30th
International Maritime Lecturers Association Conference
Split Croatia
www.imla30.org

International Maritime Lecturers Association
FACULTY OF MARITIME STUDIES

IMPROVEMENT OF ROUTINE MARITIME COMMUNICATION SKILLS THROUGH THE USE OF DIGIMAR TOOLS

Violeta Jurkovič*, Valter Suban

Abstract. Clear and effective routine maritime communication is essential for ensuring navigational safety as misunderstandings between ships and shore-based operators can lead to marine accidents and incidents. This prompted ten partners from Slovenia, Croatia, Montenegro, Finland, Sweden, and Norway to collaborate on the Erasmus+ Digimar project which seeks to improve navigational safety by enhancing the routine maritime communication skills of higher education students and Vessel Traffic Service operators. The main objective of this paper is to provide a pilot study of the data collected within the Digimar project, and examine the statistically significant differences in routine maritime communication skills among higher education students of nautical studies at the Faculty of Maritime Studies and Transport of the University of Ljubljana, Slovenia, before and after training in routine maritime communication supported by the Digimar educational tools. These differences will be calculated using data derived from routine maritime communication standard variables, analysed across two spoken corpora. The first corpus, consisting of student simulations, was collected, transcribed, and analysed in May 2024 before the students received any training in routine maritime communication. The second corpus, also comprising student simulations, was collected in May 2025 after the integration of Digimar instructional videos and chatbots in student training. The variables analysed are included in seven main categories: routine message structure, message markers, sentence structure, prowords for preventing ambiguity, ambiguity, digits and phonetic alphabet, and communication style. The findings indicate that training in routine maritime communication, which integrated Digimar instructional videos and chatbots based on authentic communication exchanges, significantly enhanced students' routine maritime communication skills. However, the results also highlight two aspects of routine communication that may not have received sufficient attention during the training: message markers and prowords used to prevent ambiguity.

Keywords: Routine Maritime Communication; Higher Education Students; Simulations; Erasmus+ Digimar; Instructional Videos; Chatbots.

University of Ljubljana, Faculty of Maritime Studies and Transport, Pot pomorščakov 4, Portorož, Slovenia

* **Corresponding author:** violeta.jurkovic@fpp.uni-lj.si

https://doi.org/10.7225/imla30.15

1. INTRODUCTION

In the global maritime industry, ineffective and ambiguous communication is frequently a contributing factor in shipping accidents. Day-to-day routine communication between ships and shore service operators (Vessel Traffic Service (VTS) Operators, Harbour Master officers etc.) can also introduce unnecessary risks (IALA, 2017). As demonstrated in a recent comprehensive data-driven quantitative study by Jurkovič (2022), routine maritime communication between shore-based service operators and ship crews often significantly diverges from the standard communication protocol. These findings are consistent with research conducted in other geographical contexts (Boström, 2020; Dževerdanović-Pejović, 2013), highlighting a strong need for widely accessible and relevant digital educational tools for routine maritime communication.

Modern technology makes it possible to develop open-access instructional videos and speech-recognition chatbots as tools to support self-directed and lifelong learning, but also tools to be used in formal educational contexts for students and in-service shore-service operators. Despite their advantages, chatbots based on authentic genres and real-life scenarios remain underutilised in maritime education. Moreover, no international project or research study has addressed maritime communication specifically from the perspective of shore service operators, who play a crucial role in navigational safety. Next, no initiative has yet focused on developing a combination of instructional videos and chatbots grounded in authentic routine communication data.

These are the main premises that provided the foundations for the Erasmus+ project titled Digital Education for Maritime Communication, or Digimar (https://digimar.si/) for short. The primary aim of the project is to improve the safety of navigation, assessed through statistically significant differences in maritime communication skills before and after the implementation of a study for shore service operators and higher education students supported by Digimar tools. The enhancement of maritime communication skills – and, consequently, navigational safety – is expected to be enhanced through g an open-access, research-based and ICT-supported digital educational tool based on instructional videos and chatbots.

