DEPARTMENT OF EDUCATION,
COMMUNICATION & LEARNING

“OTHERWISE YOU CAN PLAY DRIVING THE BOAT ON YOUR PLAYSTATION INSTEAD”:

Towards a holistic view of simulators for training in maritime education

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Thesis:	30 higher education credits
Program and/or course:	International Master's Programme in IT & Learning
Level:	Second Cycle
Semester/year:	Spring term 2020
Supervisor:	Charlott Sellberg
Examiner:	Annika Lantz-Andersson
Report no:	VT20-2920-008-PDA699

Abstract

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Keywords:	Simulator training, sociocultural approach, maritime education, material fidelity, interactional fidelity, environmental fidelity

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Purpose: This thesis aims to investigate how the training process occurred during a simulator-based exercise in maritime education, examining if and how aspects of realism during simulation co-construct the outcome of the students' learning experience. The main focus is on inspecting the relationships between human and material agents to show how these elements contribute to the learning process.

Theory: In order to investigate the interactions between the agents, sociocultural and sociomaterial theories were employed. The participants are considered professionals participating in their "Communities of Practice" to accomplish the simulated tasks and achieve the essential competences and skills (Lave & Wenger, 1991). Students, instructor, and materials are seen as agents interacting with each other and co-creating knowledge in a virtual educational context taking a "knowing-in-practice" perspective on learning (Fenwick & Nerland, 2014).

Method: The research is designed as a case study in Maritime Education and Training, studying training during a simulator exercise for training future Dynamic Positioning Officers (DPOs). The data were generalised utilising three methods. Observations, video recording, and group discussion are equally committed in this ethnographic study. To analyse the data a framework influenced by Hontvedt & Øvergård (2020) was developed, and a narrative approach was adopted.

Results: The finding showed that the prior experiences of the students, teaching-learning materials, the tools, and the task all contribute to the learning process in training DPOs in a simulator-based exercise. In particular, the relationships between instructor and students are crucial elements for the training and learning process in simulator-based team exercise. On the contrary, a realistic simulator environment is a less critical factor in co-constructing the outcome of the students' learning experience in DP training. The findings imply taking a holistic view of learning through simulations, considering how training in virtual environments fits into a number of learning activities within an educational program.

Foreword and Acknowledgment

I would like to thank my supervisor Charlott Sellberg for her valuable guidance, the opportunity to be part of data collection and use parts of the video data, comments, editing, and support. I also would like to thank the instructor at the DP course, for welcoming and introducing me to his teaching and the DP topic. Additionally, I would like to thank the students who participate in this case study and volunteer to spend some time after their course to discuss with me. Moreover, I want to thank my teacher Markus Nivara for his support in my study's process. Finally, I would thank my classmate Kristin Hull, because of her kindness to share with me some of her time in Nvivo in order to help me transcribe the discussion with the participants.

Gothenburg, May 2020

Anastasia Skarpeti

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List of Abbreviations

Abbreviation	**Explanation**
ASOG	Activity Specific Operating Guidelines
DP	Dynamic Positioning
DP systems	Dynamic Positioning systems
DPO	Dynamic positioning operator
IMO	International Maritime Organization
OOW	Officer on Watch
OSV	Offshore Support Vessel
ROV	Remotely Operated Vehicle
STCW	Standards of Training, Certification and Watchkeeping for Seafarers
VR	Virtual Reality

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Introduction

1. Background

1.1. Simulators in professional education

New technologies have established new pedagogies in the field of maritime education (Emad, 2010). In the education of professionals, many new tools can be used to improve the teaching experience and facilitate learning. One of the tools that are provided by the development of technology is *simulators*. Simulators can be devices, programs, and systems which represent tasks and environments where an operation or performance is occurring.

Many studies have underlined how advantageous it is for educational institutions and organizations to train students via simulator-based exercises. The main benefits are lower costs compared to on-the-job training, efficiency, and the reduction of risk (Sellberg, Lindmark, & Lundin, 2019; Berendschot, Ortiz, Blickensderfer, Simonson, & Defilippis, 2018), it is underlined that several studies have shown that the time and cost compared to on-the-job training is significant. Particularly, William & Lilienthal (2008) presented a table with data from Patenaude (1996) comparing the time and the cost of traditional and the simulator-based training in nine tasks that a man in aviation should perform. These data showed that the range of the degree of savings fluctuated from 50% to 3000% (William & Lilienthal, 2008). Besides, even the training in high-fidelity simulators, which are typically more expensive, is the most suitable tool compare to teach professionals in a work environment, where an accident will cause harm to humans (Kozanhan, 2019; Gibbs, 2015). Additionally, training via simulators is more ecologically friendly way than training using crafts (i.e. aircraft, vessels, trucks, busses), especially in industries such as aviation, which produces 2% of the CO_2 of the global human emission (Galant, Nowak, Kardach, Maciejewska, & Łęgowik, 2019). Finally, practice in a work environment is more time-consuming compared to performing via simulators, where students can practice specific tasks in a safe environment (Hjelmervik, Nazir, & Myhrvold, 2018). All these studies indicate that there are definite advantages in training via simulators.

The above information can reach to the conclusion that simulator-based training is valuable to the education terrain in training professionals working in sectors where a fatal accident can occur. As dangerous industries, this study considers the job of operators or maintainers whose training can result in a severe accident. To specify, simulator-based courses are applicable in training professional in sectors, such as railway (Öztürk, Arar, Rende, Öztemel, & Sezer, 2017), aviation (Dahlstrom & Nahlinder, 2009), the maritime industry (Sellberg, 2018), healthcare (Silvennoinen, Helfenstein, Ruoranen, & Saariluoma, 2012), and oil and gas industry (Komulainen & Sannerud, 2019; Susarev, Bulkaeva, Sarbitova, & Dolmatov, 2017; Fotin & Kulikov, 2014). In these sectors, trainees need to be introduced to the working environment showing them a realistic experience, aiming to facilitate the acquisition of competences in a safe way.

1.1.1. The organization of the simulator-based training

In formal learning environments, such as organizations and institutions, the simulator-based exercises have a specific structure. The form of this exercise composes of three phases: Briefing; scenario; debriefing. The *briefing* section is the introduction to the topic that is about to be taught (Sellberg, Lindmark, & Rystedt, 2018). In this part, trainees are familiarized with the simulator and the materials that they are going to use (Sellberg, Lindmark, & Rystedt, 2019). Moreover, they get informed about the tasks that they will accomplish during the practice in the simulators to acquire the necessary skills and competences (Kelly, et al., 2019). The second phase is the scenario in the simulators, where students perform specific tasks relevant to the teaching/learning goal (Rystedt, Abrandt Dahlgren, & Kelly, 2019). During the scenario, trainees play specific roles, and they act as professionals in a job environment (Sellberg, 2018; Rystedt, Abrandt Dahlgren, & Kelly, 2019). This role-playing makes students acquire knowledge because of their engagement in the simulation activity (DeNeve & Heppner, 1997; Bethany, Declan, Conor, & Kenny, 2018). Finally, the performance on the simulator-based exercise is concluded with the debriefing section. This last section is crucial since the instructor gives feedback and guide students to understand what they have done, how they can manage the same situation in a different way, and finally s/he gives a brief description of the teaching (Sellberg, Lindmark, & Rystedt, 2018; Kolbe, Grande, & Spahn, 2015).

1.1.2. Professional learning in simulated exercises

The main goal of every teaching process is to facilitate students to reuse the knowledge that they acquired during the training on the job environment and everyday life. Previous studies in simulated environments used the metaphor of *learning transfer* to describe the mechanisms that trainees utilise to rehearse skills and competences that they have practiced in the school context to on-the-job environment (Liu, Blickensderfer, Macchiarella, & Vincenzi, 2008; Chapanis, 1996). However, this view had been characterized as *problematic* when it comes to the social-cultural perspective. Rather than viewing learning to be a set of skills that trainees transfer in similar circumstances, Sellberg and Wiig (in press) claim that students learn when they are involved in social and material practices. Considering this *knowing in practice approach*, the notion of *intercontextuality* is well-suited when taking on a social-cultural perspective. Context includes all the relationships and interactions occurring in a *learning environment*. Thus, there are *school* and *working* contexts. Learners participating in such contexts receive information/knowledge by social interactions with the other individuals and the materials. Such information/knowledge is applicable in such contexts, and in combination, can create new thorough understanding. According to Engles (2006), as it reveals in Sellberg and Wiig (in press), intercontextuality occurs when individuals use the knowledge that have acquired in the learning context and connects this knowledge to the working context. Hence, trainees practicing in a simulated environment might learn how to act under simulated circumstances, and then they extend that learning to the working contexts creating *intercontextual* relationship between them. Therefore, the design of simulator activities and instructional support is the most crucial aspects of learning in simulator-based training (Sellberg, Lindwall & Rystedt, 2018).

1.2. Maritime education and Simulator training

Currently, different actors in the maritime sector, such as maritime universities, private simulator centers and simulator developers, are providing training in maritime operations through tertial education (Lau & Ng, 2015). Many organizations and institutions provide certificates and degrees to trainees that they have succeeded to fulfil the educational curriculum. These formal educational institutions provide simulator-based activities regulated by the Standards of Training, Certification and Watchkeeping for Seafarers (STCW) (Sellberg, Lindmark, & Rystedt, 2018). These activities aim to train professionals to act appropriately and assess their performance (Sellberg, Lindmark, & Rystedt, 2018). The trainees are evaluated in technical and non-technical skills. Notably, the 2010 Manila Amendments, which is the last update of STCW, analyses the knowledge (technical skills) that trainees should have to achieve the STCW (Sellberg, Lindmark, & Rystedt, 2018; Sellberg & Lundin, 2017).

