METHODS AND PEDAGOGY OF MARITIME SIMULATOR TRAINING

CoMET Project Report on Guidelines for Simulation Education used in Joint Training

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FOREWORD

This report is the second part of the CoMET project report series on developing cross-border simulator training between partners in Finland and Estonia. The aim of the CoMET Project (Internationally Competitive Maritime Education for Modern Seagoing and High Quality Port Service, CB 714) is to connect maritime simulator centres across the Baltic Sea. Simulator connectivity enables students to train within same virtual learning environment.

This report is conducted within the Work Package T1 framework for the development of simulation methodology and pedagogy. The report aims to establish the pedagogical and methodological principles to be applied in the joint simulator exercises.

The first article of the report includes a comparative study of safety-critical industries,their use of simulation as an educational tool and the process of constructing competence. The second article describes the methods and practices of planning and executing simulation training, focusing on the previously established learning objectives. The third article explores the best practices and recommendations based on interviews. The fourth article summarizes the guidelines for joint simulator training based on the previous articles and the project partners' expert workshop in simulation training.

The CoMET project is financed by the European Regional Development Fund under the Interreg Central Baltic Programme and carried out as a joint venture with the project partners Ida-Virumaa Vocational Education Centre (IVKHK) and Tallinn University of Technology (EMERA) in Estonia and the Joint Authority of Education of Kotka-Hamina Region Group (Ekami), Novia University of Applied Sciences (Aboa Mare) and South-Eastern Finland University of Applied Sciences (Xamk) in Finland.

The authors wish to thank the financier and all the project partners for their contribution to the project and this study. A special acknowledgement is extended to the maritime experts participating in the interviews and to the simulator educators and specialists who took part in the development work and the project workshop.

Antti Lanki, Vesa Tuomala, Arto Helovuo & Patrik Nyström

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ABOUT THE AUTHORS

The articles of this report are written by specialists and educators in the aviation, healthcare and maritime industries. One of the core principles of the articles was to collaboratively discuss, combine and analyse the theoretical principles that are found in simulation-based education and training in all of the aforementioned industries. As a result, in the first article a summary of the pedagogical framework and a formula of the learning process was established through an interdisciplinary consensus based on literature and experience. This principle is also used in the second article of this report in relation to methods and practices.

Arto Helovuo is the captain of an Airbus A350 and Head of Training at Finnair Flight Academy. He has gained extensive experience in developing safety management and training in high-risk environments, bringing the lessons from aviation to other safety-critical industries. *Patrik Nyström* is a former director of a simulator centre within the healthcare sector. He holds an MSc degree in human factors and system safety, and he has been heavily involved in the field of simulation since 2004. Patrik has been running many train the trainers courses, both nationally and internationally, and his special interest is the implementation of safety understanding and behaviour in simulator learning. *Antti Lanki* is a Senior Lecturer at the South-Eastern University of Applied Sciences with a Master Mariner background and seagoing experience. He holds an MSc degree in Maritime Management and has conducted and developed maritime simulator training since 2014. *Vesa Tuomala* works as a project manager for logistics and maritime projects in the South-Eastern University of Applied Sciences. He has a long business management career in the ICT sector and maritime experience from passenger and cargo vessels. He is a Master Mariner, holding an MBA degree in strategy, marketing and projecting from Henley Management College.

CONTENT

SIMULATION-BASED LEARNING IN SAFETY-CRITICAL INDUSTRIES – AN OVERVIEW OF SIMULATION PEDAGOGY AND CONSTRUCTING COMPETENCE

Arto Helovuo, Patrik Nyström, Antti Lanki

Safety-critical industries (later: SCI) are defined as industries in which safety is of paramount importance and where the possible consequences of a failure or malfunction include loss of life or a serious injury, serious environmental damage, or harm to plant or property (Wears, 2012). Commonly named examples of such industries are commercial aviation, healthcare, nuclear power plants and the maritime industry. In terms of education and training in safety-critical industries, simulation and simulators are utilized as one of the main methods of learning and competence development.

SIMULATOR TRAINING IN SAFETY-CRITICAL INDUSTRIES

The safety-critical industries are dependent on educated, qualified and competent workforce. This sets high requirements and criteria for pedagogical approaches and methods. Moreover, the nature of operations in safety-critical industries also sets limitations for learning in actual operating environments. Where real-life lessons are often a significant tool in competence development, alternative ways of learning must be applied in SCIs in order to assure operational safety. Therefore, simulators are widely used for competence development in SCIs. Simulations allow the participants to deliberately undertake high-risk activities in a safe environment. Furthermore, simulations allow SCI professionals to develop the skills they need to manage critical situations which normally – and hopefully – are never encountered in real life, but for which they must always be prepared.

In this paper, we examine the use of simulations in safety-critical industries and study the pedagogical concepts and aspects of the learning process in a simulated environment.

The selection of industries included in this overview is not claimed to be a comprehensive or complete list of all industries (SCIs) representing high-risk sectors or using simulation as part of their training regime. The selection is based on the industries' affiliation and applicability to simulation training used in the maritime industry.

AVIATION

Aviation is commonly acknowledged as a pioneering field in simulator training. The history of simulator training in aviation dates back to 1929, when Edwin Link built his first Link Trainer. The device had a basic set of instruments, a primitive motion platform, and no visual display (Lee, 2009). The reason for training with the simulator was that too many accidents happened in the initial phases of flight training. The simulator provided future pilots with an opportunity to grasp an initial understanding of the basics of flying before entering the cockpit of a real aircraft, and the resulting impact on safety was significant. The use of flight simulators as a substitute for training in an actual aircraft has since become an integral part of pilot training worldwide. Today's flight simulators replicate a real aircraft to an extent where transition training from one aircraft type to another can be completed simply by using a certified flight simulator. In modern aviation, flight simulators are used from "cradle to grave" – they play an important part in the initial phases of training as well as in the annual recurrent training until the end of the pilot's career.

In the beginning, simulators were mainly used to train the basics of flying, i.e. the use of flight controls and instruments. Gradually, the simulators improved and could represent the operation of aircraft systems precisely enough to allow for detailed training in cockpit procedures and handling of system failures. The development of simulator motion systems has been the final milestone in the evolution of flight simulator technology. With an advanced motion system, the flight characteristics can be simulated so realistically that training on an actual aircraft is no longer required (so-called "zero flight time training") (EASA, 2019).

Where the typical image of a flight simulator is usually a device with a motion system, full cockpit and high-fidelity visual system, there is great variety in how simulations are applied in pilot training. Part task trainers which can be run on tablets or virtual reality applications to familiarize trainees with the external pre-flight checks around the aircraft are also examples of simulator training in aviation. However, full mission simulations are still the core of pilot training and the cornerstone of the extremely high level of safety in aviation.

HEALTHCARE

Simulations in the field of healthcare include a broad concept of activities in many different domains of expertise, and the related training involves many different professions.

Early signs of the use of simulators in healthcare can be traced as far back as to the first models of organs that were used to train surgical skills. Hippocrates and Aristotle have already described the skills needed to be trained in medicine. References to the use of a "simulator" in an educational delivery course can be found from 1740 (Owen, 2016). Today, many of these historic "simulators" would be called part task trainers for skills training. The development of modern simulators started in the early 1960s with resuscitation trainers, which then evolved during the eighties and nineties to high-fidelity, computer driven, manikins (Bradley, 2006).

In the beginning, simulation training in healthcare revolved around training individual skills and knowledge of acute healthcare settings, including anaesthesia, a known high-risk domain. Since then, simulation activities have spread across all the domains of healthcare, and today, they form a part of both pre- and postgraduate training. Moreover, the healthcare sector has also adopted many of the safety ideas from aviation.

