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Maritime Students' Use and Perspectives of Cloud-Based Desktop Simulators: CSCL and Implications for Educational Design

W. Gyldensten[1], A.C.Wiig[1] & C. Sellberg[2]
[1] *University of South-Eastern Norway, Borre, Norway*
[2] *University of Gothenburg, Gothenburg, Sweden*

ABSTRACT: This study investigates the challenges and opportunities of using cloud-based simulators for training in maritime education and training (MET). The aim is to map bachelor students' use and perspectives to inform educational design when implementing cloud simulation into the curricula. This study uses an ethnographic design approach in the tradition of Computer Supported Collaborative Learning (CSCL) and draws on video-recorded exercises and interviews (n=22) from 1st and 3rd-class maritime bachelor's students engaged in navigation exercises on cloud simulation. The findings suggest that individual training with cloud-based simulators in MET can enhance the repetition of skills necessary for better performance in a full-mission simulator with current technology and rather straightforward instructional designs. However, the findings also emphasise that simulator exercises need to be more engaging for students in order to provide a meaningful learning experience. Hence, simulator software needs to provide the means for students to collaborate during exercises, and feedback provided by the system needs to be carefully aligned with the student's previous knowledge in order to provide adequate scaffolding.

1 INTRODUCTION

The use of cloud-based simulators in maritime education has been a new learning tool developed in recent years, offering a number of benefits such as increased accessibility and flexibility for students [1]. However, little is known about maritime students' perspectives on using these simulators and how they may impact the design of maritime education programs. In this article, we seek to explore maritime students' use and perceptions of cloud-based simulators and how they may be used more effectively in maritime education [2]. Through ethnographic fieldwork and interviews with maritime students at a university, we aim to understand the benefits and challenges of using cloud-based simulators and the implications for the design of maritime education programs [3]. Our findings contribute to the growing body of research on the use of technology in maritime education and provide valuable insights for educators seeking to enhance their students' learning experience when training in low-fidelity simulators.

This study investigates the challenges and opportunities of cloud simulators in maritime education from a student's perspective in order to inform educational design for implementing cloud-based simulators in Maritime Education and Training (MET). Cloud simulators is a cloud-based version of a desktop simulator that allows students to use the simulator from anywhere, not just on campus[1]. Desktop simulators and cloud-based simulators are utilised during basic navigation exercises designed to teach students the fundamentals of ship navigation. In maritime education and training (MET), instructor-based simulator exercises have been a crucial but restricted resource for maritime students [4]. Moreover, even if training in simulators is regulated, there are no regulations regarding the amount of time spent in a simulator. As a result, the amount of time that students are given to participate in learning activities within the simulator is often the result of an administrative compromise between the availability of the simulator and instructor resources. The relatively recent development of cloud-based simulators, in which students can practice basic navigation on their own, has the potential to be a valuable addition to the physical simulators offered today. This study takes on an ethnographic design approach, drawing on video-recorded materials from maritime bachelor students engaged in navigation exercises on cloud-based simulators (n=22), followed by group interviews [3]. The aim is to map the students' use and perspectives on the challenges and opportunities of the cloud simulator used in maritime education to inform educational design when implementing cloud simulation into the curricula. The research questions are:

4. How do MET students make use of cloud based simulators for basic navigation training?
5. What is the student's view on the opportunities and challenges of using a cloud simulator for basic navigation training?
6. How can we design exercises for cloud simulators that support collaborative learning between students?

2 BACKGROUND: COMPUTER SUPPORTIVE COLLABORATIVE LEARNING

This study draws on previous research from Computer Supported Collaborative Learning (CSCL), a research field focusing on understanding how technology can support collaboration and learning, with small groups as the unit of analysis [5]. CSCL as a research field arose in the 1990s in reaction to the introduction of software that "forced students to learn as isolated individuals" [6, p. 1]. In contrast, CSCL is based on an opposite concept: by proposing the development of software and applications that bring people together to engage in learning through joint intellectual exploration and social interaction. Since the 1990s, CSCL has grown into an evolving and eclectic research field, as researchers from different disciplines, such as education, psychology, and computer science, continuously explore how technology can support collaborative learning in a variety of settings, from formal learning in educational settings, such as schools and universities [7], to learning in informal settings, such as leisure activities and learning in the workplace [8]. Moreover, CSCL research draws on three main theoretical perspectives on learning: cognitive, socio-cognitive, and sociocultural perspectives [9]. Without going into detail on all three perspectives on learning in the CSCL field, we will focus on and adopt a sociocultural perspective [10].

