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From Simulators to Screens: A Critical Review of Online Distance Education in Maritime Education and Training

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Abstract - The COVID-19 pandemic has catalysed a transformative shift in the maritime training sector, driving the transition from traditional physical simulators to cloud-based solutions. This research critically examines the complexities of this transition, focusing on the fidelity of simulators, practical applications, and empirical evidence. The review traces the origins and evolution of online distance education (ODE), highlighting its increasing relevance in modern Education. Simulator fidelity, encompassing physical and functional accuracy, emerges as a crucial factor for effective training. Cloud-based simulators offer notable benefits, including accessibility, scalability, and cost-effectiveness; however, their ability to replicate the fidelity of traditional simulators requires further empirical validation. Current initiatives by simulator manufacturers and quality standards organisations demonstrate a readiness to adopt cloud-based solutions, yet empirical studies reveal challenges such as prolonged exercises and engagement issues. Identified research gaps include the need for comprehensive empirical validation, longitudinal impact studies, standardisation efforts, and cost-benefit analyses. Recommendations for future research emphasise comparative studies, quantitative assessments, ergonomic integration, and robust feedback mechanisms. Addressing these gaps will enhance the understanding and implementation of cloud-based simulators, ultimately advancing the quality and accessibility of maritime training

Keywords: Cloud-based Simulator, Maritime education and training, MET, Simulator Fidelity, Online Distance Education, ODE

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1.0 INTRODUCTION

In recent years, the education sector has experienced a significant and transformative change on a global scale. This change has been further accelerated by the exceptional difficulties posed by the COVID-19 epidemic (UNESCO, 2020). During this change, the field of maritime training serves as evidence of adaptation, where the combination of necessity and creativity has resulted in the rethinking of traditional teaching methods (Bartusevičienė et al., 2021). This essay explores the complexities of converting practical training with maritime simulators into online distance education (ODE), a shift prompted by the demands of the pandemic era.

The maritime industry, renowned for its stringent training standards, has traditionally depended on physical simulators to instil vital skills and competencies in seafarers. Nevertheless, the emergence of COVID-19 has disturbed traditional teaching methods, making it impossible to access traditional classrooms and physical simulators. As a result, educators and industry stakeholders felt the need to consider different options, leading to the introduction of cloud-based simulators (Knysh & Dudziak, 2020).

This transition emphasises the maritime industry's ability to recover quickly and the broader importance of adjusting to digital methods in Education. As we move through this transformation, it is crucial to

carefully examine both the theoretical foundations and the actual implementations propelling this change. By connecting academic research with practical application, we thoroughly comprehend the difficulties, possibilities, and consequences of combining technology and Education.

This essay explores the complex intricacies of transitioning maritime training from simulators to screens by integrating empirical study findings, practical implementations, and theoretical frameworks. Our goal is to shed light on the way ahead, where adaptation, collaboration, and inventiveness come together to alter the boundaries of ODE in the marine field and beyond

2.0 CRITICAL REVIEW

2.1 The origin of ODE

The origins of distance learning may be traced back to the 19th century when correspondence courses developed as an innovative educational strategy (Masalimova et al., 2022). Institutions such as the University of London were the first to introduce this approach, which allowed students to receive educational materials, submit assignments, and contact professors using postal services. This initial iteration of remote instruction established the groundwork for further advancements.

During the 20th century, distant learning expanded its scope by including radio and television broadcasts. Platforms like "University of the Air" employed various platforms to disseminate educational content to a broader audience (Simonson, 2021). The availability of radio and television facilitated the distribution of instructional resources on diverse topics, representing a notable advancement in distance learning.

The 1960s saw the emergence of open universities, a revolutionary idea aimed at enhancing the flexibility and accessibility of Education. The UK Open University, established in 1969, emerged as a pioneer in this endeavour (Weinbren, 2015). Open universities employed a blend of printed resources, broadcasts, and in-person tutorials, showcasing a dedication to diversity and catering to a wide range of learners.