The special feature of simulation training in healthcare is that simulators are used in many different ways and for many reasons. Gaba (2004) categorizes the diversity with 11 dimensions: aims and purposes of the simulation activity; unit of participation; experience level of participants; type of the skills, attitudes or behaviour addressed; simulated patient's age; technology applicable or required; site of simulation; extent of direct participation; and applied feedback method.

NUCLEAR

Development of the first models of nuclear power plant (NPP) simulators began in the 1970s in correlation with the development of computers. In the beginning, the simulators were not always copies of the real plant. During the 1980s, safety authorities established more requirements for training and emergency operating procedures and launched the use of the Systemic Approach to Training (SAT). The simulators were developed to be more plant-specific, and the training became more specific and regulated. Greater emphasis is now put on the soft skills, such as communications, decision-making and teamwork, while the technical aspects are still also emphasised. The focus of the learning objectives has been moved towards analysis and synthesis instead of skills and knowledge, and training programmes have become an integral part of overall training for a variety of NPP jobs. (IAEA, 2004)

At present, nuclear power plants are constructed using simulation as a design tool. The control panels, user interface and operation logic of the plant are simulated in the early stages of plant construction, and various scenarios of operating the plant are tested with simulators before making the final design decisions. As a result, all relevant aspects – including potential human errors – can be covered in the planning process and appropriate risk mitigation measures can be applied.

MARITIME

The first simulators in the maritime industry appeared in the 1950s. They were mainly based on the research and development done in the military (navy) and were simple skill stations for marine radar training. The first navigational bridge type simulators were developed in the 1960s and 1970s and were used for training in navigation, passage-planning and ship handling (Eda et al. 1996). Today, simulators are an established training method in the maritime industry and are used in not only bridge operations but also in cargo handling, engine control, towing, anchor handling and VTS (Vessel Traffic Service) operations – just to name a few (Sellberg 2016). Furthermore, the use of simulators in MET (maritime training and education) is incorporated into the international regulations and standards of training (STCW) (IMO 2017). The maritime simulator facilities ashore enable the training of competencies in a time and place outside of actual shipboard (or on-board) training, which typically takes place on commercial vessels and depends on the schedules set by the shipping companies and operators.

In terms of technology, maritime (bridge) simulators are becoming more and more akin to flight simulators with authentic control systems, high-fidelity visual systems and motion platforms. The main difference is still the lack of type-specificity found in aviation, as every ship is somewhat unique and even sister-ships may differ (for example) in their instrumentation. Meanwhile, in healthcare the emphasis on the human element is ever increasing. The main difference is found in the nature of human interaction and communication on-board. Due to these points, the underlying competencies of the maritime professionals should be even more critically examined, highlighted and developed, both from a technical and non-technical point of view, incorporating the best pedagogical aspects obtained from the other SCIs.

LEARNING IN A SIMULATED ENVIRONMENT

Learning in a simulated environment is based on a constructivist educational theory and, furthermore, learning by doing and gaining experiences which mimic real-life events and situations. Active participation, opportunities to apply knowledge, and feedback for one's own actions form the basis of this process. Learning takes place as a consequence of one's own actions, which results in a long-lasting memory trace.

Learning occurs in three domains – cognitive (thinking), affective (attitudes) and psychomotor (physical skills) – which contain taxonomies (classifications) that proceed from simple to complex competencies and are typically described with a verb such as identify, explain, imitate, or analyse. The cognitive domain with its associated taxonomies was first published by Benjamin Bloom (in 1956), followed by the affective domain by Krathwohl (in 1964) and psychomotor by Dave (in 1970) and Harrow (in 1972). (Krathwohl 2002:

212–218.) In the field of simulation learning practice, these domains are sometimes arranged in various other ways, one of which is: Knowledge, Skills, Attitudes and Behaviour (later: KSAB).

Simulator training that started from a pure skills training perspective has now become an important tool to train, develop and learn the whole range of KSAB for both regular, daily needs and rare events that may occur seldom but are crucial to handle correctly when they do.

This basic theory of learning and pedagogy applies to all simulator education and training in the safety-critical industries. It is, therefore, possible to construct a compiled framework of the learning process. The framework of experiential learning will include the most up-to-date knowledge and aspects and will serve as a foundation for developing high-quality simulator training in practice.

FRAMEWORK OF THE EXPERIENTIAL LEARNING PROCESS IN SIMULATOR TRAINING

For the purpose of this report and the CoMET-project, a theoretical framework describing the learning process and its core elements was created (Figure 1). The framework combines the steps of activity-based constructive learning (Engestöm 1999: 384) with a typical three-phase structure of a simulator exercise (briefing, simulation and debriefing). This framework is used in this report to examine the process of learning in more detail. It also contains the interfaces to real life that should ultimately be applied through transfer.

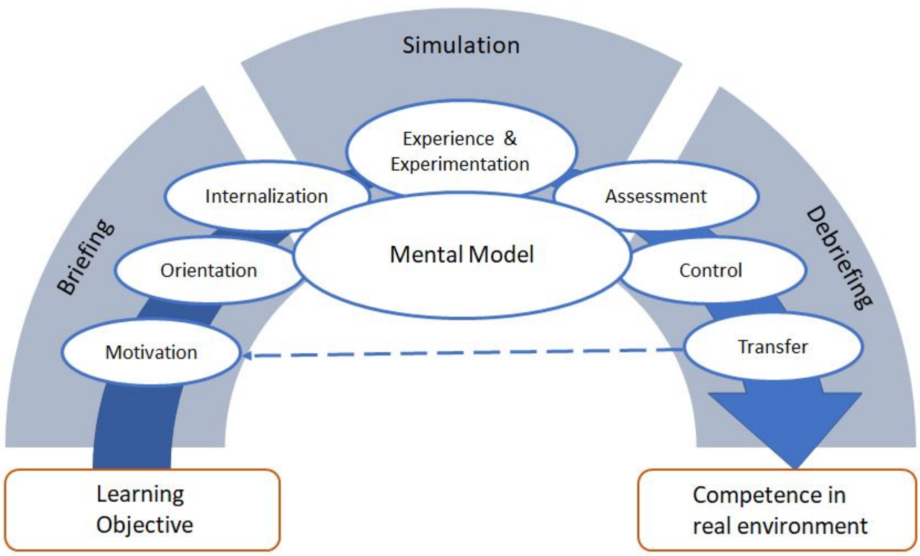

Figure 1. Learning process and the framework of constructing a mental model using simulation education and training.

OBJECTIVES AS THE FOUNDATION FOR LEARNING

Like in any training activity, the process of efficient learning starts with clear objectives. Simulator training is no exception. Since simulator exercises allow for the practical application of competence, the objectives should be defined at a practical level. A simulator exercise consists of one or more scenarios, which are designed according to the objectives. A simple question of *"what should the learner be able to do"* reflects the objective of the scenario. The next, deeper layer in objective setting normally describes *how* something should be done, such as "navigate *safely* through a shallow pass". This describes what the learners should be able to do after they have completed the scenario.

The SMART acronym is a handy guideline when creating suitable and well-defined learning objectives. SMART means: Specific – what is to be trained is defined, Measurable – how to know that the target is reached, Attainable – a reachable level is set, Realistic – for the participant and for the real work, Timely – reachable within the time available. (Lawlor 2012.)