From the sociocultural perspective, CSCL research starts with an empirical investigation of micro-interaction during computer-supported collaborative learning activities [9]. By shifting the analytical focus from individual learning to group collaboration, CSCL typically views meaning-making activities as interactional achievements [5]. This means that meaning-making is situated within the sequential order of talk and bodily conduct between multiple participants in a setting, which also becomes the focal point for the study of CSCL, using ethnographic fieldwork and case studies as the main methods of inquiry [11]. In particular, Stahl [12] highlighted how empirical studies that employ micro-interactional analyses of speech, gesture, artefacts, and technology could make the details of these interactional achievements visible in a useful way for guiding the design of computer-based artefacts as well as instructional designs. Moreover, it is common for CSCL research to involve interviews with teachers and learners directly after participation in computer-based activity [13]. Interviews are important in order to understand and examine the intricate relationship between the social and the material and refine the practices involved in computer supported collaborative learning processes [3]. Hence, as explained by Stahl and colleagues, *"CSCL research has both analytic and design components. To design for improved meaning-making, however, requires some means of rigorously studying praxis. In this way, the relationship between analysis and design is a symbiotic one—design must be informed by analysis, but analysis also depends on design in its orientation to the analytic object."* [6, p. 11].

This highlights the importance of balancing analytical and design components, which can be achieved by studying existing learning practices and incorporating this understanding into the design of new exercises. This would enable maritime instructors to create more effective and meaningful learning experiences for their students. Previous CSCL studies on simulations in MET have shown valuable for outlining the ways that the simulator instructor is central for supporting students in reaching the learning objectives of the exercise [4], the complex question of selecting the appropriate level of simulator fidelity for specific tasks and groups of learners [14] as well as the benefits of students learning together in small groups during training in the simulator [2]. For our purpose of informing instructional design when implementing a new technology in MET, we drew on both ethnographic observations of students working with cloud-based simulations at a Scandinavian university, as well as contextual interviews with the students conducted directly after completing the simulation.

2.1 *Collaboration in CSCL*

To distinguish between the different concepts of collaboration and cooperation is important when applying CSCL contexts in maritime education and training. Stahl and colleagues [6] distinguish collaboration and cooperation based on Dillenbourg's [15] and Roschelle & Teasley's [16] definitions: *"In cooperation, partners split the work, solve sub-tasks individually and then assemble the partial results into the final output. In collaboration, partners do the work 'together."* [6, p. 3] Collaboration, on the other hand, is seen as *"a process by which individuals negotiate and share meanings relevant to the problem-solving task at hand … Collaboration is a coordinated, synchronous* *activity that is the result of a continued attempt to construct and maintain a shared conception of a problem"* [6, p. 3].

There are many different types of digital tools used in CSCL activities to facilitate collaboration among its members. In a meta-analysis of 425 empirical studies Chen et al. [17] identified seven major subcategories of collaboration tools that can be categorised as: basic online discussion tools, enhanced online discussion tools, visual representation tools, group awareness tools, graphs or multimedia for instruction, adaptive or intelligent systems, and virtual environments. Moreover, Chen's [17] meta-review highlights the numerous benefits of utilising CSCL at both the individual and group level, such as enhanced knowledge gain, skill acquisition, student perception of critical thinking skills, improved problem-solving abilities, increased motivation and engagement, and better communication and social skills. Chen et al. [17] also emphasised that the use of CSCL fosters a sense of responsibility, accountability, and ownership among students, which ultimately contributes to their overall learning experience and professional development. While the simulation tools in focus for this study would fall under the virtual environment classification, student collaboration is central to traditional training in full mission simulators where the student works in teams to navigate a vessel [18]. The simulator environment is a powerful tool for mimicking the relevant features of the work setting on board an actual vessel and provides a safe setting for the construction and exploration of the task at hand. Hence, through simulated activities, the development of professional knowledge occurs collectively through the collaborative building of understanding among students in a simulator [6]. However, it is important to acknowledge that students in the simulator also cooperate by dividing tasks among each member of the bridge team to manage all the complex tasks associated with the operation of the vessel in the simulator [2].