The 1990s witnessed a paradigm shift with the emergence of the internet, which laid the foundation for the development of online Education. Learning Management Systems (LMS) such as Blackboard (Ménard, 2022) and Moodle (Moodle 2020) have enabled the online delivery of courses, either fully or partially. This transition facilitated instantaneous connection and seamless multimedia and non-simultaneous learning integration, offering enhanced student adaptability and broadening remote Education's scope.

The 2010s witnessed the emergence of Massive Open Online Courses (MOOCs), significantly challenging conventional education paradigms (Bates, 2015). Platforms like Coursera, edX, and Udacity have partnered with prestigious universities to offer free or reasonably priced online courses to a large worldwide audience (Dhawal et al., 2023). MOOCs prioritised accessibility, interactivity, and self-paced learning, promoting the democratisation of Education worldwide.

Over the past decade, traditional distance learning has evolved into ODE. This instructional method employs digital technologies to provide educational content and support learning for students physically far from the instructor or educational institution (Bates, 2015). ODE enables learners to access course materials, participate in conversations, and engage in learning activities through digital platforms, reducing the requirement for physical presence in a conventional classroom environment.

ODE encompasses critical features such as asynchronous learning, allowing students to engage with course materials at their preferred speed, and synchronous elements, such as live lectures or virtual classrooms, which aim to facilitate real-time interactions and foster a sense of community among learners (Aretoulis et al., 2023). Incorporating multimedia components, online discussion forums, and collaboration tools improves the overall educational experience in the digital setting. Mobile devices have become essential in modern times, incorporating mobile learning into distance education. Individuals can retrieve instructional material at any given time and location, promoting a constant and ongoing process of acquiring knowledge. Furthermore, the increasing popularity of microlearning,

consisting of brief and targeted learning modules, has become prominent, meeting the needs of contemporary learners with limited time.

ODE has emerged as a prominent element of modern Education, propelled by technological improvements and the growing need for adaptable learning alternatives (Baepler et al., 2014). It pertains to providing Education using digital platforms, enabling learners to access educational content remotely. This discussion examines and assesses three developing trends in ODE, specifically emphasising their potential influence on educational practices, learner experiences, and institutional tactics.

2.2 Simulator fidelity

Oliveira et al.'s (2022) systematic literature review offers valuable insights into the parameters of simulator fidelity and their implications for training efficacy in the maritime environment. The paper primarily examines the accuracy and functionality of traditional simulator settings. Still, it also discusses how these findings might be applied to ODE, precisely the effectiveness of cloud-based simulators.

The arrangement of the bridge and visual system, as emphasised in the review, is essential to physical accuracy in maritime simulators (Kim et al., 2021a). The prioritisation of expansive visual fields and detailed representations emphasises the need to establish an immersive environment that promotes efficient training. Regarding ODE, moving from physical simulators to cloud-based solutions requires careful thought about how these ergonomic elements might be used in a virtual environment (Hjellvik & Mallam, Jan 1, 2021). Cloud-based simulators must accurately reproduce authentic ship configurations and visual systems while guaranteeing effortless access and user engagement via online interfaces.

Functional fidelity refers to the degree to which a training programme accurately represents the actual tasks and demands of a specific job or activity (Oliveira et al., 2022). It is an essential consideration in designing training programmes, as programmes with high functional fidelity are more likely to prepare individuals for real-world performance effectively. Therefore, while designing a training programme, it is crucial to ensure that the programme.

Cloud-based simulators have distinct benefits in providing dynamic and customisable training programmes within ODE. Virtual sessions can be created to replicate different maritime situations, enabling trainees to participate in hands-on learning regardless of their geographical location. A study by Kim et al. (2021) comprehensively evaluates the characteristics of a cloud-based maritime simulator using the SWOT analysis approach (Table 1), while another study by Tusher et al. (2023) supports this SWOT analysis by showing that cloud-based simulators are considered less desirable when emphasising educational value, but become the most desirable choice when focusing institutional capacity and possibility of remote training (Figure 1).