The principle of defining the objective for the training is simple, if the same exact situation is anticipated in real life. This is unfortunately not often the case, especially in safety-critical industries where simulator training is used to prepare trainees for seldom occurring hazards and abnormalities. These type of situations cannot be fully anticipated or trained for. The trainees are required to stretch their abilities to manage situations beyond the exact scenarios used in their training. For this reason, SCIs are now more and more focusing on safety-critical competencies. The main difference between the traditional approach to simulator training and competence-based training is that the focus on how the trainees operate and what *behaviors* they demonstrate is deemed more important than the actual outcome of the scenario. For example, safe navigation in a shallow passage inevitably requires clear communication of intentions, continuous monitoring of the environment and prompt responses to any deviations from the plan. These safety behaviors are the actual learning objectives of the scenario. Learning these skills will allow the trainees to safely manage any situation in which these competencies are required.

The previous COMET report examined the most relevant and appropriate educational objectives for cross-border simulator training (Lanki 2020). Defining the behavioral-level objectives for these competencies is described further in the next article of this report.

MOTIVATION AND ORIENTATION IN THE BEGINNING OF SIMULATION

In adult education, the motivation of the trainees is usually content driven. They want to learn the skills they feel are relevant for themselves. For this reason, the learning assignments must be both relevant, realistic and useful. Furthermore, the objectives must be clear and they must be understood by the trainees in order to allow them to properly orientate for the exercise. Motivation and orientation go hand in hand. The briefing phase of a simulator session should start with an introduction to the learning objectives, followed by justifications for why the desired skills are relevant. The more deeply the trainees understand the demands of real life and their links to the learning objectives, the more motivated they are to adopt the required skills.

CONSTRUCTING THE MENTAL MODEL

All conscious actions are based on some kind of a mental model. In constructive learning, building, testing, assessing and tuning, the mental model of the required behavior is at the heart of the learning process. In the next paragraphs, we discuss how the mental model gradually develops throughout the simulator exercise.

Internalisation. The development of a mental model starts in the briefing. Trainees are never tabula rasa, but they already have some mental models acquired in the past. This is a basis from which they construct new ones. Learning styles and preferences may vary in the briefing phase, but the key task of the instructor is to describe the desirable behaviour in such a manner that the trainees can develop an adequate mental model of it and are ready to practically apply the model in the simulation phase. A common shortcoming in all simulator training is inadequate internalisation of the expected behaviour before moving into simulation. This impairs learning in many ways. Valuable time in the simulator is lost if the trainees are not ready to apply their knowledge according to the situational demands. As a result, they lose the opportunity to actually experience how the proper behaviour could lead to a successful completion of the learning assignment.

Experimentation. When the mental model is internalised, it is time to put it to a test and see how it works. This process starts when the trainee is exposed to the learning task in the simulator. The applicability and the maturity of the mental model become evident when tested in a realistic situation. The simulator environment often provides instant feedback for the actions taken, and aided by hints and advice provided by the instructor, the trainee can complement, adjust, and reinforce the mental model they acquired in the briefing. As a result, the mental model develops during the exercise to finally reach the level defined as the learning objective.

Experiential learning cycle. As illustrated in the framework, the phases of simulator training overlap with the training process. The purpose is to highlight the fact that internalisation and experiments do not simply belong to the briefing or simulation phase. Similarly, assessment is not only a part of debriefing but begins already in the simulation phase. These three steps of the learning process form an experiential learning cycle which emerges multiple times during the simulation; therefore, it is important that simulation exercises contain a sufficient number of opportunities to practice the expected behaviours. Each time a mental model is applied (experiment), the trainee can see how it works (assessment) and supplement it with new data (internalisation).

ASSESSMENT AND CONTROL

Assessment is an integral part of the experimental learning cycle in which new mental models are gradually developed. Trainees respond to the learning tasks during simulation training with the help of their current mental models and see how they work in the given situation. This provides them with an opportunity to assess the applicability of the model and to identify possible needs for adjustment. Assessment is a continuous process that takes place throughout an exercise and allows the trainees to see the impact of their own actions. The instructor can best facilitate this process by giving brief, direct feedback and indirect hints (Van Heukelom et al. 2010). It is of utmost importance that the trainees comprehend the connection between their actions and successful completion of the learning tasks. This improves their abilities to self-correct and learn effectively from their experiences.

Debriefing is the phase in simulator training that concludes the assessment process. During debriefing, the trainees can reflect upon the recent experience, discuss what went well and identify opportunities for improvement. The reflection process is facilitated by the instructor, but emphasis should be on self-reflection and feedback from peers. Debriefing has a significant role in the learning process as it should provide the trainees with a final comprehension of what happened, why it happened, and what to improve (Issenberg et al. 2005). The trainees' active involvement is important in composing an consistent mental model of the desired performance.

Control of the learning process is tightly linked to assessment. It refers to the trainees' awareness of the learning process and ability to regulate their own learning. With appropriate control of the learning process, the trainees are able to direct their own learning and choose how they fill the remaining gaps between what they know and what they should know. A prerequisite for proper control of learning is understanding how well the mental model meets the real life demands. With this understanding, the trainees can develop strategies to further improve the required skills and to transfer knowledge from the simulator to the actual working environment.

TRANSFER OF LEARNING TO REAL-LIFE

Transfer is a pivotal concept in simulator training. Transfer means applying the learning gained in a simulator to a real operational environment. Artificial learning environments can never replicate real life in all aspects. This difference between reality and simulated reality is best visualised with this equation: Simulation reality = (reality – X) + Y. The Y refers to the ability to change things in the simulator in order to enhance the learning, by re-doing, creating situations that occur rarely and give learners more time to solve a situation (Dieckmann 2009). Special attention should be paid to the adequate transfer of learning if simulator training is used to substitute training in an actual environment. Transfer occurs when something previously learned is applied in a new situation. The new situation usually differs from the earlier experiences and, therefore, transfer can be positive or negative. Positive transfer of knowledge improves the possibilities of successfully managing novel situations. This, previously learned models are useful to cope with similar situations. Negative transfer on the other hand hinders the successful management of a task. At worst, simulator training may lead to hazardous operating models if, for example, the features of the simulator differ from reality so that it reinforces false action patterns.

Obtaining diverse experiences is the best way to promote the transfer of learning. Therefore, simulator training should allow for the rehearsal of skills in varying conditions. The instructor should provide trainees with generalisations, rules and rationalisations that facilitate the transfer of knowledge to a broader scale of situations. Moreover, enforcing the development of metacognitive skills to control one's own learning is also a powerful way to improve transfer. (Salakari 2004: 94–97.)

CONCLUSIONS

This article has reviewed the pedagogical foundation and the framework of the learning process in simulation education. The following conclusions highlight the key messages to anyone involved in the planning, conducting or managing of simulator training.

- Simulator training has an important role in safety-critical industries where demanding situations cannot be safely trained for in real-life settings.
- Learning in a simulator is based on active participation and learning from experience.
- The objectives of training must be clear and emphasise safety-critical behaviours.
- Safety-critical behaviours rely on appropriate mental models.
- Applicable mental models develop through the learning cycle of trial, reflection and adjustment.
- Appropriate variation of scenarios is important to promote the transfer of learning from the simulator to real life.

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SIMULATOR METHODS AND PRACTICES

Patrik Nyström, Arto Helovuo, Antti Lanki

This article focuses on simulation methods and practices from a highly practical point of view. With methods, the authors mean the way of systematically planning and executing the simulation session in order to achieve learning. In the previous report of the COMET project, a list of the six most relevant and appropriate educational objectives for cross-border simulator training was created (Lanki 2020: 21). In this article, we will focus on these six objectives, discuss them as competencies, and examine each of the learning objectives critically from a simulation process point of view. The main questions are: "What are the important things to know when creating simulations around these learning objectives" and "how does that affect each part in the process".