3 METHOD: VIDEO RECORDED FIELD OBSERVATIONS AND INTERVIEWS

The ethnographic design in this study was inspired by Crabtree et al. [3], drawing on video-recorded observations and interviews from a group of 22 maritime bachelor students. The students were part of two different classes in a maritime bachelor's program and were recruited via website, email, and direct contact. The 1st year students consisted of 10 participants enrolled in a basic navigation course at the university. The third-year student consisted of 12 participants and had passed all simulator exercises in the bachelor's degree. The aim was to gain knowledge of the student's perception of the cloud simulator both from the perspective of a novice simulator user (1st year students) and a more experienced simulator user (3rd year students). The 1st year students were enrolled in a basic navigation course with a desktop simulator as the primary simulator and a cloud simulator as a supplement between the scheduled and instructor lead teaching. The 3rd year students had finished their certificate simulation training and served as an expert group. However, they had no previous experience of using cloud simulation.

The exercise was performed in the cloud simulator lab at the university (Figure 1). Each simulation lasted approximately 30 minutes and involved two students. The learning objective in the cloud simulator was Automatic Radar Plotting Aid (ARPA), a basic and important function of the navigation radar. The proficient handling of ARPA functions is a learning objective for the basic navigation course. Several measures were considered to design the study as naturally as possible. ARPA exercises were chosen as the focal point for this study because ARPA training represents the first advanced semi-automated function the student learns to master in their education, and it is a part of the certificate part of the education. The students navigated a ship in open sea with several other pre-assigned simulated ships. The learning goal was to learn how to operate the Radar and perform manoeuvres to avoid collision. During the simulation, the students received e-coach messages on the screen stating how the students should navigate and how to operate the Radar. Training to handle ARPA functions in the Radar was the main topic in the week that fieldwork took place, and the training session in the cloud simulator lab was selected for closer analysis and video recording. The lab was set up with two cloud simulator workstations containing two monitors, a keyboard, and a computer mouse. One monitor displayed the Radar, and one monitor displayed the instruments like autopilot, rudder control and turn indicators (Figure 1 and 2).

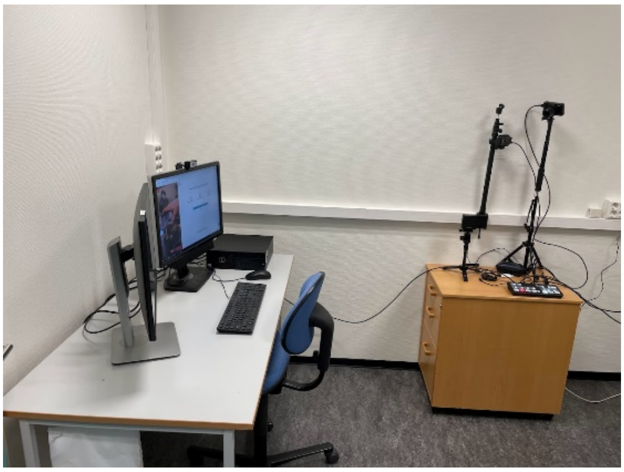

Figure 1. Picture of a workstation in the cloud simulator lab

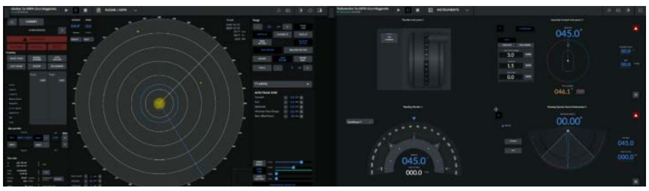

Figure 2: Screen shot of the two monitors displaying radar and instrument panel

3.1 *Data analysis and analytical procedure.*

Each student's simulation exercise using the cloud simulator was recorded on two cameras, one in front and one behind the workstation. The student's monitor was also recorded using a screen capture tool (OBS). A video mixer stored all video streams in one folder on an external hard drive.