Because of the increasing automation in vessels and rigs used in petroleum manufacturing, there are many new automatic systems such as Dynamic Positioning (DP). This system maintains the exact position and the head of the vessels or the ring utilising active thrusters during operations of loading and offloading goods at sea and drilling operations (Hurlen, Skjerve, & Bye, 2019; Dong, Vinnem, & Utne, 2017). Data collected from sensors and calculations are utilised by DP systems to manage rudders and propellers (Hurlen, Skjerve, & Bye, 2019). According to Hurlen, Skjerve, & Bye (2019) "a dynamic positioning operator (DPO) is the navigator operating the DP-system" (p. 3683). As OOW specialised in DP, professionals should be competent to prepare in advance certain activities, set-up the DP-system, check the system and in some cases regulate some wrong activities of the system (Hurlen, Skjerve, & Bye, 2019). Further, an officer on watch (OOW) specialised in DP, should be competent to plan a voyage on an offshore support vessel (OSV). These vessels have been designed "for the logistical servicing of offshore platforms and subsea installations, from installation through the full-service life of offshore fields" (DNV.GL, 2020). In term of the kind of the system redundancy, the International Maritime Organization (IMO) has classified the vessels as DP1, DP2, and DP3 (IMCA, 2018). The first class is the primary DP system for crew/supply vessels and shelf supply boats while DP2 is suitable for deep-water supply, or large vessels, and construction ships equipped with moonpools (Pearson, 2008).

1.2.1. Training to become a PDO

As mentioned, DP operations are crucial to controlling the position of vessels applied in offshore exploration and exploitation of hydrocarbons. There are various kind of DP vessels performing different operations "in terms of position excursion tolerance and consequence potential" (Dong, Vinnem, & Utne, 2017, p. 6). As Dong et al. (2017) noted, large vessels facing more collision risks to adjacent offshore installation, while "Diving support vessels and pipe-layers may pose a risk towards personnel (drivers) and assets (pipes being laid), respectively, in case of a position loss" (Dong, Vinnem, & Utne, 2017, p. 6). Reported accidents pinpoint that many mistakes were occurring because of the sensemaking of DPOs (Hurlen, Skjerve, & Bye, 2019). Hence, proper training is essential to educate OOW to conduct a complete voyage plan on an OSV. Therefore, the failure of managing the position of OSV can cause a severe accident, resulting in the harm of human and environmental hazards. A significant explosion that occurred in the Gulf of Mexico in 2010 caused the accident known as the "Gulf of Mexico oil spill" (Roberts, 2018). This accident is considered as the most massive marine oil spill in the history of the petroleum industry and caused eleven human's deaths (Roberts, 2018). According to Dong, Vinnem & Utne (2017), most of the DP accidents are caused because of failures that combine technical issues, human and organizational factors. Therefore, DP training professionals in a safe environment, such as the DP simulators is essential.

Appropriate training professionals to work on DP vessels is required to prevent accidents that occurred because of the human factor. One factor that is consider causing accidents is communication and collaboration. The maritime industry is characterized by a strict hierarchical organization, which is affected by international regulation and guidance (Wahl, 2020). The team which operate in the bridge, and particularly in DP operations, is composed by the master, the senior, and the junior DPOs. The master gives the command, while the junior is the one who is regulated by the master and the senior DP officer. According to Wahl (2020), leadership includes collaboration and communication skills, as well as decision making.

Consequently, DPOs in bridge create relationships, and their communication affects the vessel and the operations. The bridge environment, the relationships between the officers, and the hierarchy establish a small community of practice, where DPOs share their knowledge and experiences to perform the tasks. DPOs working collaboratively and respecting the authority are engaged in a community of practice that Lave and Wenger (1991) presented at their book, where situative learning occurs. The master is the commander, but the outcome is teamwork. In the simulator DP exercise, communication is also crucial.

Trainees are also participants in their community of practice imitating the DPOs community of practice in DP vessels. They develop relationships, and they should communicate and collaborate to perform the tasks properly aiming to conclude the activity. Their role in the team and their engagement in the simulator exercise make them share their knowledge (previous or current) and their experiences. This kind of teamwork facilitates the students to co-create the learning in a situative way. Hence, to examine the relationships between the trainees and between the students with the instructor during a DP simulator-based exercise to understand how this contributes to the outcome of the students' learning experience, social theories are adoptable.From the above, it has been shown that simulator training in the maritime sector and offshore industry is beneficial for organizations and institutions. The simulator provides a safe environment for the trainees. In such environments, trainees perform tasks essential for their profession and in many cases, they practice in a critical and dangerous situation like conducting DP manoeuvres alongside offshore installation (Hontvedt, 2015; Hontvedt & Øvergård, 2020). Hence, institutions want to provide simulator-based courses to train professionals performing tasks that can cause serious accidents (Sellberg, Lindmark, & Rystedt, 2018; Liu, Blickensderfer, Macchiarella, & Vincenzi, 2008).

2. Problematization

2.1. Simulator-based training and *Fidelity*

Because simulators should simulate the job environment to create the feeling of the in-job atmosphere, many studies tried to investigate whether the simulators imitate the job environment. *Fidelity* is the term that these studies use to refer to the level of realism of the simulator and the simulator-based training (Hontvedt & Øvergård, 2020; Wahl, 2020; Dahlstrom, Dekker, Winsen, & Nyce, 2009). According to Wahl (2020), the *fidelity* level of a simulator shows how realistic a training course via simulator is. Particularly, provided that the fidelity is high, the trainees have a more authentic experience compared to the low-fidelity one, which provides an inefficient environment (Wahl, 2020). A simulator platform can be a simulating computer (Susarev, Bulkaeva, Sarbitova, & Dolmatov, 2017; Berendschot, Ortiz, Blickensderfer, Simonson, & Defilippis, 2018), or a platform that simulates the work environment (Sellberg, 2018). In both cases, the design of the simulator-based course should represent the situation, the tools, and the environment in a realistic way.

Previous studies have tried to investigate whether the level of fidelity of the simulator contributes to the learning accomplishment (Wahl A. 2020; Hontvedt, 2015; Hontvedt & Arnseth, 2013). However, they relied on different perspectives and created their frameworks. For instance, Liu et al. (2008) investigated the component focusing on the *transfer* of knowledge. They formulated a framework regarding the perception that trainees *transfer* *knowledge* that they practice at the simulators to the job environment (Liu, Blickensderfer, Macchiarella, & Vincenzi, 2008). This view was also adopted by Dahlstrom, Dekker, Winsen, & Nyce (2009) (Hontvedt & Øvergård, 2020). Place the topic into other perspectives, such as the cognitive, and other studies tried to investigate the impact of the situation awareness and team communication during simulated high-speed craft navigation (Øvergård, Nielsen, Nazir, & Sorensen, 2015). Moreover, later researches based on sociocultural perspectives on professional learning examined the importance and the role of the instructors in the learning process (Sellberg, 2018; Hontvedt & Arnseth, 2013). Hence, although there is not an accepted and comprehensive framework of the fidelity term, research wanted to investigate how the realism of the simulator exercise co-constructthe learning.

2.2. Background information of the study

To examine the fidelity level of the simulator-based activity and whether it contributes in learning process of the maritime students from a situative perspective, the study investigates a DP simulator activity. In this activity, students acting as professional maritime officers work in teams to perform critical tasks in DP. The instructor participates in two way, as a tutor who teaches, and as an agent who changes roles during the scenario. Therefore, because both the students and the instructor imitate the role of professionals working in the maritime industry through the role-playing, relationships are created between the human agents (instructor-students, students-students). Additionally, performing such tasks trainees utilise tools and learning materials, which both contribute to facilitating students co-construct the learning outcome.

The simulator exercise occurred in DP simulators at a maritime university in Sweden. The students who participated in this research were third-year students and they specialised towards the offshore industry. The study takes on a situative perspective, following socio-cultural and socio-material theories on learning. Trainees are seen as participants in *Communities of practice* (students' community, DPOs' community), interacting with materials, and creating knowledge through performing critical tasks in a simulator environment (knowing-in-practice).

3. The aim of the research and the research question

This thesis examines a simulator-based training activity in maritime education. The findings contribute to educational research on simulator-based training. Besides, it reveals issues that can be considered by the educational institutions to improve the designing of simulator-based exercises. The view was to investigate the simulator-based activity, to understand if and how aspects of realism during simulation co-construct the outcome of the students' learning experience from a situative perspective. Therefore, the main research question is posed, which includes two sub-questions:

1. How is realism co-created between participants and how does it contribute to the learning process?

a. How do the relation between the agents (instructor-students, students-students) constitute the training?

b. Is material and environment fidelities essential elements co-construct the learning process in a simulator-based exercise?

Methods

1. Theoretical orientation

Learning, according to Orlikowski (2002) is a continuous and social practice. Thus learning is achieved when people/actors are engaged in the practice (Orlikowski, 2002; Fenwick & Nerland, 2014). Besides, when actors are engaged in the practice, they interact with and within their environment. This environment is encompassed materials that are enacted and contribute to the learning outcome (Fenwick & Nerland, 2014). Students in DP simulator-based course practising the essential skills acting as professionals operating in an offshore environment. Hence, in this DP simulator-based course, students act as if they are members of a team that interact with colleagues and with their instructor. The instructor, in turn, works as if he played the role of other actors in the offshore environment.

Moreover, all the actors interact with the embodied artefacts of the DP simulator to complete the tasks. In such a course, the learning outcome is co-constructed by these complicated relationships. Learning in an artificial simulator environment requires interaction between the students, between the students and the instructor, and between agents and materials. Especially, in such situation, agents act not only with the necessary tools for their profession but also with complex new technological artefacts incorporated into the simulator environment. Such complex relationships will be examined in this study. The aim is to understand how these realism elements influence the learning process.