NON-TECHNICAL SKILLS AS A COMPETENCE

The non-technical skills and Crew Resource Management (CRM) have become an integral part of simulator learning objectives in all safety-critical industry simulation activities. In the aviation industry, clear criteria for assessing these kinds of skills have been established as the result of focused development. In opposition to strict technical performance (such as a correct flight path or procedure), the criteria for good or poor non-technical performance of crew members has been much harder to define clearly. In order to avoid subjectivity when assessing behaviours like "communication" or "leadership", authorities and subject matter experts developed behavioural markers for non-technical skills. The behavioural markers are descriptions of observable behaviours of teams or individuals, not attitudes or personality traits (Flin & Martin, 2001). The behavioural markers have since been used as a foundation for the training and assessment of non-technical skills within several different safety-critical domains. They provide examples of expected behaviours that are independent of the context, such as "Communicates plans and intensions", for the focal CRM elements such as leadership, management, decision-making and situation awareness.

In aviation, the idea of behavioural markers has been extended to all core pilot competencies. The division between technical and non-technical skills has faded away in the most recent concept of pilot training – evidence-based training (EBT). EBT represents a fundamental change of mind-set in aviation training. EBT is a fully competence-based training programme addressing the core pilot competencies: i.) Application of procedures, ii.)

Communication, iii.) Flight path management (automation), iv.) Flight path management (manual), v.) Leadership and teamwork, vi.) Problem solving and decision-making, vii.) Situation awareness, and viii.) Workload management. All of the core competencies are broken down to several behavioural indicators.

Example:

Competence in vii.) ***Situational awareness*** *includes behavioural indicators such as the following:*

- *Identifies and assesses accurately the state of the vessel and its systems.*
- *Identifies and assesses the general environment.*
- *Maintains awareness of the people involved in or affected by the operation.*
- *Anticipates accurately what could happen.*
- *Etc.*

Consequently, the traditional technical performance is also described as behaviours in detailed sentences like: *"Monitors and detects deviations from the intended flight path and takes appropriate action"*. (IATA, 2013.) The key principle of the EBT concept is to focus on the processes pilots use to manage operational threats and human errors. The main idea is that when confronted by challenging and varying situations, pilots can develop safety-critical competencies and learn how to apply behaviours that improve their resilience. As a result, their capacity is stretched to manage not only the exact scenario used in training but almost any given situation, including the unforeseen. This is a key element of safety management in modern aviation where hazards are hard to anticipate due to system complexity.

This development of integrating the non-technical skills into core competencies is not yet described in other safety-critical industries in the way that aviation has been able to do. The separation of technical and non-technical skills is increasingly debated, and first steps toward a unified model are starting to emerge also in the maritime industry. Sellberg & Viktorelius (2020) have raised the question of why separate the technical and non-technical skills from each other since they are naturally intertwined . The researchers are introducing the concept of "hybrid minds" into the discussion of human factors in the maritime industry. This principle of core-competencies, each including several behavioural markers, which is used in EBT programmes in aviation is taken into account, referenced and applied in the suggestions of this paper, where applicable.

SETTING THE LEARNING OBJECTIVES

Setting the learning objectives (later LO) on a behavioural level requires well-defined practical solutions in order to enhance real learning and the possibility to apply this in a real environment. In this chapter, each of the top six (6) learning objectives of the COMET project are examined and important questions are raised in order to make the learning objectives more reachable for the learners, but also to help the instructors avoid the fallacy of using vague folk models in interpreting behaviours.

1. Compliance with rules and regulations

The maritime industry is guided by many rules, such as sea traffic rules (COLREG) and regulations. For the professionals, it is important to both know the rules and to be able to apply them correctly. In the aftermath of accidents and disasters, one of the researched aspects is *"Did they follow the rules?"* An important question is therefore: What does it really mean to comply with rules and regulations? According to Sellberg & Viktorelius (2020), the application of rules *"requires local negotiation of meaning and mutual interpretation of the actions and intentions of others"*. It seems that knowing the rules and regulations is not enough in the complex real world; instead, the correct application and, in certain situations, also interpretation of these rules is also important.

As a learning objective, compliance with rules and regulations requires answers to at least these questions: i) "Which rules and regulations are important in each trained situation", ii) "how should the rules be applied", and iii) "are there different ways to interpret the priority of the rules in different situations".

2. Situational awareness

To be situationally aware is regarded as a highly important feature of human behaviour in safety-critical industries. Situational awareness (later SA) is described by Endsley (1995: 36) as follows: "Situational awareness is the perception of elements in the environment within the volume of time and space, the comprehension of their meaning, and the projection of their status in the near future". Transferred into a simple example in the maritime industry, this could be rephrased: "Where you are now, what is around you and where you are going in the near future". Knowing all this is often easier said than done. It is not always easy to understand what to be aware of and when, when there is a lot happening around you.

Situational awareness as an LO needs specifications. What kind of things does the learner need to be aware of, when and how is this awareness executed, and are there things that need to be made explicit for the learner? This step is highly important due to the way in which humans generally interpret the wording "situational awareness". There is a tendency to regard SA as it would be explicit and well defined, and that everybody would be aware of the same things in the surroundings and in themselves. The challenge – and the reality – is that humans are aware of different things in the same situation. An example of how to make the SA as an LO more explicit and, therefore, reachable by the learners and observable by the instructors is to break down the LO into sub-criteria of the SA.

Situational awareness sub-criteria (Saeed et al. 2017):
i. Awareness of bridge systems (specific systems)
ii. Awareness of external environment (e.g. weather, traffic, own ships position)
iii. Awareness of time
iv. Assessment of changing situation (e.g. projection of the vessel future status)

Each sub-criterion consists of descriptors, entailing good, acceptable, poor or very poor command of the SA. Specifying the LO on this level helps the learner to focus and train a certain behaviour, which is applicable also in other situations.

3. Safety and risk management

Managing safety and risks during everyday operations is common in many industries. Many risks are well known and described and are the backbone of rules and regulations. Some risks are managed by protocols that should be applied if these risky situations occur. Lanki (2020) has identified three topics with special importance in safety and risk management:
i. Risk management – critical situations
ii. Risk management – equipment failures
iii. Preparedness and response techniques

Set as an LO, the learner benefits from knowing more exactly which critical situations they should be aware of and which protocols, rules and regulations would apply in these circumstances. The learner should also know which equipment failures they should be prepared for and understand the correct response techniques.

Critical situations onboard typically include the following: engine, steering and electrical power failures, collision, grounding, man overboard, fire, flood, search and rescue, and abandoning ship (ICS 2016: 123–133). When selecting this LO, the specific situation must be pre-selected as these situations may occur as planned and informed beforehand – or completely unexpectedly.

4. Effective external communication

Communication skills, both verbal and non-verbal, are an inherent part of many of the elements in the non-technical skills categories (Flin et al., 2003). While studying the communication between icebreakers and the vessels they are assisting, Boström (2020) has identified that closed-loop communication is still not used in the full extent of its possibilities to enhance safe communication. Trenkner (2005) highlights that even if the International Maritime Organization (IMO) published the Standard Maritime Communication Phrases (SMCP) in 2002, there is a need to emphasise the reasons behind the use of standardised communication. Furthermore, he highlights the importance of teaching communication in a *"well thought-out methodical apparatus generating a close to real-life maritime environment and appropriate situations"*. Lanki (2020) found that special focus is needed on the communication that takes place with external parties outside of the own ship.