Immediately after the cloud simulator exercise, the two participants were interviewed together in the simulator lab. The interviewer used a semi-structured qualitative interview guide to better grasp the students' experiences and perceptions of how to train using the cloud simulator exercise. To ensure that the students felt comfortable sharing their thoughts during the interview, they were informed that their identities and responses would be kept private and anonymised and that they could withdraw from the research at any time. The research design followed standard ethical considerations and was approved by the Norwegian Agency for Shared Services in Education and Research (SIKT)

All interviews were video and audio-recorded and transcribed by the first author. The data corpus for this study consists of 11 group interviews with two students each, ten first year students and 12 third year students. Interview transcripts from 1st and 3rd were divided into separate guides and subjected to qualitative content analysis [19]. We used data analysis software NVivo for organising and coding data [20]. Based on our research questions, the data was coded to identify salient themes from the interviews into relevant nodes [21]. A list of themes was chosen based on the observations of the exercise, including implications, contextualisation, design for cooperation, brief/debrief, and competence. The video material was used mainly when the audio material was challenging to grasp, such as when participants were talking about "this" and "that" pointing towards the monitors.

Our methodological approach is ethnographically informed, which we argue has several advantages, including providing a comprehensive overview of the phenomena under study and being sensitive to the research context. However, the approach also has limitations, for example, the small sample size, which can limit the generalizability of the findings. Moreover, ethnographic research can be subject to bias because it draws on the researcher's skill in data collection and analysis, which can lead to inaccuracies in the findings. To avoid such pitfalls, the empirical material in this study has been subjected to computer-supported data analysis as well as collaborative analysis within the team of authors.

4 RESULTS

Findings from the video-recorded exercise showed that students, although they had access to at least one peer during the simulation, solved their navigation tasks individually. There was little communication between peers seen during the simulation, and in the few examples where communication occurred, it consisted mainly of simple question-response sequences. The transcript below presents such a sequence:

1C02: [00:29:52] I changed the course to 94

1C01: [00:29:58] I changed it to 90

1C02: [00:30:00] you changed to 090

After the cloud simulation exercise, the students were interviewed about their perception of the exercise. Although all the students were pleased to have access to the cloud simulator, there was a noticeable difference in the degree of enjoyment among them. In general, the participants were satisfied with the implementation of the cloud simulator in the navigation course.

1C10: [00:11:51] It's very positive that we have access to it, that we can learn about radar and different things related to radar. It's a good tool

1C1: [00:16:48] I think we're very lucky to be allowed to use it

1C7: [00:00:47] I think it's okay.

The 1st year students had mixed feelings, from a very positive to a more indifferent view on accessing the cloud simulator. On the other hand, none of the students had any negative views regarding implementing the cloud-based simulators in the navigational course. The students emphasised that the cloud simulator was an excellent tool for learning about the basic navigation instruments and the flexibility of the simulator. One student said it was an advantage to learn about the instruments at their own pace in their spare time.

1C1: [00:04:16] And it's very useful for the introduction to radar. If you've never seen a radar image before, it's highly recommended. For the first exercises, it takes you through an introduction to radar. In that sense, it's very, very helpful

Cloud simulators offer students the opportunity to engage in repetitive training beyond that available through desktop simulators, which are usually limited. The limited time available for instructor-led instructions is often mentioned as the favourable advantage of the use of cloud simulators among the students.

1C1: [00:08:12] That's the problem with that subject. It's only simulator every other week, so we don't get continuity. That's why cloud simulator is quite useful.

After the cloud simulator exercise, the students described that the main disengagement was the discrepancy between available time and unnecessary long exercises. The students expressed that they felt some exercises were time-consuming and had too little action. They were aware that the cloud simulator was a meaningful and relevant learning arena for the introductory navigation course, but because of the long exercises and long waiting times, they struggled with the engagement to both start and complete the exercises:

1C1: [00:14:01] Some in the class have said that they don't want to do the exercises because it takes so long.

1C1: [00:14:11] After we changed course, we sat and just waited for it to pass, and it was 13 minutes.

1C5: [00:01:15]I think it's interesting, but it can get a bit long-winded sometimes when nothings happen.