1.1. Socio-cultural theories: *Participation in Practice of Community & knowing-in-practice*

In the beginning, sociomaterial approaches emphasized on the individual process in professional learning (Fenwick & Nerland, 2014). These theories, as Fenwick & Nerland (2014) claimed, underline the importance of the relation between the experience of the professions and the way that they acquire new competences, as well as they accomplish the tasks. Currently, sociomaterial theories influenced by situated and sociocultural approaches employed the theory of *Participation in Practices of Community* (Fenwick & Nerland, 2014). In DP simulator-based course, the learning is co-constructed between the participants by practicing specific tasks in this artificial environment. Trainees being members (participants) of the bridge team (community), changing roles during the scenario to perform the tasks in a particular way (practices).

In the situative perspective, knowledge is distributed among people participating in groups and interacting with their peers and the environment (Greeno, Collins, & Resnick, 1996). In this theoretical perspective, the social interaction is equally important to the interactions between the environment, the rules, and the tools (Fenwick & Nerland, 2014). People learn as participants in *Communities of Practice* (Greeno, Collins, & Resnick, 1996, p. 20). In such communities, individuals are involved in activities in which they should collaborate to accomplish specific tasks. In the DP simulator-based course students have to work in teams to carry out the tasks that are essential to reach the teaching goal. Therefore, students who are trained in the DP simulators can be understood as *participants in Practices of Community*.

Besides other sociocultural theories incorporate materials in the learning process are required to examine the simulation environment. The theory of *knowing-in-practice* imports the notion that professionals practicing through assemblages to acquire the needed knowledge (Fenwick & Nerland, 2014). These assemblages are considered the environment in which professionals are practising and the materials that they utilise during the training process (Fenwick & Nerland, 2014). Moreover, in Gherardi (2014), the *knowing-in-practice* theory was introduced to describe the *knowledge* as a "situated, sociomaterial activity, and a collective practical accomplishment" (p. 11). In the DP simulator, materials are several tools and equipment, professional and educational: DP simulator; simulated bridge environment; screens; radio; checklists; maps; DP logbook; cameras; computers; chairs; desks. Thus, *knowing-in-practice* theory seems to be suitable to investigate the simulator environment as a factor in facilitating the learning process. Additionally, sociomaterial theories introduced premises maintain that both humans and materials, which are engaged in an activity, are elements contributing to the outcome. In this view, people represent all social interactions and practices, and they characterized as human agents (Fenwick & Nerland, 2014). Materials, which are implemented in such activities, are also agents, and their value is equal to humans (Fenwick & Nerland, 2014). Therefore, the tools and the equipment which are enacted in the DP simulator are essential factors in the learning process.

2. Approaching methods

Following the situative perspective and employing the theories *Participation in Practices of Community* and *knowing-in-practice*, this study took on an approach to investigate the learning process in a simulator-based course where DP operations are trained. The methods which were involved focused on investigating the communication between the agents through assemblages. Additionally, the materials implicated in the learning process and the simulation environment were evaluated.

As it reveals from the theoretical orientation, the aim of the study emphasised on social interactions. Thus, a holistic naturalistic approach could be beneficial for planning this research. The main reason is that when it comes to examining the attitudes of people in social practice, it is essential to have a holistic view of the context since there is not an accepted truth because the truth is influenced by different circumstances (Lincoln & Guba, 1986). Besides, people have diverse identities which are built by social interactions (Lincoln & Guba, 1986).

Therefore, this research employed three ethnographic methods to examine the simulator-based activity holistically. According to Greeno, Collins, & Resnick (1996), ethnography is one of the best-established research traditions have contributed to the situative perspective. Studies of social interactions between individuals in a group of people are encompassed into the ethnography research (Greeno, Collins, & Resnick, 1996). Additionally, Hammersley (2006) suggested ethnography as the most applicable methodology of investigating thoughts and assumptions of the people when they are in "particular contexts" (p.4). Consequently, the methods that are sufficient for inspecting students training in the DP simulator-based course are implemented in the ethnography.

To understand how the training process occurs in a DP simulator exercise, observations, video recording, and group discussion were adopted. As can be seen from the plan of research (Figure 1), all these methods had been employed contributing equally to the conclusion. Observations and video recording were utilised to investigate the DP simulator exercise and how students interact with each other to perform the tasks using the tools and the materials within the simulated environment. However, the group discussion enriched the understanding of the activity, the collaborative work, the environment, and the instruments. Additionally, having the findings from the group discussion was a supportive tool of watching the videos and underpin assumptions.

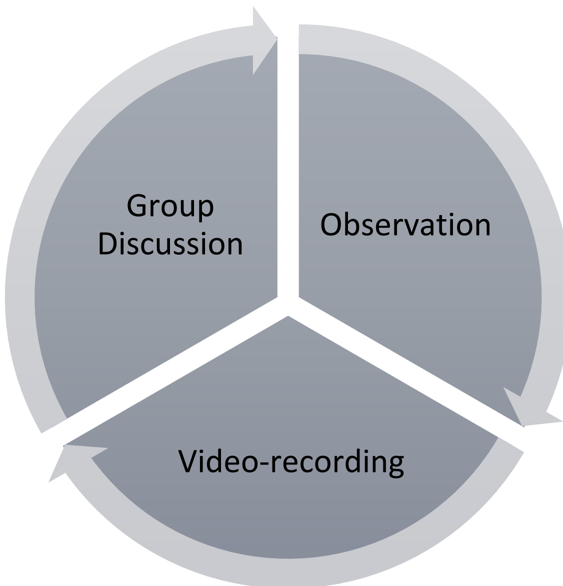


Figure 1: The plan of the research

2.1. Settings

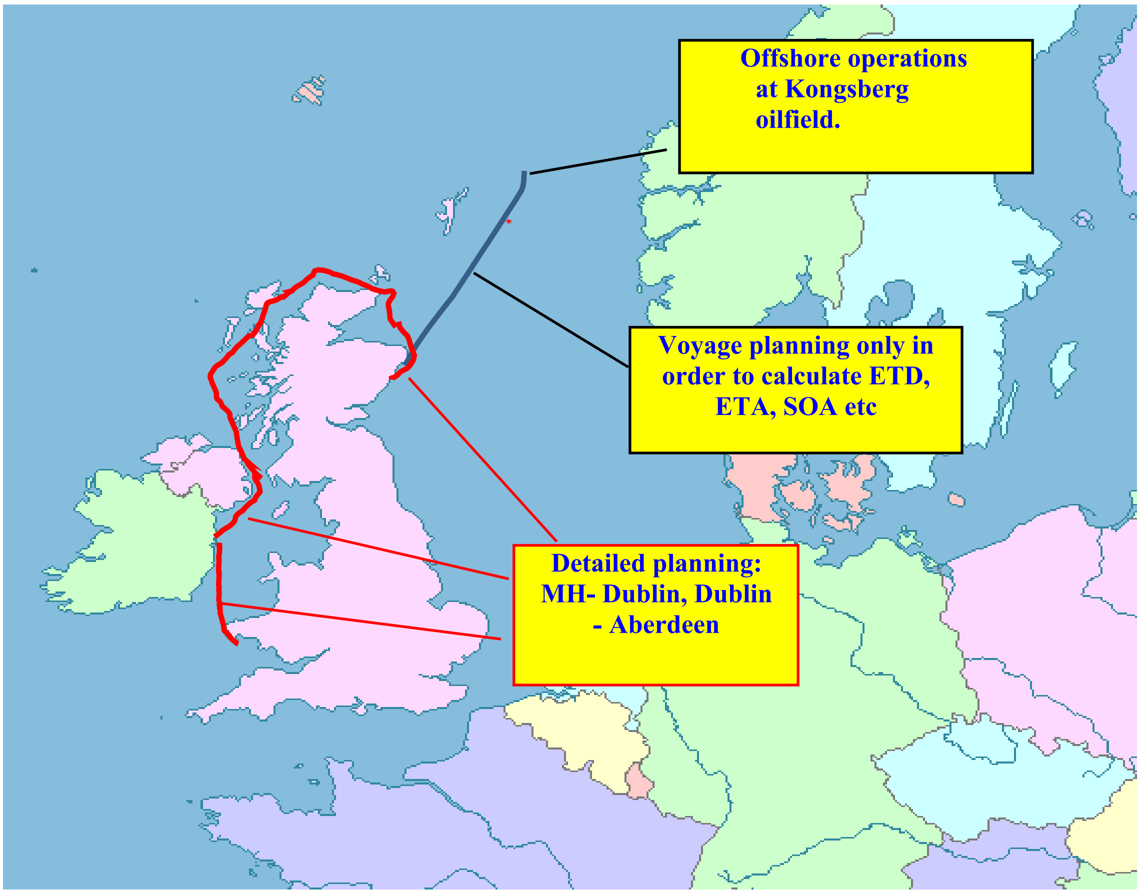


Figure 2: From teaching/learning materials: The voyage "Milford Haven – Dublin – Aberdeen – Kongsberg oil field"

A case study was conducted to investigate the interactions between human and material agents. In research, case-studies examining a specific subject illustrating essential topics (Gary, 2017). These topics improve the knowledge about an object/area (Gary, 2017). The aim was to gain a better understanding of the way that students are trained in a simulator-based course examining if and how aspects of realism during simulation co-construct the outcome of the students' learning experience from a socio-cultural perspective. Hence, DP simulator sessions in which students work in teams was chosen as a research subject. The participants in the study (n = 7) were one instructor and six students. The students were studying to become master mariners at a Scandinavian University. The DP course was offered in the last year of the studies resulting in the offshore specialization. To participate in this course, students had to succeed in the theoretical courses about DP. The teaching language is English, and the students had to perform in English as well. The instructor has professional experience from the offshore industry. In the DP simulator-course, students collaborated to conclude a whole trip from Milford Haven to Dublin, then to Aberdeen, and the voyage ends to Kongsberg oil field (Figure 2).