When communication is set as a learning objective, it is highly important that the learners know how and what they should communicate and to whom. This makes the LO easier to reach and more specified. Saeed (et al., 2017) suggests that communication would be one of the sub-criteria for teamwork and provides examples of good practices.

If standardised phrases are available and recommended to be used, they should also be directly available for the learners during the training. This could be done, for example, by providing the relevant phrases as a written note or as a poster in the simulator.

5. Decision-making

Decision-making is described as a process where one would gather information to identify the problem, go through options, assess risks and re-evaluate the outcome against the plan (Flin et al., 2003).

As a learning objective, decision-making is easier to approach when the process is observed through behavioural markers and examples. Saeed (et al. 2017), adapted from Flin (et al. 2003) proposes the use of the following sub-criteria:

i. Problem definition and diagnosis
ii. Option generation
iii. Risk assessment and option selection
iv. Outcome review

Decision-making is also connected to the time available, an understanding of the surrounding risks, and the ability to compare, prioritise and balance risks. When training explicitly the skill to make decisions, one should provide the learner with the time needed and situations where other standard protocols do not apply.

6. Teamworking

The skill of working in teams is important in high risk industries (Saeed et al. 2017), and sometimes this skill is called co-operation (Flin et al. 2003). The idea is that teamworking promotes safe practices by activating all crew and team members to actively speak up and reach mutual agreements. The teamworking skill includes positive interpersonal relations, acceptance of others, helping each other and solving conflicts (Flin et al. 2003).

When set as an LO, teamwork also requires a more specific set of behaviours and explanations to allow the learner to focus on the right things. Saeed (et al. 2017), adapted from Flin (et al. 2003), proposes the use of the following sub-criteria in teamworking:

i. Team building
ii. Considering others
iii. Supporting others
iv. Communication
v. Information sharing

Teamworking and communication are interrelated, but it is important to notice that aspects of communication also form a part of other non-technical skills. Working with the concept of teamwork often requires a clear picture of "what the team is in this training" and "when is a team required instead of just a group of professionals".

PHASES OF SIMULATION AND DESIGNING SCENARIOS

Commonly accepted and established phases of simulation training are the following: designing and planning the session and scenario, pre-briefing and education, running the simulation, and de-briefing. In this section, simulation participants include the teacher (also called instructor or facilitator) and a group of learners (students or course attendees).

Designing a scenario for a certain behavioural aspect and learning objective has influence on the actual design process. The traditional way of designing scenarios has often involved defining difficult or rare situations and then designing scenarios around these topics. If the focus is set on behavioural aspects, like in many of the LO:s set in the previous report (Lanki 2020), an important question is this: "How do we focus on the specific LO in the scenario and in what kind of situations is this LO a crucial competence?" For example, a scenario for the LO of decision-making should encourage the crew to apply the step-by-step decision process described above. Therefore, the scenario should include a problematic situation with multiple options and adequate time to properly analyse the risks and benefits using the available resources. On the other hand, learning to respond to critical situations under the risk Management LO requires a scenario involving a high workload and limited time, which differs from the one used to practise decision-making. Learning effective communication requires a scenario where information must be gathered from many sources and shared efficiently, and situational awareness in turn calls for a scenario where cues may be ambiguous or even contradictory and the crew should apply behaviours to continuously assess the situation and verify the correct course of action internally as a team and externally with other participants.

The process of designing scenarios for simulator training involves at least the following tasks:

- Choosing the specific LO that is to be trained
  - o Specify the LO according to SMART (see: Article 1 of this report)
- Answer to: *"In what kind of situation is that specific LO and skill needed?"*
  - o Everyday operations / rare situations
  - o Is learning enhanced by a situation with the time-constraints or by a time-available situation?
- Answer to: *"Is the learner given the possibility to focus on the LO in this event?"*
  - o Enough previous understanding and knowledge to handle the situation
  - o Not too many things to focus on or too difficult, but
  - o Interesting and difficult enough to keep up the learners' interest and motivation
- Attend to resource questions like:
  - o How many learners, support staff members and facilitators are available?
  - o Available equipment / simulators
- Plan for life savers (see: *facilitating learning*)
  - o What do you do if the learners do something undesirable?
  - o How can you help the learners learn?
  - o How are you prepared for unexpected events?

BRIEFING TO ENHANCE LEARNING

In order to achieve learning and transfer, there is a need to set the scene for psychological safety and learning from mistakes, so the learner is able to train without the risk of humiliation or losing face. Establishing a safe learning environment is essential in order to actively engage the participants in the simulation. The learners need to have a sense of control over what is happening and what is expected of them. The aspects of creating a safe learning environment include:

- clear expectations regarding the objectives - precise and on the behavioural level
- clear expectations regarding the environment, roles, confidentiality and activity
- establishing a fiction contract
- logistical details
- agreeing to respect the learners and their perspectives

The foundation for the psychological safety is set before the actual simulation scenario, during the start of the simulation day and during the pre-briefing. (Rudolph et al., 2006.)

FACILITATING LEARNING

An important ideological decision must be made before running a scenario as a facilitator. What should the facilitator do if the learners are in the process of executing a wrong action/response or behave in a way that would not meet the required standards? The facilitator has two main alternatives:

1. Help the learners on the fly – this is about learning good practice.
2. Let the learners execute wrongly – learning also happens based on mistakes and this will be discussed during the debriefing.

Taking into account how valuable the time spent in simulator training is, it is highly recommended to at least try to enable the learners reach as good performance as possible. This means that the facilitator should try to help the learners to achieve a correct performance by enforcing the learning progressively through:

- hints
- corrections
- explanations
- pausing
- stopping

Important questions to ask as a facilitator are: *"Were the learners ready for the scenario – did they have enough prior knowledge, skills, attitude and behaviours that were required in the scenario"* and *"what do the learners need in order to be able to execute the scenario correctly"*. The difference between facilitating correct performance during the scenario and discussing the correct performance afterwards is that in the first model the learners have actually performed the correct action, whereas in the other they actually performed the wrong one and only discussed the correct. Here is an example of the difference: *"would you be happy to fly with a pilot that has only discussed how to perform a crucial skill correctly or would you prefer that they have actually performed it correctly?"* If the skill is crucial, we obviously need to have professionals to actually perform the skills in the simulator, not just discuss them.

If the simulator software and the situation allow, there might also be the possibility to slow down the actual speed of what is happening or change the conditions of the situation by, for example, prolonging the effects of actions or changing the force of the wind affecting the situation.

DEBRIEFING

Debriefing is the final phase of simulation training where the activities involved in the training scenario are discussed with the purpose of learning, reinforcing the mental model and enhancing future practices (transfer). The structure and practices of how to perform the debriefing conversation vary. At least seven (7) different models of debriefing have been identified by Sawyer (et al. 2016). Generally, the debriefing structure involves the following parts:

i. Venting first reactions
    - to release possible immediate stress and also to get a general idea of what the learner's perception about the activity is

ii. Walkthrough of what actually happened during the simulation
    - to gather and sort everybody's views on the activity since every learner has their own view on things and they may not be aware of what others did during the scenario

iii. Reflection and discussion on what the good points were and what would need to be corrected
    - the actual analysis of activity
    - self-reflection and self-assessment in focus
    - facilitator helping to find, understand and see

iv. Synthesising the core messages
    - concrete examples of how and when to do what in the future situation
    - concrete examples of what is really important

The role of the facilitator is to steer the discussion through the different phases of the debriefing process. This process is designed to help the learners to self-reflect and self-assess, to broaden the learners' understanding of what knowledge, skills, attitudes and behaviours are involved in the trained competencies, and to provide learners with an expert opinion and assessment of their performance.