Digimar is at its halfway point as of July 2025. So far, through a review of international documents and databases of marine casualty investigation reports, guidelines for routine maritime voice communication were established, requirements for VTS operators identified, and maritime casualties in which communication was a direct or indirect contributing factor examined. In addition, the compliance of authentic communications between VTS operators and vessels, as well as student simulations with these communication guidelines was recorded before the implementation of training using Digimar tools. The findings from these initial analyses formed the foundation for the development of educational tools, available on the project website.

First, the educational tools include simulation scenarios[1] based on authentic communication situations from various geographical contexts. The second tool comprises twenty basic-level videos[2] that summarise the core guidelines for routine maritime communication. Next, nine advanced-level videos[3] are based on case studies of real maritime accidents and incidents that were caused by ambiguous or deficient routine maritime communication. These aim to deepen users' understanding of the communication guidelines and their practical application. Last but not least, the application of guidelines in realistic communication scenarios is supported by chatbots[4], currently in the testing phase.

All four tools have been integrated into the educational process on routine maritime communication for students of nautical studies at the Faculty of Maritime Studies and Transport, University of Ljubljana, Slovenia. The aim of this paper is to present the statistically significant differences in their routine maritime communication skills before and after training supported by Digimar tools, including scenarios, instructional videos at the basic and advanced levels, and chatbots.

Following this Introduction, the paper presents the standard protocol for routine maritime communication in maritime settings, from which the variables used in the statistical analysis were derived. This presentation will be integrated with a review of relevant findings from previous studies in this domain. The Method section outlines the research questions, justifies the chosen methodology, and describes the data collection procedures, study participants, and data analysis process. The Results section focuses on the differences in routine maritime communication skill scores before and after training among the selected students. The Discussion and Conclusion section interprets the findings in relation to the research aims, highlights their significance and implications, acknowledges the study's limitations, and suggests possible directions for future research in this field.

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[1] https://digimar.si/category/scenarios/

[2] https://digimar.si/category/digital-tools/instructional-videos/routine-maritime-communication-basic-training/

[3] https://digimar.si/category/digital-tools/instructional-videos/routine-maritime-communication-advanced-training/

[4] https://digimar.si/category/digital-tools/chatbots/

2. ROUTINE MARITIME COMMUNICATION

Routine maritime communication is a highly specialised and narrow-scope realisation of English for navigation and maritime communications (Bocanegra-Valle, 2013; Pritchard & Kalogjera, 2000). It is characterised by its predictable, unambiguous, clear, and simple structure and content (Johnson, 1999). Therefore, the lexis, grammar, and discourse tend to be highly regularised and limited to enhance successful sending and receiving of the message (IALA, 2017; Pritchard & Kalogjera, 2000). The structure of routine messages consists of three moves (Bocanegra-Valle, 2011). They are presented in Figure 1.

An example of a routine maritime communication exchange where the VTS operator informs an incoming vessel on the speed limit and prohibited area within the port limits is presented in Table 1.

The standard protocol of routine maritime communication was derived from three documents:

- Manual for Use by the Maritime Mobile and Maritime Mobile-Satellite Services (ITU, 2024),
- G1132 VTS Voice Communications and Phraseology (IALA, 2022a), and
- Resolution A.918(22) on IMO Standard Marine Communication Phrases (IMO, 2001).

The next section presents the standard elements of the routine maritime communication protocol, from which the variables used in this study were derived, and relevant findings from previous research studies.

a. Routine maritime message structure

In the "Initiate conversation/ establish contact" move, the addressee and calling station are identified, while 'over' is used to clearly indicate turn-taking in this move but also in the second "Send message/ exchange information" move. In the "End of conversation" move 'out' is used to indicate that the exchange is completed.

At the level of routine maritime communication structure, the division of maritime conversations into three moves (cf. Bocanegra-Valle, 2011) seems to largely follow the standard protocol of communication (Dževerdanović-Pejović, 2013; Pritchard & Kalogjera, 2000). The segment that most often tends to be left out is the opening 'initiate conversation/establish contact' move (Pritchard & Kalogjera, 2000). Also 'over' is used seldom and inconsistently in turn-taking (Jurkovič, 2022). In addition, instead of 'out' in the 'end of conversation' move to indicate that the exchange is finished, more informal alternatives are often used (Dževerdanović-Pejović, 2013).