In this course, students worked in two DP simulators (Figure 3), which have unique characteristics. Consequently, this simulator-based course was suitable for investigating the role-playing, team communication, and the interaction between the students and the materials.

Figure 3: DP simulator. Picture from the empirical data

2.2. Case study

The DP course was chosen as the case study of this research. As mentioned above the course was suitable for this thesis because it has been taught in English, promoted the collaboration-communication between the students, and was the final course contributing to their specialization towards the offshore industry. Sociocultural theories were employed in this study because the research aimed to investigate the interactions between the agents. Finally, the participated students had prior experience in the simulator training and DP, which facilitated the conducted study. Therefore, examining the interaction between advance agents/users underlines interesting and relevant to the topic of the study issues. On the contrary, investigating novice would have revealed other problems, such as their introduction to the simulator, and how they can navigate a vessel.

To understand the research topic it is crucial to have some background information about the DP course. The name of the course is “The voyage: Offshore profile”, and it is provided in the fourth and last year of the studies in a Masters Mariner programme. Hence, in this point in training the students have achieved 135 higher education credits of theoretical courses and 45 credits of on-board training. The aim of the course is to train students proficient in the skills and competences that are essential to operate as an officer of the watch (OOW) on-board a ship. Mainly, this case study examines the exercise for DP. The course guide for the Academic year 2019/2020 described the following objectives of the operations of DP*:* “Familiarise with DP II simulator in a bridge environment; Practice manoeuvre of the DP Vessel Challenger in an offshore environment; Practice set-up for DP II operation with the support of checklists; Conduct DP manoeuvres alongside offshore installation; Practice reference system management.”

Additionally, because the video-recording data are conducted from a DP simulator exercise, there is also the need for some basic knowledge. Generally, three teams consisted of two to three students were performed in the DP simulators. However, six students participated in this study (video-recording: n=3, group discussion: n=6). The simulator exercise (scenario) was carried out at a bridge operational simulator. The students applied practical knowledge and advanced the required skills to work as a team on the bridge of a ship in an offshore DP II operation. According to the description of the activity, the “The task is to plan, execute and evaluate an offshore operation with the DP II vessel Challenger. Approach Kongsberg A and proceed out to the flare tower and inspect the gravity base of the Flare Tower with the ROV. The exercise consists of two parts: Part A: Will focus on the initial set-up for a DP II operation, entry of the 500m zone and initial manoeuvre within the 500m zone. Part B: Will focus on the set-up and execution of the ROV operation.”

The assignment had been analysed to the students and the task that they supposed to perform. Students should have pre-organised the tasks and documented before they started the scenario. The PD exercise, which is presented in this thesis, was conducted according to the plan. Each team had to formulate in a document an approach to the rig Kongsberg A (Flare Tower) and set up for a DP II operation regarding industry guidelines and necessary support material. They had provided a ROV1 operation and appropriate support material, an Activity Specific Operating Guidelines (ASOG) and permission to dive checklist.

Additionally, they had to conduct a Risk Assessment (SJA Form) of the planned operation, covering at least five different steps. Finally, they had drawn up a bridge manning plan compliant applicable rules and guidelines. The roles that each student had, and they changed them during the activity were: senior DPO, junior DPO, Master.

3. Data Analysis

3.1. Data generation

To understand the characteristics of the DP simulator-based course, and conclude to a research question, unstructured observations were conducted. The inspections occurred during the first lecture, the first visit at the DP simulator, and during the DP simulator exercise. All the sections – briefing; scenario; debriefing – of the DP simulator activity were observed. For the observation, personal notes were essential to understanding the situation.

The video-recorded data that are used in this thesis are part of the project "Assessment of professional performance: Maritime technologies, knowledge and educational practices in transformation" led by Charlott Sellberg. Three cameras were utilised for filming the simulator exercise video data. One was established in the instructor's room. At the same time, two pro-Cameras were settled in the bridge operations simulator to capture the students work both with the navigational instruments and with the DP station. In this thesis, an episode lasted 77.39' from one of the DP simulator-based activity is used. In this episode, one of the teams was performed. To specify, the episode includes briefing and 65.92' of the scenario. The team was composed of three students.

Also, a group discussion with the students (n = 6) contributes as a supplement method to reach conclusions. Group discussions with the trainees are an advisable method for a researcher to receive more honest answers. This happens because some individuals feel safer to discuss topics that they could have avoided in an individual interview. According to Gary (2017), in groups, people tend to be more venturesome, and this phenomenon is well known in social psychology as *risky shift phenomenon*. Moreover, in the groups, some people are more talkative, while self-conscious people might get motivated by others (Gary, 2017). This study was conducted in English, and none of the participants was a native speaker. The group discussion with the students solved the language barrier and multicultural communication. To specify, these issues were faced because some of the participants facilitated the process. A smartphone device was utilised to collect the voice-records.

To carry out the research, different materials were used to start the study and analyse the data. All the participants signed an informed consent statement in writing and online. The writing forms were signed for the video-recorded data since they are part of another project. For the observations and the group discussion, a supplemental online consent statement was formulated. The software that was used to create the online consent forms was *Survey Anyplace*. The transcription of all the voice-recorded data analysed manually and using Nvivo software. Nvivo facilitated the transcription and corrections were made manually. Voice-recorded data were gathered from the filmed DP exercise were analysed utilising the InqScribe. Images from the video gathered data were modified into sketches using snapstouch.

3.2. Analytical approach

As mentioned above, this thesis employed three methods – observations; video recording; group discussion. While parts of the discussion group are presented in tables, which is a more objective way to demonstrate them, a narrative approach was adopted to show the data from the observations and the video recordings. To be as transparent as possible, the research questions and the framework guided the selection of the demonstrated events (Derry, 2010). Events according to Derry et al. (2010) are considered the video segments. The approach was more deductive since the events were chosen regarded to the research questions and the framework, and from the situative perspective (Derry, 2010). According to Derry (2010), the narrative analysis facilitates the description of the events in order to make them understandable to the audients. Additionally, to achieve objectivity in terms of conclusions, all three methods were used complementary to each other. Hence, in this qualitative study, the data are posed following a narrow way of analysis.

3.3. Ethical consideration

The participants were quested to participate in the research before the study began. Besides, they were informed about their right to leave the study at any time, and that their participation would not affect their future career. No subjects withdrew from the study. Hence, with respect to protecting study participants from various forms of harm or risk of damage, this study follows the General Data Protection Regulation (EU regulation 2016/679). To ensure that participants agreed to be studied, they filled out two consent forms. The first one was in writing, while the second was online (Appendix 1). Besides, this study does not use images with the faces of the participants. The study refers to the results from the group discussion utilising the letter *S* and a random number from 1 to 6. Sketches replaced the pictures from the students. Finally, since a narrative approach is adopted as a method to present the data, no participant can be identified.

3.4. Data analysis

In the introduction section, it was mentioned that there is not a sufficient framework to evaluate simulator-based activities. The term fidelity refers to the level of the realism that a simulator exercise has, but it had been defined in various ways in the research about simulator training. Hontvedt & Øvergård (2020) designed their framework based on sociocultural theories, and they encompassed the fidelity factor in the simulator-based training in maritime education (Hontvedt & Øvergård, 2020). They considered the *learning objective* as the tasks and the activities that trainees should perform on. While the term *fidelity* divided into three categories:

i. <u>Technical:</u> it attributes to the design of the simulators (i.e., tools, instruments, and environment).

ii. Psychological: mental problems and problem-solving strategies.
iii. Interactional: teamwork activities.

Because of the centre research question of this thesis – How is realism co-created between participants and how does it contribute to the learning process? – and the situative view, the realism is examined as the relationships between the human agents (instructor-students, students-students), and the engagement of human agents in the simulator exercise. To investigate these interactions, oral and body language was examined, and two sub-questions were formulated: (a) How do the relation between the agents (instructor-students, students-students) constitute the training? (b) Is material and environment fidelities essential elements co-construct the learning process in a simulator-based exercise?

Compared to Hontvedt & Øvergård (2020), the view of the thesis relies more on education and social interaction; thus, it was suitable to modify their framework and develop a new one. In this study, the *technical* fidelity is divided into *material* and *environmental* fidelity. Materials are considered teaching-learning materials, tasks, and tools, which are involved in the training process. As *interactional* fidelity, this study refers to the relationships between the human agents. Lastly, environmental fidelity includes the space that students perform, the feeling that they perceive because of the visual and sounds signs, and issues that might disturb the training (Figure 4).

Framework of Fidelity

Material Fidelity	Tools; DP simulator; Checklists; tasks
Interactional Fidelity	Interaction between the students; interaction between the students as professionals (role-playing); interaction between the students with the instructor acting in a role; interaction between the instructor with the students
Environment Fidelity	Bridge environment; feeling (visual and sounds signs); technical issues

Figure 4: Topics that are examined in this study

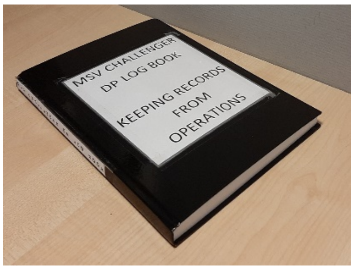
3.4.1. Observation

Observations to the DP course were made to introduce the researcher to the topic. The introduction lecture gave the necessary information about the DP, the learning materials, and the tools that students should use at the DP simulator exercise. The observation of the first visit at the DP simulator familiarised the observer with the tools, the scenario, and the tasks (Figure 5).