Some of the recognised challenges in debriefing are the possible opposite views of the participants on what actually happened during the scenario, and providing the learner with feedback, based on the assessment, in a way that will create a safe learning environment. Possible opposite views of what happened during the scenario may be solved by having a look at a video recording from the scenario. In the process, it is important to remember not to use this as a way of showing that the facilitator was right and the learner was wrong, but to try to objectively look at what happened for the purposes of learning. In every simulator training session, the facilitator is assessing the activity, even without the purpose of making an official assessment, scoring or evaluation. When observing any activity, we also assess and compare what we see with ideas we have about the activity. Assessment, in this context, does not equal to evaluation which is more about delivering a statement of the outcome, a number, credit, pass or failure. While observing a scenario in simulator training, it is important to have answers to the following questions: *"What is assessed – what is the learning objective?"* and *"against what level of competence are we assessing?"* Different tools have also been developed to make the assessment more objective and measurable, like the non-technical frameworks (Saeed et al. 2017), but there is also evidence that the reliability of these tools, in regards to teamwork performance, needs more research (e.g. Ernstsen 2020). It is important to understand that assessment of an activity is not, and should not be, equal to delivering judgmental feedback during the debriefing, regardless of the assessment model. The way you provide learners with feedback that is based on your assessment is crucial in order to maintain a safe learning environment.

Rudolph (et al. 2006) contrasts three different approaches of performing debriefing by comparing "judgmental, non-judgmental" and "debriefing with good judgement". The idea here is that judgmental debriefing produces a defensive stance in the learner who stops listening or at least, feeling blamed, does not share the reasoning behind the actions. Even if the facilitator feels they are right, there is a risk of negatively affecting the learners' future simulator learning. A non-judgmental debriefing approach might be nice for all parties, but it also might not address the more difficult issues; it is easier to avoid the actual deep problems in order to only maintain a safe learning atmosphere. It is of utmost importance that any incorrect actions are dealt with within safety-critical professions. The focus of simulation activities should always be on learning but also on keeping the reality of safety-critical activities in mind. The question of *"would you be satisfied if this action was done in real environment, with real people and equipment?"* can help in addressing the difficult topics. Most often the learners address these incorrect actions already through self-reflection or self-assessment during the debriefing. In situations where the learners are unaware or unable to approach a topic or activity that needs to be corrected, the facilitator should do so with good judgement. Debriefing with good judgement is about asking for the learners' opinions and involving them in the reflection process when providing them with feedback in a neutral way. The point is to value the expert opinion while also valuing the learner's unique view of the situation. This is done by pairing advocacy with an inquiry: advocating the observation with statements like *"I saw/heard/observed...",* offering an own opinion about the situation: *"I thought..."* and doing an inquiry by being curious: *"I wonder if…"* (Rudolph et al. 2006.)

Another important thing to be aware of and to keep in mind when debriefing on non-technical learning objectives is that lack of something – that is an abstract topic (teamwork, communication, CRM, situational awareness) – does not produce a good or a bad outcome. For example, the fact that learners did not comply with CRM or had bad communication is not a conclusion or reason for a mishap, but should be discussed at the level of certain behaviours. For example, closed loop communication, having no common goal, not taking corrective actions, or applying incorrect coordination all behaviours and activities that can be discussed and corrected.

CONCLUSION

In the conclusions, the possible and recommended methodological approaches in achieving the top six learning objectives are presented visually in Table 1 according to the different phases of simulation (planning, briefing, simulation and debriefing).

Table 1. Suggestions and advice regarding each of the six learning objectives during the different phases of simulation.

Objective	Phase	Note
1. Compliance with rules and regulations	*i. Scenario design and planning*	• Plan the situation so that the application of rules and regulations makes sense • Prepare life saver for priority and interpretation of the rules
	ii. Briefing	• Remind of important rules and regulations that apply in this scenario • Explain why a certain priority needs to be applied
	iii. Simulation	• Facilitate learning during the process • Prepare hints/help for the learners
	iv. Debriefing	• Remember that nobody applies rules incorrectly on purpose • Help the learner to understand how to apply the rules and share the ideas amongst the group • Remember that if the learner could interpret the rules in a different way, others may also
2. Situational awareness	*i. Scenario design and planning*	• Make sure that the specific aspects the learners need to be aware of are available in the situation
	ii. Briefing	• Specify what the learner should be aware of with sub-criteria
	iii. Simulation	• Facilitate learning during the process • Prepare hints/help for the learners
	iv. Debriefing	• Avoid discussing 'Situational Awareness' in general but rather focus on the sub-criteria
3. Safety and Risk Management	*i. Scenario design and planning*	• Prepare a logical situation • Balance rare situations with "everyday" events
	ii. Briefing	• Explain the difference between known risks and applicable protocols and sudden risks where no protocols are available • Prepare the learner with more specifics about the management required
	iii. Simulation	• Facilitate learning during the process • Prepare hints/help for the learners
	iv. Debriefing	• Discuss and share understanding on how to handle the situation and possible different solutions

Objective	Phase	Note
4. Effective external com-munication	*i. Scenario design and planning*	• Enforce a situation that needs to be communicated with external subject(s)
	ii. Briefing	• Specify what kind of communication is desired (closed loop, precise, correct phrases) • Provide learners with examples of good/standardised phrases
	iii. Simulation	• React to good communication with answers so correct communication is reinforced • Provide hints when poor communication is observed (bad connection/ask to repeat)
	iv. Debriefing	• Reinforce good practice • Ask for own ideas on how to make the communication better
5. Decision-making	*i. Scenario design and planning*	• Ensure that learners have the needed time to make the required decision • If rapid actions are required, prepare learners with knowledge of protocols that are applicable
	ii. Briefing	• Ensure the learners' competence level regarding the decisions to be made • Specify what kind of decisions they should train for with sub-criteria
	iii. Simulation	• Facilitate learning during the process • Prepare hints/help for the learners
	iv. Debriefing	• Discuss the sub-criteria • Explore the reasoning and rationale behind the decisions
6. Team-working	*i. Scenario design and planning*	• Ensure that the scenario requires teamwork in order to be solved • Team members should all have tasks when possible
	ii. Briefing	• Specify the teamwork with sub-criteria • Divide the individual tasks
	iii. Simulation	• Facilitate learning during the process • Prepare hints/help for the learners
	iv. Debriefing	• Remember that a team consists of many, not only the leader • Explore the ideas as a team

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BEST PRACTICES AND RECOMMENDATIONS FOR JOINT SIMULATOR TRAINING – RESULTS FROM PROJECT PARTNER EXPERT INTERVIEWS

Vesa Tuomala, Antti Lanki

The preliminary literary study of the simulation pedagogy and its importance was carried out during the spring of 2019, followed by the interviews concerning the best practices and learning objectives with the Finnish maritime experts and authorities during summer 2019. The Estonian partners EMERA and IVKHL conducted maritime and cargo handling interviews with the local experts and authorities in Estonia during the spring and autumn of 2019. The qualitative parts of these interviews focusing on the future learning needs and objectives are published in the first CoMET project report (Tuomala, 2020: 13–17). In this article, the literature and interviews have been re-analysed focusing on the nine (9) best practices and recommendations for simulation-based education. The main question is: *How do the experts on the field perceive simulation as an educational tool and what are their main recommendations for the teachers and instructors working in the CoMET project?*

RECOMMENDATIONS AND BEST PRACTICES BASED ON THE EXPERT INTERVIEWS

The interviews were conducted during the year 2019 in Finland and Estonia. The interviewed professionals were experts working as authorities, officers on board ships, crewing or management staff members for shipping companies, port cargo-handling personnel and educators or apprenticeship coordinators. All of the interviewed experts had strong professional experience and background. The total number of interviewed persons, Finnish and Estonian, was 34. (Tuomala, 2019.)