There are many students who emphasise that long waiting times in the cloud simulator are one of the reasons for their disengagement. In addition, they refer to another group of students who do not do any cloud simulator exercises. This is due to the amount of time consumed waiting for the next challenge or event. This is why many of these students feel that the cloud simulator should be optimised in such a way that it will reduce waiting times. This will make the experience more enjoyable for them. This disengagement also leads to distractions away from the cloud simulator. One student said that he/she often went away from the computer and made coffee waiting for the next event in the simulator. Another common distraction is the use of mobile phones during simulator exercises.

1C1: [00:13:48] There have been several times where I have made myself a cup of coffee or done something else just to pass the time. Used my Phone

As for the text-based briefing before the exercise, students were pleased with how it was implemented and did not see it as a disadvantage. Most students do not miss instructor-led briefings, as one student stated: "I think it's quite nice to be independent." A student stated that the e-couch messages that accompanied the exercise were very helpful, and the exercises should be easy to perform no matter what:

1C2: [00:03:01] No, I think it's nice to be a little independent as well.

1C1: [00:03:05] And the introduction you receive in the beginning explains everything, so if you read it carefully, you'll know what to do

1C6: [00:07:40] But the messages with E-coach are quite helpful.

1C6: [00:07:46] It takes quite a bit to not be able to complete an exercise regardless

Students are more open to a digital debriefing format after the exercise. The students are unsure of how this should be presented and even struggle to understand how it can be implemented in the simulator. It is not very significant, but some sort of statistics would be helpful in a debrief one student said. Some students mentioned that a debrief map with ARPA data would be helpful. Another student said debriefing in general, was a good idea, but it wasn't crucial on easy cloud-based simulators exercises.

1C09: [00:03:05] Debriefing is definitely a useful thing. It could be nice, but it's not something that's done in these exercises. It's not incredible important.

1C09: [00:10:29] So you could get something like this, for example, where it shows the ARPA and the CPA. You could get something like that, or a graph showing the CPA and where it goes, if you were within 1.5 nautical miles once or

1C5: [00:07:07] Maybe not for such a simple exercise, I don't think that's necessary

1C2: [00:16:09] And then an overhead image where you can see the tracks of where you have sailed and where others have sailed

In the bachelor study program, the cloud simulator is contextualised to prepare students for the upcoming full mission simulator. The students in the interviews said the cloud simulator prepared them for the full mission and made the entry process more straightforward. As one 3rd class student said, if he had used the cloud simulator to learn the radar before he started on the full mission, he would not be so nervous and might have learned more in the full mission because he would be more secure on the radar. Another student reflected on the bridge teams and the importance of familiarising oneself with all the instruments before starting the full mission. One student even wanted to have exercises that reflected the learning goals of the full mission. During the full mission, the learning curve was quite steep, and it was difficult to follow each instrument's lesson when you only were at a station every third week (Navigation, Radar, and Helmsman). As part of the full mission simulator, the student could be trained on their own on cloud simulator exercises with learning goals based on the full mission simulator exercises.

3C5: [00:23:32] Things also move quickly when it comes to new topics, like when we started with the dead reckoning thing and such. You did it the first time and felt that you had it by the end of the exercise, but three weeks later when you had to do it again, you had to start from scratch. If you had something like this (Cloud Simulator), you could work with it, repeat it, and you don't have to spend a lot of time on it, just repeat it once a week or so, and suddenly you know it much better

3C07: [00:06:25] I think maybe it would have given us a better understanding of things that came a bit later for us.

3C-03:[0:11:00]: I remember in one of the early exercises, we had to sail at night. We couldn't see anything (poor visibility), and everyone was so nervous. We had to navigate solely by radar. But with something like this, you could become more accustomed to it. You would have a better foundation for it.

3C-04: [00:10:04]: The important thing is the (Radar) tools and the (Radar)modes (TM, RM, TV, RV) in the radar. Getting familiar with them so that when you go down to the full mission simulator, you know that you don't have to be uncertain.