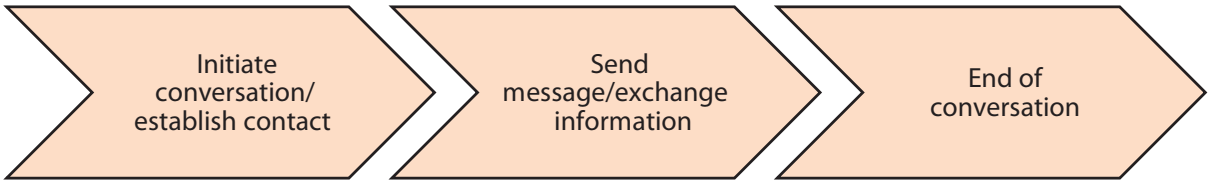

Figure 1. General structure of routine maritime communication messages (Bocanegra-Valle, 2011).

Table 1. Routine maritime communication example.

Move	Speaker	Message
Initiate conversation/ establish contact	VTS	Motor Vessel Seabass, this is Sandybay VTS. Over.
	Vessel	Sandybay VTS, this is Motor Vessel Seabass. Over.
Send message/ exchange information	VTS	Information number one. Maximum speed inside the port limits is six knots. I repeat. Maximum speed inside the port limits is six knots. Information number two. A prohibited area within the port limits is marked with yellow buoys Charlie 3 and Charlie 4 on the charts. I repeat. A prohibited area within the port limits is marked with yellow buoys Charlie 3 and Charlie 4 on the charts. Over.
	Vessel	Received. Maximum speed inside the port limits is six knots. A prohibited area within the port limits is marked with yellow buoys Charlie 3 and Charlie 4 on the charts. Over.
End of conversation	VTS	Request. Stand by on VHF channels 08 and 16. Over.
	Vessel	Received. I will stand by on VHF channels 08 and 16. Out.

b. Message markers

The purpose of message markers is to keep the communication to the point and clear so that the probability of understanding the purpose of the message is facilitated. The message markers include 'question', 'answer', 'intention', 'instruction', 'advice', 'information', request', and 'warning'.

In general, message markers are underused by all communication agents involved in routine maritime exchanges (Dževerdanović-Pejović, 2013b; Perea-Barberá & Parada Galindo, 2020) while in some contexts their use seems to be limited to 'information' and 'question' (Jurkovič, 2022). Moreover, they are usually incorporated with the following phrase and not used as an isolated marker preceding it (Boström, 2020).

c. Simple and unambiguous sentence structure

The structure of statements needs to follow the subject + verb + object sequence, if applicable, while questions need to begin with the appropriate wh-question word (e.g., what, when, which, who). Fully worded answers need to be provided to questions to avoid ambiguity. Finally, each sentence needs to cover one event or piece of information to ensure simplicity.

Although the absence of closed-loop feedback in disambiguation strategies carries a significant risk of miscommunication and potential hazard (John et al., 2019), it appears to be underused in real-world maritime communication (Boström, 2020; Jurkovič, 2022; Pritchard & Kalogjera, 2000). The guideline advising against the use of extended messages where a single phrase conveys multiple events is not consistently followed during icebreaker operations (Boström, 2020). In practice, such longer messages often include two or three message types, a finding also supported by Jurkovič (2022).

d. Avoiding ambiguity

Ambiguity needs to be avoided by not using modal verbs, especially in terms of epistemic modality, nor abbreviated forms, especially 'won't' as a homophone of 'want to'.

The use of modal verbs and abbreviated forms, in particular 'won't' as a homophone of 'want to', possibly has the highest potential for causing navigational risk. Although they are seldom used in authentic routine maritime communication (Jurkovič, 2022), an example from 2023 from the Northern Adriatic Sea shows the high potential for miscommunication. A ship leaving the port asked a ship approaching the port: "You won't cross ahead of me, correct?" The incoming ship answered: "Yes, I want to cross ahead of you." to which the outgoing ship replied: "Okay." The miscommunication arose from the outgoing ship's use of "won't", a homophone of "want". This clearly violated the recommendation for not using abbreviated forms in spoken maritime communication. First, the two vessels did not realise that a misunderstanding had occurred. An accident was avoided by the appropriate action of the outgoing ship and intervention of the VTS operator (see Perkovič et al., 2023). On the other hand, student simulations seem to contain more modal verbs used as hedges (John et al., 2019).

e. Supporting unambiguity

Unambiguous communication is supported by the use of three prowords. 'Repeat' is used when the speaker repeats an important part of the message. 'Say again' is used when the receiver is not sure they properly understood the speaker's message. 'Read back' is used when the speaker would like to verify that the receiver properly understood the speaker's message by reading it back.