The interviews were conducted using a semi-structured questionnaire with four (4) main themes: i) current strengths and weaknesses in maritime and port cargo handling training and education, ii) needs and views on developing the current ways of simulator-based training, iii) expertise and competencies needed in today's maritime industry, and iv) expected changes in expertise and competencies in the near future. In the article in the previous report, these results were analysed in order to identify the specific educational needs and lists of the skills and competences (Tuomala, 2020: 14–15). These lists were used to establish the main learning objectives for the CoMET project.

In this article, the literature study was re-examined and the interview results were analysed again to identify and summarise the most important and frequently addressed recommendations and practices. The result is a summary containing nine (9) recommended best practices (later: BP) which should be taken into consideration in all simulation-based education in the CoMET project. These BPs are tabulated (Table 1) and explained below.

Table 1. Exercise scenario drafts, their scope and proposed learning objectives

Number	Recommended Best Practice
BP 1	Learning environment
BP 2	Competent instructor
BP 3	Confidentiality and sense of security
BP 4	Motivation
BP 5	Interaction
BP 6	Giving and receiving feedback
BP 7	Simulator exercise description
BP 8	Communication
BP 9	Time

BP 1, Learning environment: According to the respondents, the social and physical environment has an impact on learning in creating the authentic atmosphere. The technical condition of the simulator is also important. The virtual learning environment enables quick decision-making and learning "hard-facts" in a practical way.

BP 2, Competent instructor: The instructor must master both the substance-matter and the pedagogical skills to succeed. The role of the instructor is crucial in assessing the students' skills and keeping up the interactivity. According to the respondents, the simulation instructor should be an active participant in the exercises. The instructors should also develop themselves continuously. Instructors from both the deck and the engine department should update their skills and knowledge from time to time, with regard to both the existing vessels and the new ships in shipyards.

BP3, Confidentiality and a sense of security: The students need to have clear rules for the simulation to achieve a good learning outcome. The exercise events should be confidential and consensual and they should not be discussed outside. The confidentiality of the simulation exercises gives everyone an equal opportunity to increase their skills through practical work. Students improve their learning and problem-solving abilities by performing correctly as well as incorrectly – learning from mistakes is also important.

BP 4, Motivation: Students need to be focused and have the right attitude to the simulation event. Motivation is kept up by short and punctual simulator exercises. Joint simulator exercises with the deck and engine department of the vessel and with the port authorities was considered to increase the motivation of the students.

BP 5, Interaction: This was considered to refer to wide and multidimensional ways of understanding and being understood in social situations. In the simulation, interaction is influenced by the atmosphere, environment, and experiences of the situation. Interaction is an important factor for the success of a simulation exercise. Interaction and social skills are considered important by the respondents, such as navigational bridge team members and CRM.

BP 6, Giving and receiving feedback: Feedback was considered to be one of the most important aspects of simulator exercises. Every exercise should be reviewed and the competence of the students assessed. The students may learn inefficiently or even incorrectly without feedback. A direct, constructive feedback discussion is more effective than getting written feedback after the exercise. Receiving feedback for simulations from students helps to further develop the exercises. This should be done in the end of debriefing according to the respondents. Feedback can be given (if necessary) during the simulation (interrupting it) if the situation develops in a critically wrong direction. After the interruption, the situation is reviewed, feedback is given, and the exercise continued in the right direction.

BP 7, Simulator exercise descriptions: The simulation exercise should be repeatable and systematic for the learning objectives to be achieved uniformly by every student. The simulator training material defines clear objectives and comprehensive guidelines for both practice and instructor work. The content of the exercise should be described in written form so that the students or instructors do not have to adapt or interpret the subject matter. The material describes the roles of participants and how the simulator is suitable for the exercise. The training material may also include hardware instructions.

BP 8, Communication: Based on the interviews, poor or lacking communication was seen as one of the main features of human error. Communication was seen as a component of many other skills such as decision-making, teamwork, leadership, stress management and professional interaction. Some of the respondents emphasised the importance of good communication and social skills in working life. Teachers and instructors should communicate as clearly as possible to be understood and to avoid confusion.

BP 9, Time scheduling: A simulation exercise is typically a short-term exercise. The simulation begins with planning, the setting of learning goals, and a pre-study introduction by students. The exercise experience consists of briefing, simulator work, and debriefing sessions. This should be scheduled for not more than two and a half hours, with the simulator exercise lasting for about twenty to forty minutes. According to the respondents, simulator spaces can typically be poorly ventilated, so many students and instructors may experience headaches or nausea after exercises. Consequently, the instructor should think carefully about the schedule and include breaks and “cooling-off” time.

CONCLUSION

The interviewed professionals had a clear and detailed vision about simulation education from the practical point of view. Their recommendations were summarised into nine (9) best practices. Most of the respondents considered modern simulators realistic and relatively easy to use. Almost all of the participants encouraged the use of simulators and recommended increasing their use. However, simulators should be used in conjunction with actual practice (such as onboard training). Due to the modern basic education, the students’ skills and aptness in information technology was believed to be quite good, which lowers the barrier for using simulators. As the requirements for the digital and “high-tech” competencies increase, the basic (traditional) skills should still not be neglected. The basic skills should be practised in theory and the simulators included in the studies as early as possible.

The so-called soft-skills, such as communication and social skills, were emphasised in the responses, and teaching them in the simulators was encouraged. According to the interviewed professionals, the old hierarchical ways have slowly subsided to give way for a more team-oriented culture. For example: as the number of crew members onboard ships decreases, the individual responsibilities and competence requirements increase. The students should be educated to become independent and engaged professionals.

The teachers’ and instructors’ competence was addressed and deemed sufficient. Some respondents emphasised the need of updating and maintaining the acquired competence. This could mean periodical visits to institutions and workplaces involved in the industry. Teachers should also try to convey as realistic an image of the industry and workplace as possible. It was believed that some of the students may have an unrealistic or idealised image of the maritime industry. Co-operation between educational institutions and other stakeholders should be encouraged and increased. For example: teachers can invite VTS operators to train together with the students.

These recommendations and best practices are meant to be used as reference and guidance in developing the CoMET project simulator exercises. However, many of these results and recommendations can be applied to other forms of cross-border or joint training.

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GUIDELINES FOR JOINT SIMULATOR TRAINING – RESULTS OF THE EXPERT WORKSHOP

Antti Lanki

An expert workshop was organised between the CoMET project partners' simulator trainers and educators in Kotka, Finland in January 2020. The workshop was a two (2) day event focused on maritime simulator pedagogy and methodology. During the workshop, the main objectives included discussing and evaluating relevant simulator pedagogy, exploring scenario planning, and developing the methods and practices for joint-op simulation using the EMSN (European Maritime Simulator Network) platform. A total of nine (9) simulator trainers and educators attended the workshop, and the tasks were carried out in two (2) to four (4) working groups which compiled their progress for the common discussion. After the workshop, all the data and notes were combined and analysed. The results form the guidelines and limitations for joint training (specifically in the CoMET project), proposed exercise scenario drafts and recommended methods and practices for conducting the training in the four (4) phases of a simulation: set-up, briefing, simulation and debriefing.

The suggested pedagogical approach to be used in simulation-based education in the CoMET project involves constructivist experiential learning and the framework of mental models as described in the first article of this report (Helovuo et al., 2021). Each partner shall consider the difficulty and challenge of the exercises based on their student group. Each exercise should have at least one (1) of the six (6) learning objectives (Lanki, 2020: 21) as the educational foundation and more can be selected as secondary objectives. However it is not recommended to have more than three (3) objectives in total per one exercise.