Left: DP system that instructor uses to add fitueares to the DP simulator

Right: Radio

Left: Bridge operation simulator. The outside view of the bridge, and the instruments that students use during operations



Right: DP note book. Professional usually record the events in it

Left: Instruments for maneuvering (autopilot and steering)

Right: DP operator system

Figure 5: Picture were taken during the observation occurred at the introduction to the DP simulator

3.4.2. Video recording

To analyse the video-recorded data a narrative analysis was employed. The focus was on events, which transcriptions were added as subtitles. The video segments were divided into major and significant events. Major events cover major themes, while significant events are usually shorter events having specific characteristics such as obvious starting and ending points, there is a continuous conversation, incorporate various knowledge, and implicate "inquiry strategies" (Derry et al., 2010, p.19). Thus, because of the video-recorded data that were available, it decided to group the *major events* into two categories: Briefing; Scenario. Each of them had been divided into sub-categories, which can be identified as *significant events* (Tables 1 & 2).

To specify, the purpose of analysing the video segments was to understand the relationships between the human agents, and their interactions with and within the materials. Hence, emphasising on the *significant events* guided the study. In these events, the body language, and the voice tone that agents had was examined.

Briefing: Significant events	**Time**
Introduction to the students and explain the scenario	00.00-00.40
Check the checklists and the students' plan	00.40-9.52
Instructor leaves	10.34
Roles	10.50
Scenario	11.04

Table 1: Significant events and the time that they occurred during the briefing

Figure 6: Analysis of the briefing using InqScribe. The instructor leaves, and the students started the scenario

Scenario	**Times**
DP collaboration	N=16
Communicate with the instructor	N=19
Unexpected events	N=4

Table 2: Significant events and how many times they occurred during the 66.35 minutes of the filmed scenario

Figure 7: DPOs (students) report to the rig Kongsberg A (instructor) that they change to DP

3.4.3. Group discussion

The discussion topics were organised into four main categories. The first one was the introduction to the topic and included questions about general information about maritime education and the DP course. The second category revealed the opinion that students have about training in a DP simulator environment. The tasks that they had to execute during the scenario was the third part of analysing the voice recorded data, while the fourth one was about role play and how they were decided their teams.

Findings

1. Observation

The observations showed that both collaboration and communication between the students and between the students with the instructor facilitate the training process in the DP simulator activity and therefore the students' learning experience. The team of the students to carry out the tasks for DP simulator exercise had to collaborate and communicate with the instructor, who was acting as a different professional at the offshore centre. At times, the instructor added extra features in the scenario, such as additional vessels which might cause collisions. Moreover, he created communication problems to make students find ways to approach the offshore station without proper communication with the station. These issues advanced the level of the exercise resulting to make students collaborate to find a way to execute the task imitating the job of the professionals.

2. Video recording

The videos revealed much information about all kind of fidelities. The tools that students utilised during the scenario are authentic. Both DPs were representative to the on-vessel DPs. From the briefing section was identified that trainees had already prepared the checklists and the plan of the trip (Figure 8). Therefore, students had acted as they had prepared for an on-vessel voyage. An interesting insight was that the instructor underlined that this team had found a new way to conclude the voyage (Figure 8). Additionally, this inside supports the idea that simulator training improves the learning process of the students, who co-create new knowledge by engaging in the activity. Finally, since all students performed efficiently, it seems that the chosen tasks are suitable for training third years students.

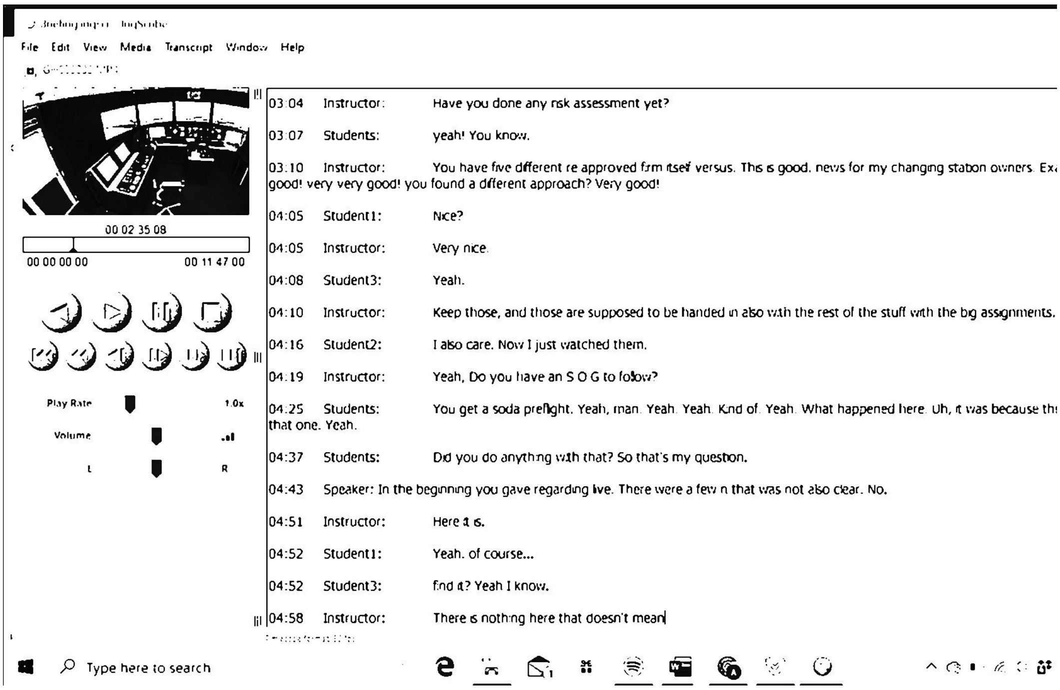


Figure 8: Analysis of the briefing using InqScribe. The instructor is impressed by the plan of the students and the checklists that they had prepared

The second fidelity is known as *interactional*. In this study, situative learning was examined to review the communication and collaboration in DP simulator training. Hence, analysing the data, the focus was on the interaction between the agents (students & instructor). As mentioned above, the team of the students had formulated the plan of the voyage, and the checklists needed for performing the tasks before the DP simulator exercise. They collaborated to overcome difficult situations (Figure 9), and when someone needed help, there was another one assisted him (Figure 10). Figure 10 presents an event that occurred during the activity. Students, as professionals having their roles (master, senior, and junior DPOs) and accepted the hierarchy, informed each other about the metres that they had. Notably, the master said “fifty”, and the senior DPO repeated “fifty”, while the junior DPO said “fifty”, but his voice indicated a hesitation. Then, the master DPO explained “five-zero”, and finally the senior DPO replied, “Okay, I’ll take it”.

Figure 9: They students found where was the DP class.

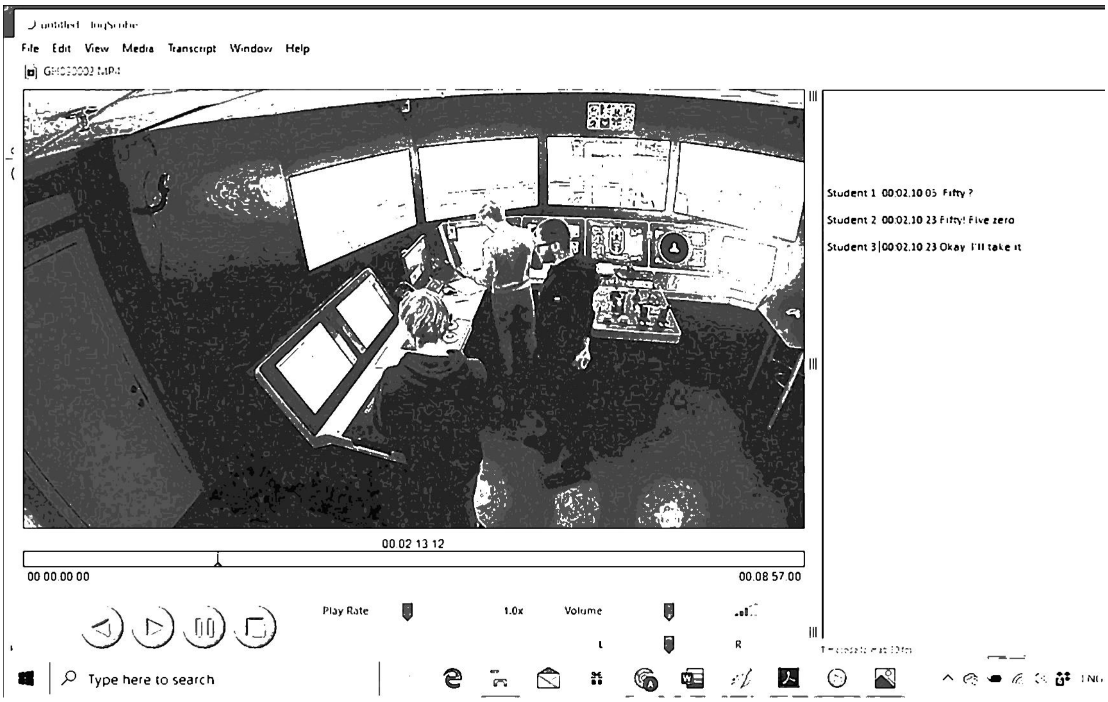


Figure 10: Student asked if it was the number "fifty", and the other answered "Fifty. Five Zero"

The events showed the interaction between the trainees and the instructor were many (Table 2). The instructor was acting as facilitator, or he used to play the role of the man sited in the rig Kongsberg A, or someone in their boat. When a technical issued occurred, he came at the bridge facilitating the students (Figure 11). On the radio, he changed his voice and his roles.