When it comes to prowords used to support communication, speakers often use alternatives rather than those specified by the standard communication protocol. For example, instead of using 'received', speakers frequently opt for more conversational expressions like 'go ahead' and 'roger' to confirm receipt of a message (Dževerdanović-Pejović, 2013).

Regarding the indication of misunderstanding and prompting clarification, the prowords most commonly employed are 'repeat' and 'say again', which Boström (2021) identifies as accepted elements of the standard IMO SMCP (2001) phraseology. In terms of the use of prowords, Jurkovič (2022) found that full compliance with the standard protocol of communication is recorded in less than 4% of cases of authentic routine maritime communication.

f. Digits and phonetic alphabet

All numbers, such as times or arrival and departure, pilot boarding times, quantities of cargo on board, etc. need to be pronounced as separate digits. The phonetic alphabet needs to be used to spell out, for instance, ships' call signs, geographical areas, or other information.

In authentic routine maritime communication, the phonetic alphabet is used consistently and in compliance with the standard protocol of communication while the rule of pronouncing numbers as separate digits is fully observed in almost 80% of cases (Jurkovič, 2022).

g. Communication style

Communication needs to be formal, avoiding unnecessary forms of politeness, and should be delivered at

an appropriate pace and with clarity. To date, no research has examined clarity, politeness, and pace in communication within the maritime domain.

3. MATERIAL AND METHODS

3.1. Research Question

As stated in the Introduction, the main goal of the Digimar project is to enhance navigational safety by identifying statistically significant improvements in maritime communication skills following the use of Digimar tools. The project involves shore service operators and higher education students across six countries (Slovenia, Croatia, Montenegro, Finland, Sweden, and Norway). As a first step, this study focuses on higher education students of nautical studies at the Faculty of Maritime Studies and Transport, University of Ljubljana, Slovenia. The research question is: "What statistically significant differences in routine maritime communication skills can be observed before and after training supported by Digimar tools among the students at the Faculty of Maritime Studies and Transport, University of Ljubljana?"

3.2. Corpus of Student Simulations

This study is based on two corpora of student simulations of routine maritime communication collected within the Digimar project. The first corpus was collected in May, 2024, i.e., *before* the implementation of the study using Digimar educational tools. The second corpus was collected in May, 2025, i.e., *after* the implementation of the study using Digimar educational tools. This training is especially relevant, as routine maritime communication is a mandatory skill for all future officers in charge of a navigational watch on ships of 500 gross tonnage or more (IMO, 2015), as well as for VTS operators (IALA, 2022b).

The first (pre-training) corpus was collected in May, 2024, based on seven simulation scenarios prepared on the basis of authentic recordings of routine maritime communication in the area of the Port of Koper, Slovenia. These included reporting upon entering Sector 5 of the Adriatic Reporting System, anchoring, pilotage, ship drills, speed limit in port, and bunkerage. This corpus contains verbatim transcripts of 135 student exchanges recorded by 35 students. It consists of 24,941 tokens (running words). Some students had previously received initial training in routine maritime communication while the majority had not. However, due to the limited number of enrolled students, different groups needed to be included in this sample.

The second (post-training) corpus was collected in May, 2025, based on seven slightly altered and adjusted scenarios used for the collection of the first corpus. This corpus contains verbatim transcripts of 91 student exchanges recorded by 15 students. It consists of 19,417 tokens (running words). This group of students received comprehensive teacher-led training in maritime communication, including routine maritime communication, supported by the use of Digimar tools. The latter consisted of the classroom and teacher-led use of:

- four instructional videos at the basic level (Structuring Routine Maritime Communication, Message Markers – question, answer, request, Message Markers – information, advice, warning, and Avoiding Ambiguity), designed to develop a solid understanding of the standards governing routine maritime communication.
- three instructional videos at the advanced level (Collision in a Congested Waterway, Near-miss between Incoming and Outgoing Vessels, and Collision in Foggy Conditions), based on real-world accidents and/or incidents used as case studies, designed to critically examine the standards governing routine maritime communication.