SCENARIO AND EXERCISE PLANNING

On the first day, the workshop participants were divided into two groups that started discussing ideas on the settings, themes and scenarios of the joint training. The teams concluded that the maximum limit of bridge teams (ships) that is possible between all the partners' three (3) centres is eleven (11); however this is only the upper limit and smaller-scale exercises are also acceptable. The working groups concluded that the six (6) learning objectives can be incorporated into the scenarios in an effective, practical and varied way.

The first step of the process was to start drafting applicable maritime scenarios, which are realistic and applicable to be emulated in a simulator. Some of the proposed scenarios were actual events and situations the experts had seen or experienced onboard. Other proposed scenarios were discussed as being interesting or challenging in terms of expert judgment, interest and observation. The majority of the participants felt it was important to have some local Baltic areas and situations included (such as the Gulf of Finland traffic separation schemes), as all the partners' students will be sailing and working in the region frequently or at least occasionally. The common themes and suggestions included the following: understanding and applying "rules of the road", joining traffic separation, overtaking and meeting ships, scheduled traffic (e.g. VTS, pilots), ship with defect or damage, and search and rescue operations.

The second step was to assign specific learning objectives (selected from the pool of six) to these drafted scenarios. The limit for selected objectives was two (2) for each scenario, as many scenarios can be created in a way that the learning objective can be any of the six (6) main objectives. A consensus decision was made within the groups and the main objectives assigned. It is important to note that these combinations of scenarios and objectives are not set in stone – they can be mutually agreed and changed if the scenario and the setting of the exercise or the curriculum changes. In the development stage of a new exercise and in scenario planning, it is recommended to refer to the methods and practices presented in the second article of this report (Nyström et al., 2020). The basic scenario drafts and their proposed learning objectives are summarised in the table below (see: Table 1). The first column of the table includes the main theme of the exercise and the scope of the relevant maritime function(s) or competence(s). In the second column, two (2) proposed learning objectives are assigned to each scenario. The scope (first column) refers to the broader context or rules that are essential in the maritime profession.

Example: Colreg refers to the international "rules of the road" which are essential for safe navigation to prevent collisions between two or more vessels. Thus, when Colreg is listed in the table it means that the focus of the exercise scenario should be on collision prevention and compliance with other applicable rules, like rule 10: Traffic separation schemes.

Table 1. Exercise scenario drafts, their scope and proposed learning objectives

Exercise scenario and scope	Proposed main Learning Objectives
Joining the Traffic Separation in Gulf of Finland – Colreg – Navigation and watchkeeping	– Compliance with rules (1.) – Decision-making (5.)
Search and rescue in open sea – IAMSAR – GMDSS procedures – Navigation and watchkeeping	– Communication (4.) – Situational awareness (2.)
Ships approaching and leaving a Baltic port (e.g. Vuosaari) – MRM – VTS, pilotage and GMDSS procedures – Navigation and watchkeeping	– Situational awareness (2.) – Teamworking (6.)
Heavy traffic in a coastal fairway (e.g. Tallin buoy 1) – Colreg – Navigation and watchkeeping – Ship handling	– Decision-making (5.) – Teamworking (6.)
Ship experiencing defect or failure in traffic (e.g. black-out) – Bridge/engine emergency procedures – VTS and GMDSS procedures – Navigation and watchkeeping	– Safety and risk management (3.) – Communication (4.)

METHODS AND PRACTICAL CONSIDERATIONS OF JOINT SIMULATOR TRAINING

On the second day of the workshop, the participants focused on the practical aspects and structure of joint-op simulator training. Two (2) working groups discussed the practical aspects of setting up and conducting a joint simulator training event among the project partners. The scenario drafts from the first day were used as a basis for the discussion. The joint-op simulation event was divided into four (4) distinct phases:

i. Set-up (and preparations)
ii. Briefing (and instructions)
iii. Simulation
iv. Debriefing

It was concluded by the working groups that connected simulator training adds complexity and unknown variables to the education. It was agreed that one (1) centre shall be the overall leader (main instructor) for the event. This can mean coordinating the entire curriculum or rotating the coordinator on a day-by-day basis.

In the *set-up* phase this means technical aspects, connectivity and networks, available resources (like staff and learners) and interactivity. The main instructor has prepared and sent the other participants the training document which is checked together before the other participants enter the scene. In the *briefing and instruction* phase it is imperative that the main objective is shared and commonly understood. Every partner must be aware of their own student group's competence level, as well as that of the connected centers' groups, and adapt accordingly. Motivating the groups needs to be considered, as well. It was agreed that the training session should begin with an overall video briefing by the main instructor. This should take approximately 15 minutes. The *simulation* phase refers to the actual running of the scenario and should last up to 90 minutes (depending on the scenario). Before any difficult situations occur in the exercise, there should be a short period (10 minutes) of "easy sailing" in the beginning to orient and immerse the groups. Every partner's instructor(s) shall mainly monitor the performance of their own student groups and take notes. It was decided that two (2) exercise scenarios per day is sufficient, unless the exercises are very short (less than 30 minutes). If any technical difficulties or faults occur, the exercise should be paused to determine the cause. The debriefing phase starts with bridge-team reflections and self-assessments. When the individual bridges have reflected on the scenario, each centre debriefs their own bridge teams. This can be done by the instructor individually (one bridge team at a time) or commonly (all bridge teams together), whichever is more appropriate. After the centre-specific debriefing, there should be a common video-conference debriefing and discussion between all the participating centres. Depending on the joint simulation event and the number and duration of the exercises,the common debriefing can also be arranged as a single end-of-the-day discussion. However, it is recommended that every participant has a possibility to comment any event of the exercise in a joint session. After the debriefing, feedback is collected from every participant. The feedback should address learning (pedagogical aspects), joint simulation training (methods) and general data (arrangements) in order to improve the training procedures for future events.

CONCLUSION

The guidelines for joint simulator training between the CoMET project partners were created by collecting and compiling data from the expert workshop organised for the CoMET project partners' simulator trainers and educators. Before the workshop, a study on the main learning objectives was conducted and introduced. The results of the workshop include exercise drafts (scenarios), planning and agreeing on the joint exercises and methodological considerations, and limitations for each phase of the event.

When planning a joint simulator exercise event (using the EMSN platform), a main instructor needs to be assigned. The main instructor can be from any of the partner institutions, and it is advisable to rotate the responsibility between the partners. The main instructor holds a key role in the overall design of the exercise scenario and should document and convey the information to the other partners in advance.

In the documentation and planning of joint exercises, the following topics should be addressed and agreed on between the participants. This can be achieved by using a standardised document or form.

- Main topic and overview of the exercise
- Learning objective(s)
- Participating centres (and contacts)
- Time schedule
- Exercise specifications
  - Location/area
  - List of ships, including starting position and vector
  - Time and date
  - Environmental conditions
  - Communication methods (for ship-to-ship and to instructors)
- Intake requirements for participating students
- Briefing instructions and methods
- Debriefing instructions and methods
- Debriefing reflection, assessment and feedback form(s)

In addition to the written document, all relevant files and data may be shared among the participating centres. For example, if all the centres have the same manufacturer's equipment or software, it is possible for the main instructor to send the exercise file directly to the others, reducing the need for manual adjustments in the other centres. The ships' intended routes can also be sent in advance.

These recommendations and results are intended primarily for maritime bridge-simulator education using the EMSN platform. However, many of these results and recommendations can be applied to other forms of cross-border or joint training.

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