intended professional purpose and context (Hutchinson & Waters, 1987; Ismajli, 2025). Cadets are demonstrably pragmatic learners, dedicating substantial time (M=85 minutes/week) to tasks that closely approximate career demands, supporting the necessity of performance-based learning in high-stakes fields (Dewan et al., 2023). This observed engagement contrasts sharply with the low participation in asynchronous, decontextualized activities like forum discussion (M=2.8 posts/week). This pattern suggests that for vocational learners, the perceived relevance and urgency of the task supersede general interaction metrics often prioritized in standard online learning platforms (Kristiana et al., 2023). Therefore, the LA system in ESP must shift from monitoring generic engagement (e.g., login frequency) to performance-based metrics that genuinely reflect the operational readiness required by STCW (Diahyleva et al., 2024; Gurbuz & Celik, 2024).

However, this kind of engagement is in sharp contrast to participation in asynchronous, text-based activities such as forum discussions (M=2.8 posts/week). Instead of being central to overall engagement for online learning more generally (Kristiana et al., 2023), forums seem unpopular here, implying that in high-stakes vocational training where urgency and relevance displace extrinsic motivation (Masuku & Bauk, 2025; Skarpeti et al., 2025), there are no post-hoc opportunities for unidirectional discussion. For instance, this suggests that, for ESP learners, the most valuable practice of language use times in terms of its relevance to the development of communicative competence is an authentic practice, and the least valuable is a decontextualized obtaining of knowledge. The abstract nature of this hierarchy implies a) the LA systems in ESP have to be tuned such that they focus on performance-based metrics rather than plain engagement indicators to represent the actual state regarding student preparedness (Diahyleva et al., 2024; Gurbuz & Celik, 2024).

5.2 The Contextual Realism Gap and Threats to Skill Transfer

The most significant finding is the manifestation of the "contextual realism gap" which explains the performance drop observed in quantitative results (timed simulation: M=75% vs. standard oral test: M=82%). This gap is driven by a systemic failure of the digital platform to replicate the high-stress conditions aboard a ship, as detailed in the qualitative data. Cadets confirmed that the “sterile” online environment, devoid of essential stressors like engine noise and radio static, hinders the transfer of skills from the predictable digital locale to the unpredictable operational bridge (Yoshida et al., 2020). This finding aligns with established literature in fields like aviation and medicine, where simulation fidelity, encompassing both physical (auditory environment) and psychological (cognitive stress) aspects, is paramount for effective skill transfer (Koukourikos et al., 2021). While a scenario may possess conceptual fidelity, the lack of physical and psychological fidelity risks negative transfer, potentially breeding a false confidence that is fragile under real-world pressure (Paddy, 2016).

5.3 Navigating Technological Barriers and the Feedback Loop

The efficacy of any online program is contingent on its technical infrastructure. Severely lagged audio confounded which communication strategies the cadets were practicing in close to 80% of sessions, thereby directly violating the pedagogical intent behind the practice of real-time communication. This is characteristic of the larger digital deprivation challenge that persists for Indonesia and other developing areas and is a real challenge to equitable learning (Fatimah et al., 2024; Yaqin et al., 2024). Additionally, this study discovered an important missing link in the feedback loop.

In contrast, cadets were provided with no corrective feedback for their oral pronunciation or fluency during the simulations, although they appreciated automated feedback for written vocabulary-related tasks (82% engagement). That could, in short, result in communication mistakes that may endanger lives at sea and that can be fossilized (hard to remove) in time. But this challenge could be a perfect fit for the entry of contemporary Artificial Intelligence (AI). Tools powered by Artificial Intelligence (AI) with automatic speech recognition (ASR) capabilities offer the prospect of offering learners immediate feedback on their pronunciation, down to the phoneme level; thus, filling the exact gap identified by the cadets (Elimat & AbuSeileek, 2014; Sun, 2023). However, caution should be exercised for fear of algorithmic accent bias, that is to say that systems trained on native English speakers will discriminate against those without native accents, those who fail to meet a certain threshold are penalised. Hence, institutions need to make a critical decision on what AI tools are being utilized as they are often based on their own global English data sets Population trend (Ha & Pham, 2025; Lewis, 2025).

5.4 Addressing Methodological Limitations and Policy Implications

5.4.1 Threats to Validity and Future Directions

This study has limitations inherent to its design. Internal validity may be partially threatened by the device heterogeneity and local network conditions experienced by cadets, which were the source of the reported audio latency. External validity is limited by the single-institution sample, the specific LMS used, and the cultural context of Indonesian maritime education. The use of TOEFL-equivalent baseline scores as a control variable mitigates the threat of pre-existing proficiency differences (T. Kim & Lintott, 2022). Future research should employ a comparative design across multiple institutions with varying simulation fidelities to disambiguate whether lower simulation scores are purely due to the realism gap or partially influenced by the strictness of the timed scoring rubric.

5.4.2 Policy and Pedagogical Recommendations for STCW Compliance

The findings necessitate three actionable recommendations for enhancing online Maritime English pedagogy:

1) Adopt Gradual Stress Inoculation

   To close the contextual realism gap, simulations must be re-engineered to integrate gradual auditory stressors (e.g., engine noise, radio static) and psychological stressors (e.g., forceful time limits). This requires the use of high-fidelity audio equipment and server stability capable of handling the additional environmental layer without incurring latency.

2) Re-engineer Collaborative Learning

   Replace low-engagement forums with structured, task-based collaborative simulations where cadets must resolve emergencies together, eliciting realistic teamwork and required SMCP usage (Joras, 2011; Strevens, 1988).

3) Implement AI-Driven Oral Feedback

   Institutions must adopt validated AI-based resources for delivering personalized pronunciation and fluency feedback. Institutions must prioritize AI systems trained on Global English datasets to avoid accent bias against non-native speakers, ensuring equity and effectiveness (Ha & Pham, 2025; Lewis, 2025).

6. Conclusion

This study investigated the effectiveness of online Standard Marine Communication Phrases (SMCP) training using a novel learning analytics framework, a critical concern for enhancing international maritime safety ans STCW compliance. The integrated diagnosis revealed two key findings: first, engagement with perfomrance-based tasks is effective, with radio simulation time showing a strong positive corelation ($r=0.61$, $p<0.01$) with oral proficeincy scores. Second, this effectiveness is undermined by a pronounced 'contextual realism deficit', evidenced by cadets' lower performance in timed simulations (M=75%) compared to standard oral tests (M=82%), as the simulations lacked real-world stressors and technical constraints. Consequently, the single most actionable implication for curriculum design is the mandatae for institutions to integrate gradual stress inoculation into digital simulations and adopt. AI-driven Automatic Speech Recognition (ASR) tools to provide personalized pronunciation feedback, thereby addressing the crucial oral feedback gap. A limitation of this research is the single-institution sample, which restricts the external validity; future work should employ comparative studies to disambiguate the realism gap from scoring rubric strictness. Ultimately, these contributions provide an empirically supported roadmap for maritime colleges to move beyond superficial compliance, ensuring digital training systems genuinely translate into enhanced operational competence and maritime safety worldwide.

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