On the other hand, the chatbots developed on the basis of 43 scenarios based on authentic routine maritime communication exchanges from different geographical contexts were designed to apply the routine maritime communication standards in simulated exchanges. The chatbots were introduced to the students, who were encouraged to use them autonomously in a self-regulated manner outside regular classroom hours.

The recordings for the both corpora were received from the students in a.wav format. They were transcribed into a clean verbatim transcript, which excluded pauses, stutters, and conversation fillers.

3.3. Data Analysis

An Excel sheet with variables to be observed (see 2 Routine maritime communication) was created by the Digimar project consortium under the leadership of the University of Rijeka, Croatia. Each element was then labelled for compliance with the standard protocol of routine maritime communication.

For each element, two variables were created: the expected value, representing expected compliance with the standard communication protocol, and the observed value, reflecting actual usage in each conversation. The symbol (/) indicates instances where an element was omitted despite being expected. Since the Digimar project focuses on the specific needs of shore-based service operators, this study analyses only the VTS operator's compliance in

Table 2. Expected and observed values for the use of the message marker 'question'.

Speaker	'Question'	Expected value	Observed value
VTS	MV Seabass, MV Seabass. This is Sandybay VTS. Over.	0	0
Vessel	Sandybay VTS, this is MV Seabass. Over.		
VTS	**Question.** What is your ETA to Sandybay pilot station? Over.	1	1
Vessel	Our ETA to Sandybay pilot station is 12.00 local time. Over.		
VTS	**(/)** Do you carry and dangerous cargo? Over.	1	0
Vessel	No, we do not carry any dangerous cargo.		
VTS	Received. You do not carry any dangerous cargo. Stand by on VHF channels 08 and 16. Out.	0	0

student simulations, not the vessel's. The elements subject to compliance and their values were then transferred into an IBM SPSS (version 28.0) database. Table 2 presents the expected and observed use of the message marker 'question'.

The coefficients between the observed values in relation to the expected values were calculated for each analysed element. For instance, the coefficient in the example presented in Table 2 for the use of 'question' is 0.50. In other words, 'question' was used by the students in this conversation in 50% of expected cases. In this way, coefficients for all elements of the standard protocol of communication were obtained.

The main statistical method used was the independent samples t-test. This test can be used when we want to compare two groups (in this paper the pre-training group data against the post-training group data) using the mean value of the variable that we would like to explore (in this paper, the coefficients between the observed and expected values) (Singh, 2007). The use of this test enabled the identification of statistically significant differences in the level of compliance (at $p < 0.05$) with the standard protocol of routine maritime communication in the two corpora of student simulations – the first recorded before the implementation of training supported by Digimar tools, and the second recorded after the implementation of training supported by Digimar tools.

4. RESULTS

First of all, the results indicate that training in routine maritime communication, which integrated Digimar instructional videos and chatbots based on authentic communication exchanges, significantly enhanced students' routine maritime communication skills. This means that such training had a statistically significant and pedagogically meaningful impact on students' ability to comply with international standards for routine maritime communication.

Figure 2 visually summarises the improvement in routine maritime communication skills scores from pre-training (May 2024) to post-training (May 2025) while Table 3 provides detailed statistical data for this comparison for the variables presented in 2 Routine maritime communication. Across nearly all measured variables, students achieved statistically significantly higher compliance with the standard protocol of maritime communication after training. These gains were confirmed using independent samples t-tests, nearly all showing p-values < 0.001, indicating strong statistical significance.

