SIMULATOR-BASED TRAINING FOR MARITIME OPERATIONS: A COMPARATIVE STUDY

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Abstract Maritime simulator-based training has attracted considerable attention in recent years. Most of the nautical institutions incorporate simulators for seafarer training. To fulfill the maritime educational requirements globally, the International Maritime Organization (IMO) ensures corresponding training requirements for all maritime educations through the STCW regulations. However, the STCW requirements regarding obligatory simulator training simply concern Automatic Radar Plotting Aid (ARPA) and Electronic Chart Display and Information System (ECDIS) training. IMO has published the model course 6.10 - *Train the simulator trainer and assessor*. The model course is a guideline and aims to promote uniformity in the simulator training. Nevertheless, the model course should not be "*implemented blindly*", since one should acknowledge the institutions own resources and apply them in an appropriate way. Consequently, some variation in different institutions simulator training is expected. The objective of present study is to discover how such variations exist in the European full mission simulator training facilities. Semi-structured interviews were conducted to clarify each of the participating institution´s simulator training design. The interviews comprised of relevant performance indicators - e.g., Identical elements and feedback- selected after a detailed literature review. The findings present interesting variations and similarities in the European simulator training related to the designated performance indicators. Subsequently, the European full mission simulator training was found to differ, depending on whether or how, the designated indicators have been implemented.

Keywords: Maritime Education and Training, EU maritime institutions, Performance Indicators, Comparative study

1. Introduction

Simulator-based training is now widely used by maritime institutions for nautical training programs. Simulator training can introduce different complexities depending on the simulator´s fidelity [1]. The full mission simulator is described as one of the most complex simulators with a high fidelity. The full mission simulator introduces the student to complex tasks that require teamwork [2]. Therefore, a full mission simulator introduces the student to realistic tasks most similar to reality [2-4]. To fulfill the maritime educational requirements globally, the International Maritime Organization (IMO) ensures corresponding training requirements for all maritime educations through the STCW regulations. However, there are difference in training facilities available in IMO member states and therefore a variation in implementation of regulations and quality in maritime training is expected in different states. Such variation, although expected, has not been studied by academia sufficiently.

The present study aims to compare the simulator training used in different nautical bachelor educations in different states within Europe. The simulator instructors from six nautical institutions in different countries were interviewed. The comparison includes countries approved and listed on the STCW *"white list"* as specified by latest revision; *MSC.1/Circ.1163/Rev.9*. The study will not evaluate the simulator training in relation to specific STCW requirements, but instead, measures variations in the simulator training based on performance indicators selected from a relevant literature review. Since the main purpose of a nautical bachelor education is to educate future bridge officers to operate a vessel, the comparative study focused on the full mission simulator training. [5]. The following research question was the focus of study to support the research platform for the global maritime training programs:

"How does the full mission bridge simulator training deviate among European countries?"

2. Performance indicators

A total of 8 performance indicators were identified. However, a detailed analysis of variation between the training facilities on these indicators will be available in a subsequent journal article. For the purpose of this paper, 2 relevant performance indicators were identified for elaboration, they are: Identical Elements, and Feedback.

2.1 Identical Elements

The theory of identical elements emerged from Thorndike and Woodworth [6]. They argued that transfer of training would occur easily if the first activities in a training scenario

had identical components and tasks, as the following activity performed in real life. Therefore, a simulator training with as many identical elements as possible to reality could increase the transfer of training [3]. When establishing identical elements for a maritime simulator-based training, one must therefore look at the activity performed in real life [6]. During the bridge watch, a proper look-out shall be kept at all times [7]. The officer on watch can operate the bridge alone, except during; "*reduced visibility, costal navigation, increased traffic or other special conditions"* [8]. Subsequently, 1-2 persons usually operate the bridge. Thus, an identical training scenario in the simulator should include 1-2 students in each bridge [3, 6-8].

2.2 Feedback

An important training skill during simulator training is the use of feedback [9]. A simulator session is suggested to include 4 main steps; *Briefing*, *Planning*, *Simulator Exercise* and *Debriefing*. The briefing should introduce the students towards the exercise to be executed, the objectives, and how these are covered in the exercise. After the exercise, the students usually meet the instructor for a debriefing session, preferably all together in a classroom, where the instructor has the possibility to play back the session. The debriefing is for the students to receive feedback about their performance, to review their own actions, and to learn from each other [9]. However, students can also come to rely too much on these tutoring tools [10]. If such a scenario would occur, it could reduce the understanding, instead of increasing the knowledge of the students. Such scenarios can be prevented by the instructor as long as s/he´s aware of when and how much guidance and feedback to give. This can also be called *"fading",* where the complexity slowly increases by *"gradually withdrawing tutoring support from the training process"* [10, p. 132].