Figure 11: The instructor entered to check the DP simulator

Environmental fidelity is the one that included the view of the vessel, the bridge environment, and the sounds. The sounds of the waves and the vessel were through all the videos of the scenario. Trainees had the feeling that they are actually in a boat (Figure 12), and they had the view of the oil rig. Notably, Figure 12 shows that the student moved from on-site of the bridge room to the other trying to have a better view of the rig. Nevertheless, four unexpected events took place, that could possibly have disrupted the students. These events were one technical issue, and three times the leading researcher entered to check the cameras. The trainees showed that they were not affected, maintaining their focus at the task at hand (Figure 11 & 13).

Figure 12: Students moved to the other side of the simulator bridge to watch the offshore rig

Figure 13: Another person entered, while students were continuing the performance without to look who had come

3. Group discussion

The discussion with the students was illuminating and gave information about their perceptions of their training in a simulator-based course. In their opinion, simulator exercise is necessary, but it must be in combination with educational material, such as literature, and internship at the vessels (Table 3). Before entering the simulator, they claimed that it is crucial to have already studied the literature. Hence, literature works as a supplement in their learning. However, they underlined that they need more practice in the simulator to get familiar with the equipment and their functions (Table 4).

S(i)= Student
R= author/researcher

S6:	Ah (laughing) the practical matter is built on the theoretical. You need it to a tool to be able to … like have to get everything together, like if you have not having read anything, you don't know anything
S1:	Yeah! You need to have some. Because all we read… in other courses we always have like this …. we have some preparations. We do the week before the simulation exercise. Because if you haven't had any specific task for that … [background sounds… agreeing], yes, for that… the simulation that you have prepared for them. You can't get anything out of it. You can't just go into the simulator and drive around in circles, circles, circles without any purpose. You need to have a task to bring knowledge [Background sounds/agreeing & ensuring] and fast to demolish the rear view for the familiarizes you when we know something is wrong.
R:	*So, you prefer firstly to study the literature and be prepared about what you are going to do? practice! You must do it.*
S1:	You must do it for short years.. otherwise it has no meaning. It's meaningless.
S3:	Does this just come up …
S1:	Otherwise you can play driving the boat on your PlayStation instead. If you just want to drive boat.
S1:	Yeah, I think it's like a complement to just reading in literature and studying. But it's not a complement to do the actual thing.
S2:	It's a good tool for learning. But we need more practice. We need to get more and more, like it. [The main] … It's like, you know, a lot of training, lots of it may come out of it. Yeah.
S1:	[background sounds: agreeing]
S2:	It's good to…
S1:	It's good to recognize all the functions and stuff that we go through throughout the years. But all the functions of the equipment.

Table 3: Practicing in a DP simulator and learning: Comments from the discussion

The tools that they utilised during training in the simulator are the same that they are going to use on the job. Hence, it gives them the experience that they need when they start working in a vessel. The scenarios are structured to train them in specific tasks in a short time (usually around 2-5 hours). Thus, they are quite more advanced than everyday activities in a vessel (Table 4). They feel lucky having this introductory DP simulator training because they have an experience that usually professionals can have it only as additional training (Table 4).

S(i)= Student, SA= All the students
R= author/researcher

R:	*Yes. So, do you feel that the equipment represents [background sounds: yeah] the equipment that you're going to use?*
SA:	Yeap!
S1:	So, for instance, the ECDIS and the radars [others: Yeah .] It's exactly the same!
SA:	It's the same!
S1:	[Same for the ....] The difference is the data that is fitted into it and the environment that you did that your… It's like much [of] that like the DP , you know , during the DP simulation where we're standing with this small box . That's the actual DP computer. And that's the …
S2:	[list ...]
S1:	It doesn't look the same. It's exactly the same one that they have on the ship. It's just that in the simulator, our computer feeling the simulated being that, well, the current values. But the control works exactly the same for us, as it does that on the real vessel. So, for the technical skills, I think it's really good to have the simulator training, but maybe for like the environment and how ... Yeah. Yeah. Some stuff you can't do in a simulator.

P2:	... the teachers they are Prepared to see some solution that maybe we need to come to. Problems that they may want us to solve them.
PA:	Yeah.
P3:	They say they expect us [they are pretentious], they have expectations
P2:	problems to be solved. Maybe we wouldn't do it in real life. But they want us. To solve it in a specific way. But if we solve it in the other way, there is not counting.
R:	*So, they want you to follow a specific plan. And if you don't follow that plan, which includes many tasks, tasks that you have studied before [you ….*
PA:	Yes.
R:	Yes! I see! So, it’s mostly that they assess you according to the task. Not if you finish the scenario.
P1:	Yeah. That’s right.

P3:	Yeah. Yeah. Again, for the DP because it's so specific. So, it's an advanced step in a simulator. So, we are lucky that we get this first DP course already in school and because many other people, they go for years to become an officer in the vessel. Maybe they work on other ships for some years and then they get employed on this DP vessel and then they go to school .They have this course because Chalmers educates like people already in the business and not only students here . So then to take the course and they go 60 days to vessel and then they go back, take another course, and then 60 days more than that [
P4:	because their work as juniors, we can start working as juniors
P3:	other 60 days maybe

P2:	but you need induction,
P5:	you need lectures, you have the induction and then 60 days then again you can start working.

Table 4: Simulator and Material fidelity: Comments from the discussion

Moreover, some interesting topics to discuss with the students were the role-playing and team consistency. They changed roles from *master DPO* to *senior* and to *junior* during the exercise intending to achieve experience from every position. Regarding the crew consistency, they had chosen their groups from the beginning of the year influenced by their relationships. Only one of the students had changed team because as he mentioned, he did not care about the group, but he wanted to have different experiences (Table 5).

S(i)= Student, SA= All the students
R= author/researcher

	. . .
P2:	the third was the captain of the vessel. So, it was a junior DPO. So, junior dynamic positioning officer. And then we had the senior dynamic position officer. And then the third one was the master of the ship.
R:	*Okay. And did you play all these roles?*
PA:	Yeah. We switched around
P2:	we switched around. That was, what it fits much, because everybody wants to try all the roles. So sometimes we...
	. . .
P2:	. Yeah. We said it in Swedish to what's on the radio that we change the roles so that we changed. because the captain in our group, we had the task navigation so that the captain didn't do that much. The captain just did the communication overview communication. So if you would have played the role as captain throughout the whole scenario, you wouldn't get in the actual training DP training.
	. . .
P4:	when you Go to working every position to get to know the time to get out like. Overall, the job, the instruments, the driving, the communications like everything is important. And if you don't have been working as a master or senior or well blablabla, then you don't know how it works. It's good to have a knowledge of everything. Yeah, when we go out as second officers, so we're going to drive the boats. later on. Maybe the cop kept us. But it's a- it's a ladder.
P5:	Yaeh, there is a ladder of hierarchy.
	. . .

P2:	It's more that you pick your friends . I think [
PA:	Yes .
R:	Yes . Because you have better communication with people who you communicate generally .
P3:	And since September , the teachers told us that this team that you choose now in September , you will work with during the rest of
PA:	the rest of the coming months .
	. . .
P5:	I changed group, but I changed not because I preferred to. I just want to work with many people as possible to see how people manage because I don't care because maybe they're friends and they're friends work. For me, it's not one is not practicing because when it comes to vessel, you don't choose people to work with.
P6:	So, it wasn't mandatory, but it was suggested to do
P2:	It's good to change around. So, they said many people see different situations and different structures, how people help in the work and they don't work [
P1:	through all those years with the simulations. It really doesn't matter who you're. It's very rare that you get really annoyed with someone.

Table 5: Interactional fidelity and Communication in teams: Comments from the discussion

Discussion & Conclusion

For this master's thesis, three different research methods were conducted to address the question of how the realism of the DP simulator exercise is co-created between the participants and the simulator and how realism contribution to the learning process. To answer this central question, two sub-questions were structured viewing to examine the level of *reality* of the simulator training between the agents (humans and materials). Because of the absence of an accepted framework of *fidelity*, it was essential to create a framework influenced by Hontvedt & Øvergård (2020) to explore the relationships between the agents through assemblages. As it had been mentioned, fidelity is the term that previous studies used to refer to realism (Hontvedt & Øvergård, 2020). Because this study emphasis on relationships and interactions through training in a DP simulator exercise, the framework explicitly focused in three kinds of fidelities, material, interactional, and environmental. Through all these concepts of fidelity, this master's thesis examined the relations between the humans (Participation in Practice of Community), and between humans with and within the artificial environment (knowing-in-practice). Hence, the unit-of-analysis investigated was the relationships between the students, the instructor with students, as well as between the human agents with the materials/environment. The study intended to understand how these elements, human and material, co-construct the outcome of the students' learning experience in an artificial educational environment.

In regard to this, a sociocultural approach was adopted to examine the training in this DP simulator exercise and the relationships concreated between the human and material agents (Greeno, Collins, & Resnick, 1996; Fenwick & Nerland, 2014). Taking on a sociocultural approach, the findings showed not only that, but also how, the relation between the agents (instructor-students, students-students, students-environment, students-materials) interplay with the students' performance during the DP simulator exercise, and the perception of the students about the training through DP simulator exercises. Moreover, the trainees acted as professionals used the material imitate that they were in a vessel, and they handled the tasks properly. Hence, this DP simulator exercise created a feeling of realism in several dimensions, presented below.