If we first consider the categories at the macro level (i.e., routine message structure, message markers, sentence structure, prowords – ambiguity digits and phonetic alphabet, and communication style), the greatest improvements were observed in the message structure of routine maritime communication ($t=35.320$, $p < 0.001$), and the use of message markers ($t=25.731$, $p < 0.001$). Before the training, students followed the routine message structure with a compliance rate of 35%, which increased to 91% after the training. The difference is even more pronounced in the use of message markers, where compliance rose from just 1% to 62%. Statistically significant improvements were also recorded in the sentence structure category (90% pre-training versus 96% compliance post-training; $t=6.760$, $p < 0.001$), the use of prowords for preventing ambiguity (49% versus 64%; $t=2.364$, $p=0.009$), the proper use of digits and the phonetic alphabet (69% versus 100%; $t=10.656$, $p < 0.001$), and communication style (93% versus 98%; $t=8.488$, $p < 0.001$). On the other hand, the differences in the category of ambiguity could not be computed because modal verbs, 'won't', or other abbreviations were never used in either pre-training or post-training student simulations, which is why this category is not represented in Figure 2.

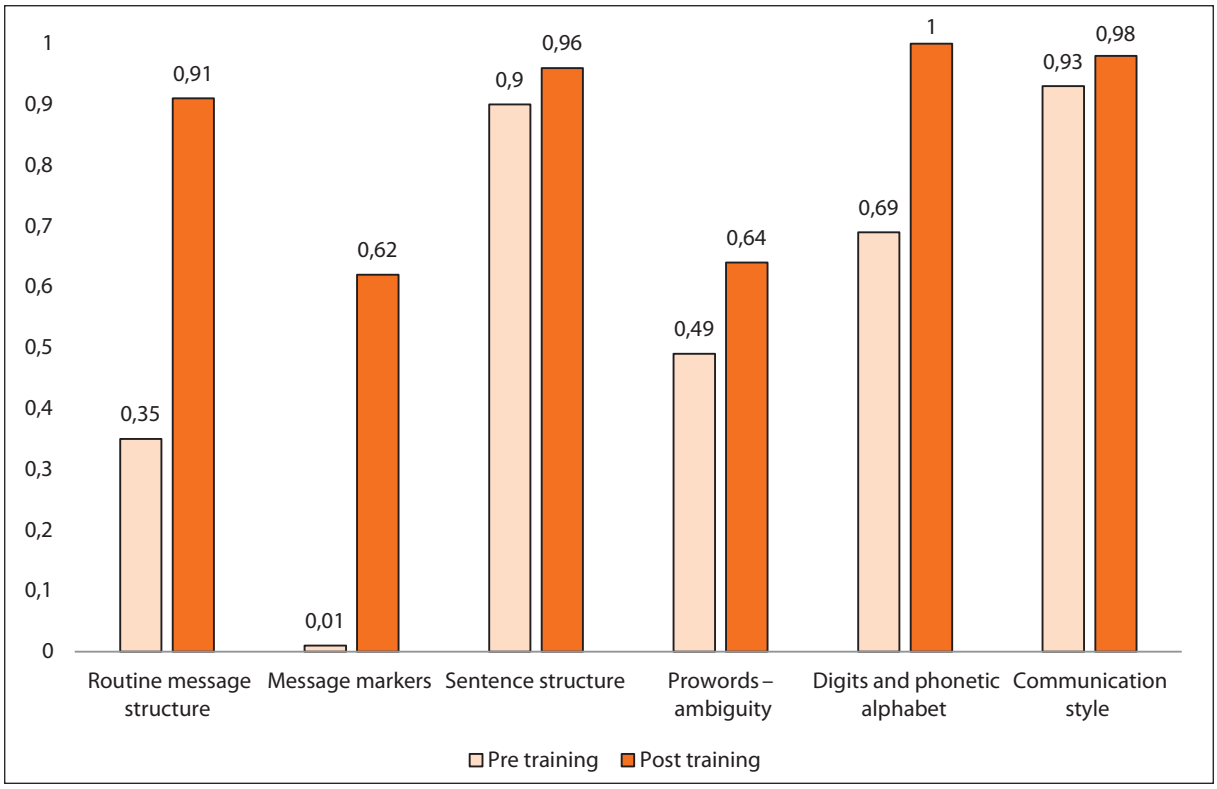

Figure 2. Comparison of routine maritime communication skills scores before and after training.

Turning to individual variables within these macro-level categories, we can observe statistically significant increases at the $p < 0.001$ level in nearly all cases. In this presentation, we will focus on those values that are not statistically significant, and/or where the rate of compliance does not exceed 85% (Table 3) as these indicate elements where training in routine maritime communication supported by Digimar tools did not yield optimal results.