Table 1 Cloud-based maritime simulator SWOT analysis (by Kim et al., 2021b)

Type of simulator	Internal factors		External factors	
	Strengths	Weaknesses	Opportunities	Threats
	VR.S5 - Real-time feedback from trainees (AR)	VR.W5 - Limited team cooperation and interaction		VR.T4 - Danger of technology hype VR.T5 - Technological acceptance barriers
Cloud-based (CB) simulator	CB.S1 - Ubiquitous learning CB.S2 – Self-directed CB.S3 - Less capital intensive CB.S4 - Limited maintenance of hardware CB.S5 - No need of physical presence	CB.W1 - Lack of social interaction CB.W2 - Lack of formative assessment CB.W3 - Limited transfer of learning, unclear application in MET CB.W4 - Lack of team training opportunities	CB.O1 - Geographically separated synchronous learning CB.O2 - Novel mode of training and assessment CB.O3 - Possible use in post COVID-19 era CB.O4 - Highly scalable	CB.T1 - Cyber security CB.T2 - Lack of institutional support CB.T3 - Internet connectivity and speed barriers

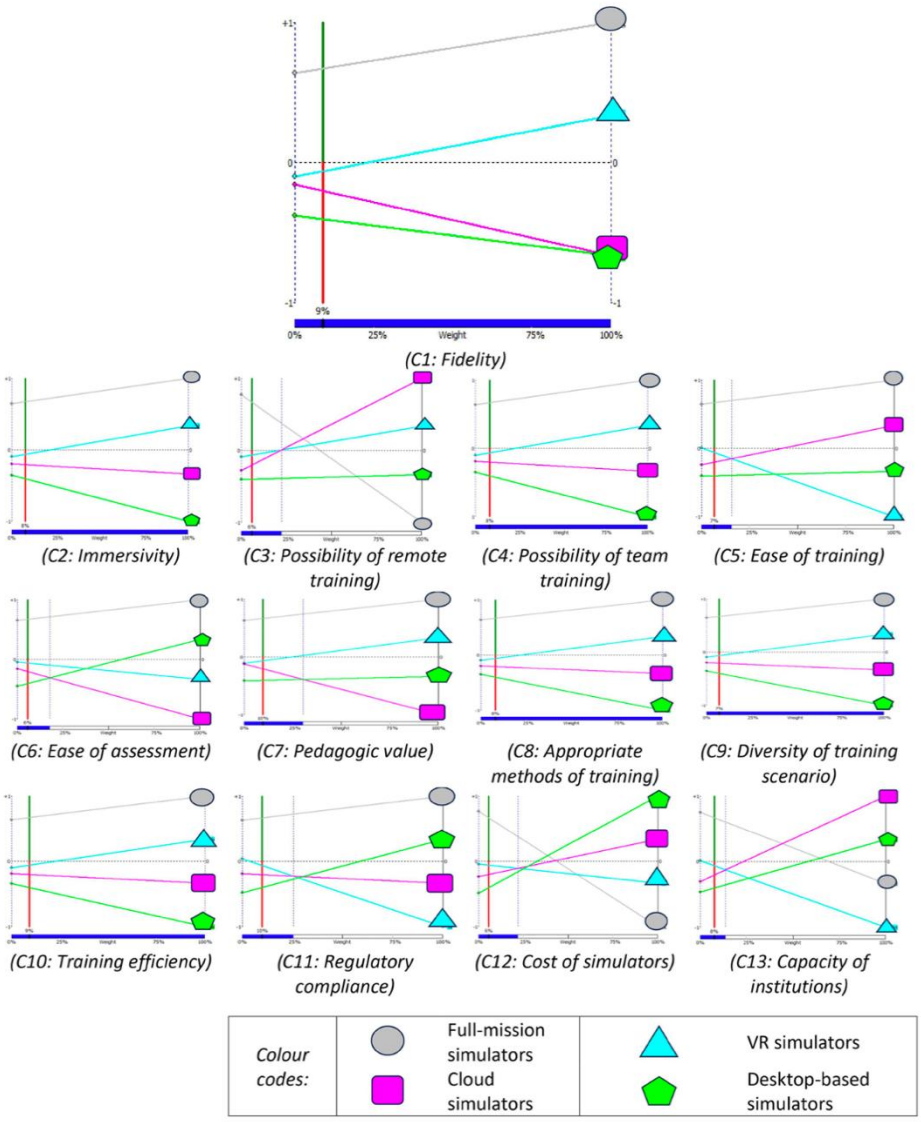

Figure 1 Comparison of maritime simulators sub-criteria (by Tusher et al., 2023)