3. Methodology

The research aims to understand simulator training in the participating countries, and how their facilities construct the specific training. Consequently, a qualitative research method is utilized in this research. Furthermore, since this study aims to understand how different institution´s perceives the phenomenon; *full mission simulator training*, A hermeneutic phenomenological method is utilized.

The data was collected through a semi-structured interview based on an interview guide [11]. The samples were selected based on specific parameters. All samples had to be located in different countries within Europe, presented in the *MSC.1/Circ.1163/Rev.9.* Additionally, they had to facilitate classes of approximately 30 students, increasing the comparability. Six

institutions were selected, with eight informants constituting a stratified sample of key informants. The main criteria for selecting them as key informants was the fact that they are all simulator instructors.

This study utilizes a *top-down perspective* where the theoretical concepts are defined first with respect to performance indicators and subsequently, the codings are presented (See Table 1). Since the codes are predefined, the coding is deductive.

Table 1 Codings for data analysis

Main Codings	Sub Codings	Literature sources
Identical Elements	Nr of bridges Nr of students/bridge Nr of instructors	[3, 6-10]
Feedback	Briefing Debriefing	[9, 10, 12, 13]

4. Results

The simulator facilities at six participating institutions (termed as Cases) displayed some variation with respect to the identified performance indicators: Identical elements and feedback as illustrated below.

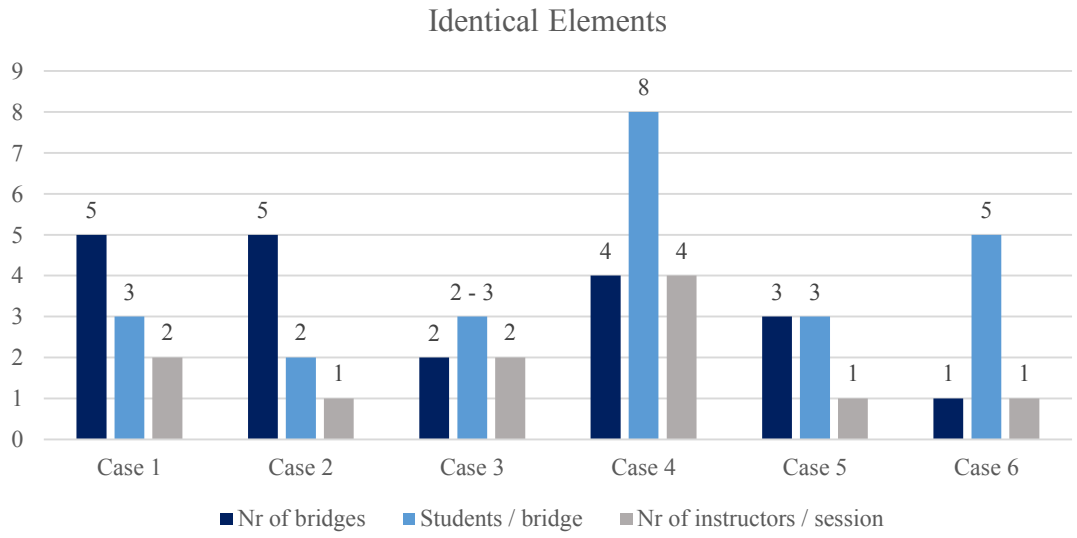

Figure 1 Identical elements

4.1 Identical elements.

Case 1´s full mission simulator consists of 5 bridges, with 3 students in each bridge. The simulator training is monitored by 2 instructors. Usually one instructor is monitoring the 5

bridges from the instructor room with the use of cameras located in each bridge. Furthermore, the second instructor can enter the bridges to support the students, or act as an external person, for example as a pilot. Case 2´s full mission simulator consists of 5 bridges, with 2 students in each bridge and the simulator training is monitored by 1 instructor. In the beginning of the course the instructor participates in the bridges and intervenes in the training. However, successively, the instructor decreases the intervening. Case 3´s full mission simulator consists of 2 bridges, with 2 students in each bridge during the watch officer course. However, 2 extra students' works as "relieving officers". During the ship-handling course each full mission bridge contains 3 students. The simulator training is always monitored by 2 instructors which try to get the students to "*learn by doing"*, and by reflecting on their performance. Case 4´s full mission simulator consists of 4 bridges, with 8 students in each bridge. The simulator training is monitored by 4 instructors. The informant explained that the instructors mostly stay in the bridges with the student´s, but sometimes leaves them alone for 5 – 10 minutes. Case 5´s full mission simulator consists of 5 bridges, however, only 3 bridges are utilized for the students. The informant described the bridges to hold 3 students each, however each group were originally consisting of 4 students. 1 student from each group were described to be taken out, subsequently, founding a communication group. Furthermore, the simulator training is monitored by 1 instructor. The instructor monitors the students during the exercise and tries to intervene as little as possible to enhance self-learning. Case 6´s full mission simulator consists of 1 bridge, with maximum 5 students. The simulator training is monitored by 1 instructor. During training, it was explained that the instructor interacts with the students via for example intercom and VHF.