We can see that the rate of compliance, expressed as the mean value, does not exceed 85% in the post-training corpus for two categories although the changes between the pre-training and post-training corpora are statistically significant. The first such category is message markers. In the post-training corpus, the compliance rate is 71% for the message marker 'question', 33% for 'answer', 56% for 'advice', 78% for 'information', and 46% for 'request'. The second category is prowords used to avoid ambiguity. The compliance rate in the post-training corpus is 64% for 'repeat', 40% for 'say again', and 81% for 'read back'. It is important to note, however, that in many cases the relevant communicative function was fulfilled — for example, the speaker did repeat the content, the receiver was asked to say their message again, or to read back the speaker's message — but alternative expressions may have been used instead of the prescribed prowords (e.g., using 'repeat' in a non-standard way).

Table 3. Comparison of routine maritime communication skills scores before and after training.

	Pre training		Post training		t	Sig
	Mean	SD	Mean	SD		
Routine message structure	0.35	0.32	0.91	0.21	35.320	<0.001*
State addressee	0.46	0.49	0.93	0.24	21.768	<0.001*
This is	0.16	0.37	0.86	0.34	32.751	<0.001*
Identify calling station	0.18	0.38	0.86	0.34	31.824	<0.001*
Over	0.57	0.49	0.99	0.07	20.677	<0.001*
Out	0.30	0.46	1.00	0.00	13.387	<0.001*
Message markers	0.01	0.13	0.62	0.47	25.731	<0.001*
Question	0.01	0.13	0.71	0.45	14.887	<0.001*
Answer	0.00	0.00	0.33	0.48	2.646	<0.001*
Intention	n/a[5]	n/a	n/a	n/a	n/a	n/a
Instruction	n/a[6]	n/a	n/a	n/a	n/a	n/a
Advice	0.00	0.00	0.56	0.50	n/a[7]	<0.001*
Information	0.02	0.14	0.78	0.41	14.625	<0.001*
Request	0.00	0.00	0.46	0.50	9.643	<0.001*
Warning	0.00	0.00	0.00	0.00	n/a[8]	n/a
Sentence structure	0.90	0.20	0.96	0.12	6.760	<0.001*
Subject + verb + object	0.96	0.17	0.94	0.21	1.691	0.046*
One phrase – one event	1.00	0.00	1.00	0.00	n/a[9]	n/a
Fully worded questions	0.87	0.33	0.94	0.23	1.783	0.038*
Fully worded answers	0.82	0.38	0.89	0.30	1.147	0.127
Ambiguity	0.00	0.00	0.00	0.00	n/a[10]	n/a
Modal verbs	0.00	0.00	0.00	0.00	n/a[10]	n/a
Won't	0.00	0.00	0.00	0.00	n/a[10]	n/a
Other abbreviated forms	0.00	0.00	0.00	0.00	n/a[10]	n/a
Prowords – unambiguity	0.49	0.49	0.64	0.47	2.364	0.009*
Repeat	0.52	0.50	0.64	0.48	1.161	0.124
Say again	0.00	0.00	0.40	0.49	4.954	<0.001*
Read back	0.00	0.00	0.81	0.39	n/a[11]	n/a
Digits and phonetic alphabet	0.69	0.45	1.00	0.00	10.656	<0.001*
Digits	0.61	0.48	1.00	0.00	11.401	<0.001*
Phonetic alphabet	1.00	0.00	1.00	0.00	n/a[12]	n/a
Communication style	0.93	0.13	0.98	0.06	8.488	<0.001*
Formality	0.91	0.28	0.96	0.17	4.167	<0.001*
Pace	0.95	0.21	0.99	0.04	5.466	<0.001*
Clarity	0.94	0.23	0.99	0.06	5.671	<0.001*

[5] t cannot be computed because at least one of the groups is empty. This study analyses only the VTS operator's compliance in student simulations while the message marker 'intention' can only be used by vessels.

[6] t cannot be computed because at least one of the groups is empty. None of the scenarios used in student simulations contained content where the message marker 'instruction' would have been used.

[7] t cannot be computed because at least one of the groups is empty. The message marker 'advice' was never used in the pre-training student simulations.