The evaluation highlights the necessity of adopting a more complete methodology to evaluate the accuracy of simulators and their influence on training results. Although traditional full-mission simulators have been preferred for their high level of accuracy, the extent to which cloud-based

simulators may achieve similar training results has not been thoroughly investigated. Cloud-based solutions provide the advantages of scalability, accessibility, and cost-effectiveness, making them appealing choices for online distance education (Kim et al., 2021c). Nevertheless, additional empirical validation is needed to confirm their ability to replicate traditional simulators' physical and functional accuracy.

The review recommends that future research prioritise quantitative studies that isolate individual aspects of simulator fidelity and assess their influence on training outcomes. This approach is specifically applicable for evaluating the effectiveness of cloud-based simulators in online distance education. Conducting comparative analyses between traditional and cloud-based systems can yield significant insights regarding the advantages and constraints of each approach. In addition, standardising language and broadening the geographical range of study can improve the applicability of findings and provide a more comprehensive comprehension of simulator accuracy in various circumstances.

The systematic study thoroughly examines the accuracy and realism of simulators in the maritime field. Its findings also have relevance to the changing field of online distance education. Cloud-based simulators have significant prospects for improving accessibility, flexibility, and scalability in marine training. However, the usefulness of simulators depends on their capacity to recreate traditional simulators' physical and functional characteristics accurately. Future studies should focus on closing this gap and thoroughly investigating the possibilities of cloud-based solutions in determining the future of maritime Education.

2.3 Practical applications

2.3.1 Simulator manufacturers with cloud simulation

Simulator makers, training providers, and quality standard organisations are highly prepared to use cloud-based solutions for maritime training. This readiness is mainly driven by the difficulties caused by the COVID-19 pandemic. The summary of the preparedness of each entity:

2.3.1.1 DNV

DNV has acknowledged the growing need for remote training methods during the pandemic and has developed a new certification, called simulator class D, to address cloud-based distant learning simulators that require virtual reality (VR). This project entails working with simulator suppliers and end-users to guarantee adherence to international requirements and legislative restrictions. DNV prioritises upholding elevated levels of authenticity and conduct in remote simulation settings, particularly concerning the facilities provided for instructors and assessors (DNV, 2021).

2.3.1.2 Kongsberg

Kongsberg Digital has recently introduced K-Sim Navigation CLOUD, a navigation simulation solution that operates in the cloud and is specifically built to comply with DNV's Class D standards. No text was provided. The system offers institutes flexibility through fundamental navigation training, the integration of blended learning opportunities, and the availability of stand-alone simulation exercises. Kongsberg Digital utilises sophisticated physics engines, hydrodynamic modelling, and visual systems powered by Unreal Engine to provide very realistic training experiences (Digital Ship, 2023).

2.3.1.3 Wärtsilä Voyage

Wärtsilä Voyage provides an affordable Ocean Learning Platform incorporating simulation capabilities to verify and enhance seafaring personnel's essential navigational and engine room skills. The platform minimises the requirement for physical simulators, travel expenses, and time spent away from family, allowing for more frequent utilisation of simulations for planning, training, and assessment. By incorporating simulations into the Ocean Learning Platform, Wärtsilä Voyage enhances the link between experience learning and other learning methods, like e-learning and evaluations (OCEAN Technologies Group, 2023).

2.3.1.4 FORCE Technology

FORCE Technology offers SimFlex Cloud, which allows users to assess port designs and offshore renewable projects through online engineering studies. The simulator provides sophisticated functionalities and lifelike simulations to fulfil hardware and software prerequisites. SimFlex Cloud enables data-driven and resource-optimised decision-making by visually representing the benefits and constraints of proposed port designs in real-world scenarios (FORCE Technology, n.d.).