Material fidelity

The concept of *material fidelity* was used to examine how representative the tools that trainees had to interact with, whether the DP II simulator was similar to on-the ship DP, the similarity of checklists, whether the problems of the exercise were realistic, and if the students could perform the tasks. The assemblages were tools and materials; students as professionals were practising (before and during the DP simulator exercise) through these assemblages (Fenwick & Nerland, 2014; Gherardi, 2014). As tools are considered the screens of ECDIS, radio, checklists, maps, DP logbook, and all the equipment essential to accomplish the whole voyage of the vessel and the tasks. From the observation and the discussion revealed that all the tools, the DP II simulator, and the checklists were exactly the same. According to Hontvedt (2015), having representative equipment adds value to the learning process. From another perspective, Liu et al. (2008) mentioned that training utilising inappropriate equipment might affect the learning outcome. Their view was that learning is transferred, and there is positive and negative transferring (Liu, Blickensderfer, Macchiarella, & Vincenzi, 2008). The negative transferring occurred when the system is not designed accurately (Liu, Blickensderfer, Macchiarella, & Vincenzi, 2008). Thus, practicing with tools which are not representative of the *real* affects the way that professionals perform.

On the contrary, this thesis adopts the perspective that students practicing in a school context are capable of re-using this knowledge and modifying it to fit with the new knowledge which reveals from the job context (Sellberg & Wiig, in press). Therefore, whether there is a tool which is not *exactly* the same, because of development or other reasons, the trainees as professionals are accomplished to connect these two contexts through *intercontextuality* to establish a new knowledge related to the new context (Engle, 2006). However, in a relevant study in DP simulator exercise, Wahl (2020) claimed that the equipment and the operating system in DP should imitate the real instruments.

Additionally, the DP simulator exercise occurred in a formal educational environment aiming to facilitate the learning process. The educational goal is always co-constructed by the school context, which meant that teaching and learning materials are equally important in the training process. Hence, material fidelity, which is presented in this thesis framework, should examine the tasks and the literature that students had to study before the DP simulator exercise. The results indicated that students were capable of carrying out the tasks and find ways to overcome issues such as communication with the offshore centre and approaching the rig. Besides, they had studied literature and passed exams in DP before they start performing at the simulators. Hontvedt (2015), in his study, demonstrated the topic of the importance to develop proper simulator activities in training. According to his study simulator exercises have the potential to improve the training process when they had designed considering the training goal, the technological fidelity of the simulator, and the scenario as corresponding elements affect the outcome (Hontvedt, 2015). As technological fidelity, he referred to the designing of the simulator. Hence, theoretical competence and practicing scenarios incorporating specific tasks interplay with possibilities to develop knowledge of professionals/trainees/students in a simulator-based exercise.

Interactional fidelity

Interactional fidelity included the inspection of the relationships between the human agents. Human agents in simulator training are the students as trainees and students as members of the bridge team (DPOs). Additionally, the instructor as a teacher, and as an actor in the community of practice. To understand these different relationships is crucial to realize that all the human agents - students and instructor - have two identities/roles. Students are trainees, and they had to study before the DP simulator activity and sit for exams. They had to prepared materials such as the voyage plan, and the checklist as homework before the simulator performance. This homework was a team-work outcome affected by the knowledge of students, and by their interaction. The second role of the students was acting as DPOs during the simulator exercise. They had to adopted *characters* according to their *working specialization*, which was affected by the hierarchy. In the introduction was mentioned that in such a community of practice, hierarchy is part of the working environment. One student was the *master*, the other *senior DPO*, and the last one *junior DPO*. The video showed that their roles as professionals influenced their actions through the simulator exercise (master: "fifty", senior: "fifty", junior: "fifty", senior: "Okay, I'll take it"). Each one had specific role, and his decisions were influenced by the impersonation of the character (*master DPO*; *senior DPO*; *junior DPO*) Besides, the importance of hierarchy was underlined during the discussion group ("Yeah, there is a ladder of hierarchy").

Likewise, the role of the instructor was double. He had to be *the teacher* (fundamental role) and facilitate the performance of the student. While, at the same time, he had several other roles: a member of the crew; the man at the offshore rig; a mariner of another vessel creating a collision. Therefore, the job of the instructor was essential during simulator activity. Before the exercise, he introduced students to the scenario, and he checked the *homework*. During the scenario, he helped students overcome some issues, such as restarting the DP II simulator when a technical issue occurred. Moreover, the instructor advanced the exercise to train students to find a way to overcome critical situations, for example by providing new challenges in the unfolding of events during the scenarios. For instance, when playing the role as the man settled at the offshore rig, the instructor asked students to find another way to approach the rig, as he stated that there were some constructions in front of the rig. This sort of *filling in* by adding imaginative functions is in line with previous on simulator-based training. For example, Sellberg (2017) show how instructors were acting out body movements in the simulator, as if the ship was moving in certain ways.

The findings showed that *interactional fidelity* contributes to the training and co-constructs the outcome of the students' learning experience through the DP simulator exercise**.** The observation, the video-recorded data and the discussion group indicated that students collaborated as professionals. Particularly, because of the excellent communication skills of the students, they succeeded in the simulator exercise performance. The comments of the instructor when he was checking the homework (plan and the checklists) supports this conclusion. These results support Wahl (2020) study, which examined whether collaborative activities in a DP simulator exercise contribute to the learning outcome. Her results showed that learning is affected by social practice. Similar studies in maritime simulator-based training showed that perceiving learning is positively influenced by the social interaction and the activities that students practiced on (Hontvedt & Arnseth, 2013). Hence, trainees acting as professionals participate in their *Communities of Practice* to accomplish the tasks and achieve learning, which indeed is a continuous and social practice (Greeno, Collins, & Resnick, 1996; Orlikowski, 2002).

However, communication between the trainees is affected positively by elements such as *friendship*. From the discussion revealed that most students had decided their teams because of *friendship*. They claimed that "... you have better communication with people whom you communicate generally". Thus, it seems that they believed that *friendship* facilitates communication between them. Only one of the students had changed crews because he wanted to have a realistic experience. Notably, he underlined that "...because when it comes to the vessel, you don't choose people to work with". Studies in the working environment have proved that friendship relationships are an element to succeed (Gordon & Hartman, 2009). Hypothetically, no relationship or bad relationship between the trainees might contribute to the learning negatively, which deserves further attention in research on simulator-based training.

In this DP simulator exercise, the job of the instructor as facilitator was notable. As a teacher, the instructor was prepared to intervene and support students. This readiness of the instructor shows that the interaction with the students was suitable, taking on account the relationship instructor-students. Previous studies on maritime simulator training have proved that the role of the instructor is crucial in the learning process (Sellberg, 2018). His part is essential and extremely complicated. While students had only to act as professionals, the instructor had to act as *teacher* and *actor* at the same time. This view supports Sellberg (2018) study, which showed that simulator-training courses are highly depended on the instructor. The same conclusion was revealed from Kelly et al. (2019), in their study of a simulator operation room. In this setting, the instructor was explaining, in detail, the positions that trainees should have according to their role, how to use the materials, and issues that they should take into consideration when they start performing the scenario (Kelly, et al., 2019). These conclusions open the new research questions about if and how trainees can achieve learning through simulator-training independently, for example, through the student-led simulator exercises that takes place at the simulator center.

Environmental fidelity

The third type of fidelity was examined in this master's thesis was *environmental fidelity*. In this study, environment fidelity referred to the bridge environment. Therefore, the feeling of students acting in the bridge of the vessel, the sounds of the waves, the view from the bridge, and technical issues or other unexpected events was explored. Observations and videos of the simulated activity showed that the sounds in the simulator were similar to be in a bridge of a big vessel through a voyage in *normal* weather situation. Additionally, the view from the simulator bridge could change turning all around like a bridge in a vessel.

During the simulation, the students were acting like DPOs and from their body language, it was apparent that they were focused on fulfilling the tasks at hand. However, there are reasons to believe that the students focused more on accomplishing the tasks than being in a realistic simulator environment. The main event that supports this opinion is that when other people entered the simulator bridge room unexpectedly, the trainees did not react. On these occasions, students continued practicing without even turn their face to the door. These findings are in accordance with Wahl (2020), who examined a case of DP simulator training, and concluded that in such activity, the layout of the bridge does not affect learning. Instead, the physical and functional characteristics of the simulator environment were found to be more relevant to the tasks and the scenario (Wahl, 2020).

Although the environment seems not to affect learning *per se*, other issues, such as technical problems can disturb the training process. During the DP simulator exercise, a technical issue occurred, and the students had to stop the performance. The instructor entered the simulator room and restarted the DP simulator. In this case, elements such as the quality of the simulator system, the experience of the instructor, the good communication between the students, resulted to solve the problem quickly and efficiently. However, technical issues can disturb the learning experience of the students the training process, especially when students are novice, and they do not have the experience to realise that there is an error in the system. In such cases, educational institutions need to have a skilled instructor and exceptional technical equipment (Ravikanth, Bahuguna, Glaser, & Shivalkar, 2018; Sellberg, 2018).

Conclusion

This master's thesis examined a simulator-based activity in maritime education, adopting the situative perspective. It employed three different methods to provide a holistic view of the social practices occurring between the humans in the simulator environment. The findings indicated that the preparation of the students, the excellent relationship of the member of the team, the experienced instructor, the teaching-learning materials, the similarity of the professional tools, and the tasks all contribute to the learning outcome in training DPOs. Notable, the most important elements of realism co-construct the outcome of the students' learning experience in the DP simulator-based training were the relationship between the human agents, the teaching-learning materials, the similarity of the DP system, and the tasks. Contrariwise, the realism of the simulator environment does not influence the learning experience of the students in the DP simulator-based exercise.

Most of the findings are in accordance with most of the similar previous studies. However, there is a need for more extending research to understand whether these findings changing in other kinds of simulator-based training, such as utilising devices, computer programmes, or Virtual Reality (VR). Besides, training already maritime officers to specialise them in DP might reveal more issues, because training experienced professionals is more complicating practice than training experienced students.