[8] t cannot be computed because at least one of the groups is empty. None of the scenarios used in student simulations contained content where the message marker 'warning' would have been used.

[9] t cannot be computed because the standard deviations of both groups are 0. In both corpora, the students consistently complied with the recommendation that each phrase needs to contain a single event.

[10] t cannot be computed because at least one of the groups is empty. Modal verbs, 'won't', or other abbreviations were never used in either -pre-training or -post training student simulations.

[11] t cannot be computed because at least one of the groups is empty. 'Read back' was never used in pre-training student simulations.

[12] t cannot be computed because the standard deviations of both groups are 0. In both corpora the students consistently used the phonetic alphabet when required.

5. DISCUSSION AND CONCLUSION

The main objective of this study was to establish statistically significant improvements in maritime communication skills following the integration of Digimar tools in the routine maritime communication training among students of nautical studies at the Faculty of Maritime Studies and Transport, University of Ljubljana, Slovenia.

First of all, the results indicate statistically significant improvements in the routine maritime communication skills among this group of students across all observed categories, i.e., routine message structure, message markers, sentence structure, prowords designed to prevent ambiguity, digits and phonetic alphabet, and communication style. This also means that the compliance rates in student simulations with the standard protocol of routine maritime communication were considerably higher than those reported in studies based on authentic routine maritime communication data (Boström, 2020; Dževerdanović-Pejović, 2020; Jurkovič, 2022; Perea-Barberá & Parada Galindo, 2020; Pritchard & Kalogjera, 2000), as well as in studies of student simulations where participants had not received any explicit training in routine maritime communication prior to data collection (John et al., 2019).

However, the results also point to certain elements of routine maritime communication that possibly did not receive sufficient attention during the training, in particular message markers and prowords used to avoid ambiguity, where the rate of compliance in the post-training corpus did not exceed 85%. These results might be attributed to the insufficient focus placed on the use of chatbots. As described in 3.2. Corpus of student simulations, the chatbots were designed to support the application the routine maritime communication standards in simulated exchanges, which requires higher order thinking skills (i.e., application) than instructional videos at the basic level (remembering) and at the advanced level (understanding and application) (see Bloom et al., 1956). However, the students were only introduced to chatbots and encouraged to use them autonomously in a self-regulated manner outside regular classroom hours while several instructional videos were used in a teacher-led interactive manner in class.

This is particularly important because failure to comply with the elements in these two categories might bear the highest inherent navigational risk. In fact, message markers can be used efficiently also when critical situations start developing (IALA, 2022a; IMO, 2001; Perkovič et al., 2023) to facilitate the understanding of the message on the part of the receiver. In addition, the prowords 'repeat', 'say again', and 'read back', and the communicative acts enacted by them have the inherent potential for avoiding ambiguity and therefore navigational risk.

Future research in the domain of routine maritime communication may take several directions, which would also address some of the limitations of the present study. First, corpora of student simulations should be compared with pre- and post-training corpora of authentic routine maritime communication of VTS operators to identify key similarities, differences, and shortcomings. Most importantly, in this study, the training in routine maritime communication was teacher-led and only supported by the use of Digimar tools. Thus, the effectiveness of these tools for autonomous and self-directed learning requires future investigation.

Furthermore, a longitudinal study involving a post-training spoken corpus recorded among the same group of students after one year would allow for an examination of the long-term effectiveness of the training. In addition, new simulation scenarios could be developed to encourage students to use elements of routine maritime communication that this study could not evaluate (e.g., the message markers 'instruction' and 'warning'). It should be reiterated, however, that the scenarios used in this study were based on authentic communication exchanges in the local geographical context.

Finally, another potential target group for such training includes maritime pilots, who are alongside VTS operators the other principal communication agents in routine maritime communication in English with bridge teams, particularly ship masters. Training tailored for pilots and subsequent comparison of pre- and post-training corpora would also support the research-based identification of necessary extensions to the Standard Marine Communication Phrases (IMO, 2001) for pilotage and tug assistance, as previously proposed by Čulić-Viskota (2014).

Acknowledgements: This research was partly funded by Erasmus+ Digimar (2023-1-SI01-KA220-HED-000151704). This research was partly funded by the Slovenian Research and Innovation Agency (L7-60164).

Conflict of interest: None.

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