2.3.1.5 Thet A Marine

Thet A Marine provides the Wärtsilä Voyage Cloud Simulation as a highly efficient method for delivering classroom training remotely. The cloud simulation platform offers access to maritime and technology simulators, such as ECDIS, radar, engine room, and liquid cargo handling that meet the standards set by IMO and STCW. This programme enhances learning opportunities by offering immediate access to simulators outside conventional training facilities (Thet A Training Center, 2023).

2.3.2 Summary

In summary, these initiatives illustrate a collaborative endeavour by simulator manufacturers, training providers, and quality standard bodies to adopt cloud-based solutions and adjust to the changing requirements of the maritime industry, specifically in light of the difficulties posed by the COVID-19 pandemic.

2.4 An empirical study

Gyldensten et al. conducted a study on the effectiveness of cloud-based simulators. The study included video recordings and interviews with deck cadets students to gain insights into their encounters with a cloud simulator for navigation training (Figure 2). A total of 22 students were selected for the study, comprising two distinct groups: first-year students who were being taught fundamental navigation skills and third-year students who had more advanced knowledge of the subject. Students predominantly engaged in independent work throughout the simulations, with minimal peer interactions. After completing the tasks, the students were interviewed regarding their opinions.

Figure 2 Workstation for video recording *(by Gyldensten et al., 2023)*

In general, students expressed satisfaction with the availability of the cloud simulator; however, there were variations in their enthusiasm. First-year students exhibited a variety of emotions, but none of them stated any negative opinions. The users regarded the simulator as beneficial for acquiring knowledge of navigation equipment and admired its adaptability. Nevertheless, several pupils perceived the exercises as excessively lengthy and the waiting periods demoralising, resulting in diversions.

The students responded favourably to the text-based briefings that preceded the exercises and found the independent learning approach conducive to their comfort. They were receptive to digital debriefing forms but had reservations about their effective implementation. Many students expressed that the cloud simulator adequately equipped them for the complete mission simulator and desired exercises that aligned with the learning objectives of the whole mission.

Ultimately, the study demonstrated that students appreciated the cloud-based simulator's adaptability and readiness for more advanced training. However, they encountered difficulties with the duration of the exercises and their level of involvement. They proposed enhancements to decrease waiting times and improve the learning experience.

2.5 Integration of research and practice

The amalgamation of scholarly theories (research) with real-world applications in the maritime training industry, explicitly concerning cloud-based simulators, uncovers both areas of agreement and points of dissent.

2.5.1 Alignment

I. DNV's Certification Initiatives: The research findings, especially those highlighting the significance of simulator accuracy and capability, have impacted the creation of new certification criteria by organisations such as DNV. The introduction of simulator class D certification is in line with findings from research, recognising the necessity for immersive and functionally precise cloud-based simulators to guarantee efficient training.

II. Manufacturer offers: Companies that produce simulators, such as Kongsberg Digital, Wärtsilä Voyage, FORCE Technology, and Thet A Marine, have adjusted their product offers to match the research results and meet certification standards. For instance, Kongsberg Digital's K-Sim Navigation CLOUD and Wärtsilä Voyage's Ocean Learning Platform combine sophisticated physics engines, hydrodynamic modelling, and visual systems to offer authentic training experiences that accurately replicate real-life scenarios, aligning with the focus on simulator accuracy emphasised in research.

2.5.2 Divergence:

I. Empirical Studies vs. Practical Experience
Empirical studies offer helpful insights into the valuable efficacy of cloud-based simulators, but actual experiences may uncover issues not represented in research. Gyldensten et al.'s research on maritime students' utilisation of cloud-based simulators revealed unanticipated challenges, like prolonged exercises and waiting times, which theoretical studies may not have entirely predicted.

II. Perspectives of Training Providers
The practical execution can differ depending on the viewpoints and priorities of the training providers. Although research highlights the significance of simulator fidelity and functionality, training providers may prioritise cost-effectiveness, scalability, and convenience when choosing cloud-based solutions. This may result in variations in how implementation approaches are carried out compared to theoretical advice.

There is a substantial agreement between academic theories and practical applications regarding using cloud-based simulators for maritime training. The research findings have impacted the certification criteria and product offerings of simulator makers, demonstrating a mutual recognition of the

significance of simulator accuracy and capabilities. Nevertheless, there are differences in several aspects, particularly in converting research findings into practical applications and the diverse viewpoints of training providers. To effectively integrate research and practice in maritime training, it is crucial for researchers, practitioners, and certifying organisations to collaborate and work together.