4.2 Feedback.

For Case 1, The briefing was explained to occur before the exercise where the instructor describes the task they are going to perform in depth. After the exercise, an internal debriefing is conducted by the students in each bridge, followed by a debrief in the classroom. All exercises are replayed and the students can see each other´s performance. For Case 2, The simulator training always starts with a briefing where the instructor explains the exercise, and different ways to approach it. After the exercise a debriefing is executed together with all students in a classroom. Information regarding what was good, and how they can improve are given to the students. Additionally, a strategy which involves thanking students who might have done mistakes is utilized. This strategy is exploited to teach the students that mistakes in a simulator is not dangerous. More importantly, both themselves and others can learn from their mistakes. All exercises were recorded as AIS-targets and

replayed during the debriefing. Furthermore, all groups performances were described to be discussed in the debriefing, among the students themselves, and among the students and the instructor. For Case 3, The briefing is mainly conducted at the first day of the course, afterwards the simulator training simply includes exercises and debriefing. After the simulator exercise the students must reflect on three questions: *"What did you do well, what could you do differently, and what have you learned?"*. Then, the student´s sailings are replayed in a classroom where the students must elaborate on the three questions asked earlier in the session. For Case 4, Briefings were described to be performed before every exercise, regarding the objective´s for the exercise, and the different scenarios. The debriefing was described to occur after all simulator exercises in the briefing room. There, the exercises are replayed, and the students are given information about what to improve. For Case 5, The simulator training usually does not start with a briefing but with a debriefing from last weeks' exercise, conducted by the students. It was mentioned that debriefings had been done by the instructor in previous years. However, the conclusion was that *"the outcome was zero"*. During the week the designated group will prepare for the debriefing. The group will receive the replay of their exercise in combination with some suggestion regarding what they should focus on. Finally, at Case 6, Every simulator session was described to start with a briefing. The student´s receive information regarding the weather, ship data, possible faults and the routing. After the simulator session is completed, it was described that everyone will meet for a debriefing. The instructor and the student´s will analyze their performance with the use of the recorded exercise.

The results for both performance indicators: Identical elements and feedback are summarized below in Table -2.

Table 2 Summary table of findings

Main Codings	*Sub Codings*	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Identical elements	Nr of bridges	5	5	2	4	3	1
	Nr of students / bridge	3	2	2-3	8	3	5
	Nr of instructors / session	2	1	2	4	1	1
Feedback	Briefing	Yes	Yes	No	Yes	No	Yes
	Debriefing	Yes	Yes	Yes	Yes	No	Yes

5. Discussion

5.1 Identical Elements

As we can see in Table 2, there exists a variation regarding how many students each case encompassed in their simulator bridges. Furthermore, four cases; 1, 2, 3 and 5, facilitated 2 - 3 students / bridge, in comparison to case 4 and 6, which facilitated 5 – 8 students / bridge. The IMO model course 6.10 clearly states that the student´s must be introduced to identical scenarios to reality [9]. Case; 1, 2, 3 and 5 utilizes approximately the same amount of student´s in each bridge as they would be in a real world scenario out at sea. This indicates that the trainings are organized in a way to present the students to as identical scenarios as possible with the activities performed in real life [6, 9, 10]. Case 4 and 6 performs their training with 5 – 8 students / bridge. This indicates a negative transfer of training with a lack of identical elements [3, 7-10, 14]**.**

Furthermore, the IMO model course 6.10 recommends that the simulator training should include minimum 2 experienced instructors [9]. The number of instructors varied from 1 respectively 4. Case 1 and 3 utilized 2 instructors during the simulator training, in accordance to the IMO model course 6.10 [9]. Half of the cases; case 2, 5 and 6, utilized 1 instructor during their simulator training´s, which is below the recommended minimum requirement. However Case 4, utilized 4 instructors, which exceeds the minimum requirement, and could therefore be seen as a beneficial amount of instructors [9]. Nevertheless, if we look at the instructors intervening, it was mentioned that case 4´s instructors barely leaves the student´s alone in the bridge´s. This indicates that the student´s might come to rely too much on the instructors [10]. This suggests that the students in case 4 does not get the opportunity to practice any, or almost no, experiential learning, which could result in a reduced understanding, due to a reduced independency [9, 10].