5 DISCUSSION

Ludvigsen & Arnseth [9] states that a scaffolding process can be thought of as a cognitive division of labour between students and the tool(s) that they are using as part of the learning process. Students should be able to connect prior knowledge to a task and to future practice through scaffolding. It is possible to support students to collaborate more productively, and the knowledge that is represented can be displayed in a number of ways that can facilitate cognitive development as a result. Scaffolding can be seen as an important tool in computer-based learning [9]. In a cloud simulator context, students are alone without an instructor or fellow students to communicate with. Scaffolding in this setting is based on the student’s prior knowledge, the written text is presented as a brief and e-coach message received during simulation. Hence, it is important that the learning objective of the exercise is designed to meet the students at their level of understanding in order for the student to be able to build further on prior knowledge and, at the same time be challenging enough to facilitate professional learning. The student in our study that uses cloud simulator states that they use it mostly at home on their own computer. They communicate how they like having access to the simulator also off campus, and that they appreciate the flexibility and repetitive training that it offers. Mainly, the students in our study does not feel the need for an instructor to be present, arguing that the e-coach messages work well for this particular task. Thence, the scaffold provided by the e-coach seem to meet the needs of the students at this point in training. However, we found other challenges with the students' use of cloud simulators, mainly in connection to feelings of boredom and feelings of meaningfulness in scenarios where things move at a slow pace. For this reason, it is important to consider the following features when designing simulation software as well as in designing tasks for students.

The first feature is an exploration of specific content [9]. Students' abilities to participate in complicated problem-solving are directly tied to the activities they complete and the structure of those tasks. To gain such knowledge the activity must be meaningful to the students. In the perception of the students, they feel that they are wasting time, waiting for the next action or event in the exercise. One student said that the cloud-based simulators is interesting, but it gets tediously long sometimes. A tiresome exercise cannot be seen as a complicated problem-solving exercise designed to give the students deeper knowledge. In light of these findings, a recommendation is to design educational tasks that might be more meaningful for students, for example, by adding work-relevant tasks to the training of ARPA equipment. Such work-relevant tasks can be, for example, to continuously take positions and/or keeping a logbook.

The second feature emphasises the use of simulations and dynamic visualisation to create affordances in which students can test hypotheses and manipulate parameters [9]. This feature serves cloud simulators well, it is naturally a simulator where the students manipulate parameters to learn how to operate the different bridge instruments. At the same time, the students must have exercises allowing them to test out how their actions are impacting the simulation and learning how to operate a ship safely and practicable. Another option is to frame the exercise in a problem-based learning context where the students use the instruments to test different parameters and how that influences the simulation. In the current version of the cloud simulator, there is no option to see outside the vessel as there is no visualisation available. A better visual lookout would help the student visualise the exercise, which could enhance learning.

The third feature is to encourage students to collaborate in their work. One way to approach this is to use internal and external scripts. Ludvigsen & Arnseth [9] suggest that students scripting collaboration with plays, scenes and roles, using internal scripts close to prior knowledge. The e-coach messages can serve as scripts for the students in lack of fellow students to collaborate with. The messages can be internal for suggestion or repetitive knowledge and external for what to do. E- Coach messages can have different transmitters over what type of action the students are expected to execute. To differentiate this, different scripts in the maritime context can come from the captain taking the form of direct orders, instructional feedback that can come from an instructor and visual cues on what is happening outside the vessel, which can be communicated by the helmsman or lookout.

The fourth future envisioned students forming their own aims, and using various concepts and ideas, and developing more complex forms of reasoning [9]. In achieving this, the student must understand the link between the learning gaols, the cloud simulator and upcoming learning goals in the full mission simulator. They must understand why they are learning this and in what context. Hence, debriefings should be conducted after each exercise. In order for students to be able to perform the exercises without instructor support, an appropriate format for debriefing can be written debriefings, where students are asked to reflect on the simulation in a textual format.

6 CONCLUSIONS

In this article, we have aimed to explain how students make use of cloud simulators, as well as gaining insights into their perspective of using cloud simulator in navigation training. Furthermore, we have suggested some key features to consider when designing cloud simulator exercises based on CSCL. The findings suggest that individual training with cloud-based simulators in MET can enhance the repetition of skills necessary for better performance in full mission simulator with current technology and rather straightforward instructional designs. However, a challenge is how to frame meaningful exercises in cloud-based simulators. This study contributes with an empirically based and theory-driven description of how to design simulation software and educational tasks to provide meaningful learning experiences for maritime students.

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