2.5.3 Implications for Future Practices

Integrating research and practical application in implementing cloud-based simulators for maritime training has significant implications for the future of online distance education.

I. Improved accessibility and increased flexibility
Maritime training can be improved by using cloud-based simulators, which provide increased accessibility and flexibility. This allows seafarers to access top-notch training materials no matter where they are located. This comprehensive comprehension underscores the significance of using technology to surmount educational obstacles, facilitating the adopting of more inclusive and accessible practices in online distance education.

II. Economic efficiency and expandability
Using cloud-based solutions, training providers can diminish expenses linked to physical infrastructure and travel, enhancing the cost-effectiveness and scalability of marine training. The comprehensive comprehension emphasises the capacity of cloud-based technology to democratise education and broaden the availability of training opportunities for seafarers globally.

III. Ongoing Enhancement and Advancement
Integrating research insights with practical implementation cultivates a perpetual enhancement and ingenuity culture in online distance education. Training providers can enhance and improve cloud-based training programmes for seafarers and the maritime sector by combining input from empirical studies and practical experiences.

IV. Standardisation and Quality Assurance
Collaboration among academic researchers, industry practitioners, and certification authorities enables the establishing of standardised training techniques and guarantees quality assurance in online distance education. This comprehensive knowledge highlights the significance of matching theoretical frameworks with industry standards and best practices to maintain the integrity and efficacy of maritime training programmes.

V. Integration with Technological Advancements
The comprehensive comprehension of simulator training conducted through cloud-based platforms influences future practices by promoting adapting to technology changes. To keep up with the ever-changing landscape of technology, training providers must be adaptable and quick to respond to new trends and advancements in online distance education. They aim to give seafarers pertinent, captivating, and efficient training to equip them for real-life obstacles.

3.0 CONCLUSION

To summarise, the progression of remote learning from its modest origins in the 19th century to the contemporary era of ODE has been characterised by notable breakthroughs in technology and instructional approaches. The trip has been marked by integrating several forms of communication, such as postal services, radio, television, and the internet, all of which have contributed to the growth and diversification of educational options. The advent of ODE in the 21st century has fundamentally transformed conventional learning paradigms, providing students with unparalleled flexibility, accessibility, and involvement.

Several new trends in the field of ODE have the potential to significantly impact educational methods, learner experiences, and institutional initiatives. Microlearning, which prioritises the delivery of concise and targeted learning modules, accommodates the preferences of modern learners and encourages active participation and adaptability. Nevertheless, educators should remain cautious of certain disadvantages,

such as oversimplification and inadequate context, to guarantee a well-rounded approach to curriculum design.

Overall, analysing academic research and real-world application of cloud-based simulators for maritime training emphasises the need to combine theoretical knowledge with actual execution to create online distance education's future. Notable findings from this analysis include the significance of simulator accuracy and capabilities, the possibility of cloud-based solutions to improve accessibility and flexibility, and the requirement for ongoing enhancement and innovation in training methods. In the future, this integration will be essential in shaping online distance education by encouraging cost-effectiveness, scalability, standardisation, and quality assurance in maritime training programmes. By utilising technology and adopting collaborative methods, the maritime sector can guarantee that seafarers receive top-notch training that equips them with the necessary skills and abilities to negotiate the complexities of the modern marine environment. Integrating research and practice in online remote Education is a transformative shift that enhances the dynamic, accessible, and practical training paradigm.

The research identifies several gaps in the transition to cloud-based maritime simulators. There is a need for comprehensive empirical validation to ensure these simulators can match the fidelity of traditional ones. Additionally, longitudinal studies are necessary to understand the long-term impacts of using cloud-based simulators. Efforts to standardise these systems and conduct thorough cost-benefit analyses are also required. By addressing these gaps through comparative studies, quantitative assessments, ergonomic integration, and robust feedback mechanisms, the effectiveness and implementation of cloud-based simulators in maritime training can be significantly improved

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