Case 1, 2, 3 and 5, all mentioned a dynamic intervening where the students were alone at the bridges, indicating an encouragement of experiential learning. In addition, each of these case´s tried to guide the students, make them aware of situations, and described how they could discuss different solutions together with the students [10]. The experiential learning in case 3 and 5 is suggested since both mentioned *"learning by doing"* and *"self-learning"* as an important factor to be aware of when interacting with the students [10, 15]. Case 1 described the second instructor to enter the bridges as for example a pilot, or as an instructor to support the students, indicating the utilization of guidance [10]. The providing of independency for the students in case 1 is also suggested, since there is only one instructors intervening in 5 bridges, enabling experiential learning [10]. Case 2 described how the

instructor tries to reduce the interaction further on in the training and subsequently, tries not to intervene at all. This could reduce the risk of the student´s relying on the instructors to guide them and successively, improve the student´s performance and experiential learning [10].

Case 6 described the interaction to occur via the intercom or VHF, indicating a low personal interaction with the student´s in the bridges. Thus, indicating high experiential learning for the students. On the other hand, the absence of personal interaction might occur due to the fact that only 1 instructor is utilized during the simulator training [9]. Consequently, due to the absence of personal interaction, this indicates that the student´s in case 6 receives less guidance during the simulator training, reducing their understanding [10].

5.2 Feedback

The briefing was analyzed to be conducted by case 1, 2, 4 and 6, as can be seen in Table 2. The reason for this conclusion steams from the IMO model course 6.10, where a simulator session is suggested to include *briefing, planning, simulator exercise and debriefing* [9]. Consequently, a simulator session is suggested to start with a briefing, which four of the designated institutions complied with.

The simulator exercise was followed by a debriefing in five out of six cases; 1, 2, 3, 4 and 6. Case 5 was described to have a debriefing done by the students in the beginning of the next simulator session. Nevertheless, it was mentioned that the debriefing had been performed by the instructor in previous years, yet the outcome of this was close to zero. This could indicate that the previous debriefings performed by the instructor was conducted in an insufficient way. Primarily since feedback is found as an important tool to influence learning, and as an important part of a debriefing [9, 12]. However, this also suggests that the debriefings performed by the students may in fact enhance their learning outcome, due to an increased responsibility and hence, interaction when performing the debriefings [16]. Postponing the student's reflections until the next week as in Case 5, could however reduce the learning outcome. This is suggested since the memory of their performance could have faded and subsequently, is not as specific as if one had performed the debrief directly after the exercise.

If we look at the other cases which were found to perform the debriefing in compliance with the literature review. There is still a great variety in how the debriefings are performed and how the feedback is given. Case 1 described their debriefing to contain two distinctive segments, one internal debriefing, indicating that each group gets to reflect on their own

performance [9]. Followed by a debriefing with all the students, which suggests that all students can learn from each other, in combination with received feedback from the instructors [9]. Case 2 performs a debriefing in the classroom together with all the student´s. It was described that a strategy of thanking students who might have made a mistake was utilized, since everyone can learn from this. Furthermore, this could be related to the theory of Dewey [15], *"learning by doing"*.

Case 3 explained that the students must reflect on three questions – e.g., *what did I do well, what could I have done differently, and what have I learned*, after leaving the bridge. These questions can be related to the three questions; *where am I going, how am I going* and *where to next* by Hattie and Timperley [12], Black and Wiliam [13]. By asking these three questions the students must reflect on their performance, and thereby, enhancing their understanding [9, 12, 13]. The sailings are replayed, feedback is given to the students, at the same time they must share their three question´s with each other [9]. This indicates that the student´s learn from each other by sharing their reflections regarding their own performance [9]. Case 4 and 6 was described to replay their exercises, where the students receive feedback regarding their performance.

5.3 Limitations

Some limitations of the study deserve attention due to research design. They would include the interpretation with respect to language, as English was used for all the participating institutions which was not native language for some of the institution. Furthermore, due to time-limitations and other factors, this study did not utilize observation as a method. Which could have been beneficial to understand each institutions simulator training in actual conditions, reducing the possibility of imprecise data collected from the informants. Finally, the scope was limited to only European countries. Future studies, with more participating countries and deeper investigation of listed performance indicators will add to increased understanding of variations across institutions and their effect on maritime training.

6. Conclusion

The objective of this study was to explore different institution´s full mission simulator training as a phenomenon. Since there are limited regulations regarding simulator training, thus, an existing variation between different institutions simulator training was suggested. The selected performance indicators; Identical elements and feedback, were found to deviate depending on how the different cases had implemented these indicators in the training.

Subsequently, even though some simulator trainings in Europe appears to be performed similar due to comparable proceedings, the implementations of these proceedings create dissimilarities. This study paves the way for deeper understanding of differences in the training facilities amongst the EU maritime institutions and subsequently this work is a step towards implementation of homogeneous quality in maritime simulator education across the STCW member states.

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