All in all, training via simulator can facilitate the learning process provided that this training is formulated in a formal learning environment. Simulators can be an excellent teaching-learning tool when this tool has been incorporated into an educational curriculum having specific teaching goals. Simulators are educational tools and provide learning when the scenarios and tasks are designed to educate people to become professionals. Additionally, the role of the instructor in such a context is crucial. Hence, this thesis concludes that simulator-based training facilitates the learning process when there is a well-organised educational *environment* "Otherwise you can play driving the boat on your PlayStation instead".

Limitations

This qualitative study wants to examine how training process occurs in a DP simulator exercise examining if and how aspects of realism during simulation co-construct the outcome of the students' learning experience. The approach is naturalistic, and therefore the view is influenced by the complex dimension of reality because each participant and the author have different perception about it (Lincoln & Guba, 1986). Following this approach, the main limitation of the thesis can be the subjectiveness of the author who analysed the data, i.e., the assumptions of the findings might be affected by my background in the education field. In order to minimise the subjective impact, three qualitative methods for data collection was conducted, providing triangulation of results (Lincoln & Guba, 1986). Since the overall objective is to understand team simulator activities and suggest new pedagogies to improve training, the study utilised three methods to provide a holistic view of training in a simulator environment taking on both the opinion of the instructor and the perspectives of the students.

Additionally, another limitation of this study is that the technical system of the simulator and the scenario from the perspective of the designer or the maritime industry are left out. Future studies can combine these field in order to improve both maritime education and simulator training. Lastly, this is a case study conducted in DP simulator activity, which has unique characteristics. Therefore, the conclusions might be challenging to transfer to other training activities or contexts. For instance, the results showed interesting and vital material aspects of training teams in simulators, but these components might not influence trainee operators working individually.

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Appendix 1

Instructor's consent form

Information to study participants

1. Form of consent The purpose of the study and the necessity of your participation in my research: The research project is carried out for my master's thesis purposes at the University of Gothenburg. My study focuses on examining the efficacy of utilizing simulators in DP training by emphasizing on the trainees' reflection and the learning outcome. Hence, your participation, as an instructor at the DP simulator-based course, is essential for the aim of the study.

2. Description of the study: The methods of the research are "observations", "video-recoding", and "group interview". The observations will be conducted on the 24th of January lecture, on the 29th of January visit at the DP simulator, and during the performance in the simulators on the 10th, 11th, and 14th of February. Additionally, the video-recording data obtained from the training in the simulators on the 11th of February will be used. Finally, the research will be concluded with a "group interview" with the students.

3. Protection of your personal data: The collected data will be used only for the study, and they will be handled following the General Data Protection Regulation (EU 2016/679). As the researcher, I am responsible for protecting your data in such a way that no unauthorized persons can gain access to them. Your personal information, such as your name will be not used. I guarantee your anonymity since I will use a coding system to name you both in my master's thesis. Besides, your voice-recordings will not be provided to anyone except me. You have the right to access your data (voice-recordings and transcripts), and you can ask for its deletion according to the General Data Protection Regulation. If you would like to access your data, contact the researcher. In case you feel offended with the way that your data is handled, you also have the right to report your concerns to the Swedish Data Protection Authority, which is the relevant regulatory agency.

4. The results of the study: Having concluded my master's thesis, I can provide you with the results and my study's paper as well. In case you are interested in getting informed, you can contact me, the researcher, via e-mail.

5. Participation is voluntary: I would like to underline that your participation in this study is voluntary. As long as you decide to participate, you should sign the following consent form. Finally, you are free to quit the study anytime you want.

6. Contact information: Master's student: Anastasia Skarpeti +46 (0)72 448 3561 gusanask@student.gu.se Supervisor: Charlott Sellberg +46 (0)766-186557 charlott.sellberg@ait.gu.se I have received written information about the study and have had the opportunity to ask questions. I can keep the information provided to me.

Figure 14a: Information to study participants (online)

Students' consent form
Information to study participants (trainees) 1. Form of consent The purpose of the study and the necessity of your participation in my research: The research project is carried out for my master's thesis purposes at the University of Gothenburg. My study focuses on examining the efficacy of utilizing simulators in DP training by emphasizing on the trainees' reflection and the learning outcome. Hence, your opinion, as trainees the DP simulator-based course, is essential for the aim of the study. 2. Description of the study: The methods of the research are "observations", "video-recoding", and "group interview". The observations will be conducted on the 24th of January lecture, on the 29th of January visit at the DP simulator, and during the performance in the simulators on the 10th, 11th, and 14th of February. Additionally, the video-recording data obtained from the training in the simulators on the 11th of February will be used. Finally, the research will be concluded with a "group interview". Participating in the "group interview" means that the participants will be asked some questions, and their honest opinion is needed. There is no wrong and right response. The data will be collected by a voice-recorder, and I will transcribe them manually. 3. Protection of your personal data: The collected data will be used only for the study, and they will be handled following the General Data Protection Regulation (EU 2016/679). As the researcher, I am responsible for protecting your data in such a way that no unauthorized persons can gain access to them. Your personal information, such as your name will be not used. I guarantee your anonymity since I will use a coding system to name you both in my master's thesis. Besides, your voice-recordings will not be provided to anyone except me. You have the right to access your data (voice-recordings and transcripts), and you can ask for its deletion according to the General Data Protection Regulation. If you would like to access your data, contact the researcher. In case you feel offended with the way that your data is handled, you also have the right to report your concerns to the Swedish Data Protection Authority, which is the relevant regulatory agency. 4. The results of the study: Having concluded my master's thesis, I can provide you with the results and my study's paper as well. In case you are interested in getting informed, you can contact me, the researcher, via e-mail. 5. Participation is voluntary: I would like to underline that your participation in this study is voluntary. As long as you decide to participate, you should sign the following consent form. Finally, you are free to quit the study anytime you want. 6. Contact information: Master's student: Anastasia Skarpeti +46 (0)72 448 3561 gusanask@student.gu.se Supervisor: Charlott Sellberg +46 (0)766-186557 charlott.sellberg@ait.gu.se I have received written information about the study and have had the opportunity to ask questions. I can keep the information provided to me.
Figure 14b: Information to study participants (online)

GÖTEBORGS UNIVERSITET

Till deltagare i studien 2019-11-18

Medgivande till medverkan i ett forskningsprojekt om simulering

Vi vill fråga dig om du vill delta i ett forskningsprojekt. I det här dokumentet får du information om projektet och om vad det innebär att delta.

Under 2019–2021 kommer ett forskningsprojekt kring simulering att genomföras. Forskningshuvudman för projektet är Institutionen för Tillämpad informationsteknologi vid Göteborgs universitet. Med forskningshuvudman menas den organisation som är ansvarig för studien.

I projektet studeras träning och examinationer som genomförs i simulatormiljö. Eftersom undervisningen kommer att spelas in med videokamera behöver vi ditt medgivande för att kunna videofilma ditt deltagande. Inspelningarna skall enbart användas i forsknings- och utbildningssyfte. Syftet med projektet är att utveckla kunskap om hur yrkesmässiga kompetenser tränas och bedöms med hjälp av simuleringar, och hur kvaliteten i undervisningen kan utvecklas. Vi vill därför betona att vi inte är intresserade av enskilda personers prestationer under träning eller examination.

Ditt deltagande är frivilligt och du kan när som helst välja att avbryta deltagandet. Om du väljer att inte delta eller vill avbryta ditt deltagande behöver du inte uppge varför, och det kommer inte heller att påverka din framtida anställning. Om du vill avbryta ditt deltagande ska du kontakta de ansvariga för studien (se nedan).

Projektet kommer att samla in och registrera information om dig. Dina svar och dina resultat kommer att behandlas så att inte obehöriga kan ta del av dem. Ansvarig för dina personuppgifter är vanligen forskningshuvudmannen. Enligt EU:s dataskyddsförordning har du rätt att kostnadsfritt få ta del av de uppgifter om dig som hanteras i studien, och vid behov få eventuella fel rättade. Du kan också begära att uppgifter om dig raderas samt att behandlingen av dina personuppgifter begränsas. Om du vill ta del av uppgifterna ska du kontakta Charlott Sellberg (se nedan). Dataskyddsombud vid Göteborgs universitet är Kristina Ullgren som kan nås via email dataskydd@gu.se. Om du är missnöjd med hur dina personuppgifter behandlas har du rätt att ge in klagomål till Datainspektionen, som är tillsynsmyndighet.

Bedömning av professionellt agerande: Sjöfartens teknologier, kunskap och undervisningspraktiker i förändring

Alla personer som medverkar på inspelningarna kommer att vara anonyma i den rapportering som kommer ut av projektet. Namn kommer att ändras till fiktiva namn i de texter som publiceras. Bilder från videoinspelningarna som används vid rapporteringar kommer även de att anonymiseras så att personerna inte är möjliga att känna igen. Om du önskar ta del av den rapportering som kommer ur projektet, kontakta Charlott Sellberg (se nedan).

Kontaktpersoner vid frågor eller funderingar:

Charlott Sellberg
Göteborgs universitet
076–0776685, charlott.sellberg@ait.gu.se

Olle Lindmark
Chalmers tekniska högskola
031-772 26 45, olle.lindmark@chalmers.se

Meddela i talongen nedan om du vill delta eller inte

- -

Samtycke till att delta i studien

Jag har fått muntlig och skriftlig informationen om studien och har haft möjlighet att ställa frågor. Jag får behålla den skriftliga informationen.

☐ Jag samtycker till att delta i studien

☐ Jag samtycker till att uppgifter om mig behandlas på det sätt som beskrivs i forskningspersonsinformationen.

Plats och datum	Underskrift

- -

2

Figure 15: Information to study participants (in writing)