**CLASS LEADERSHIP AND METHODS TO OVERCOME**

**THE LIMITS OF VIRTUAL EDUCATION**

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**Abstract** *The number of fields in education where simulators have been used increases as technology develops. Today, one of the fields where they are used widely is maritime. With the introduction of simulators in maritime education, students can receive bridge or engine training depending on the type of simulator without going on board, and they can experience the real situation and conditions. This enables them to get to know the profession they will perform in the future more closely, to experience its positive and negative aspects, to be prepared for dangerous situations they may encounter on board, and to react to them with composure, thus preventing negativities and accidents. As the types and competencies of simulators vary, so do the teaching methods used in simulators. While some teachers prefer simulator training based on certain scenarios, others prefer to practice with more theoretical information and precise commands. In this study, after a small-scale evaluation of how to use the evidence-based teaching method, which is a teaching method mostly used in social sciences, in simulators, a sample case study on simulator training with evidence-based teaching methods was tried to be developed. The effectiveness of this study, which is a theoretical evaluation, can be assessed after implementation.*

**Keywords:** *Simulators, maritime, education and training, evidence-based method*

**1. Introduction**

Using simulators in classrooms as a teaching tool is a technique that allows students to handle an event as if it were real and work on it in the classroom. In other words, it is a teaching approach based on a model developed by reality to support learning. That means simulation is to imitate a real situation in which participants or students work around certain principles to discuss an event problem in various aspects, analyze a document, and create similar ones on a model.

Simulation techniques are used in many fields. Some of these are war games in military training, pilots working on aircraft models, flight training on the structure of the pilot's cabin with the possibilities of computer systems, driving training of driver candidates on special tracks, revitalization of the parliament in the classroom environment in political science and training of doctor candidates on cadavers. Simulation allows trainers to experience rare real-life dangers associated with their areas of work thus enhancing a safe working atmosphere. It also enables the trainee to respond correctly when such occurrences happen as they have already experienced it, though in a simulation setup (Demirel & Albayrak, 2020)

**2. History of Simulators**

The simulation history goes back 5,000 years, from the Chinese War Games called "WEICH", to the 1780s until the Prussians used these games on the trains of their army. Since then, the heads of all military powers have used war games to test military strategies under simulated environmental conditions. During World War II, the great mathematician John Van Neumann developed a new technique from military and operational games, the Monte Carlo Simulation Technique. As a quantization technique, when working with neutrons at the Los Alamos Scientific Laboratory, Van Neumann Simulation was used to solve physics problems that were complex and expensive to analyze manually or with physical models. The stochastic nature of neutrons suggested using a roulette wheel to deal with probabilities. Because of the game structure, Van Neumann called the study of the change of laws the Monte Carlo Model. In the 1950s, with the advent and combined use of business computers, simulation developed as a management tool.

A diagram of a simulation

Description automatically generated with medium confidence

Figure 1. Steps in Monte Carlo Simulation (Pandey, 2023)

Specialized computer languages were developed in the 1960s to handle large-scale problems more efficiently. In the 1980s, simulation programs written to deal with sequencing states from queued inventions were developed. They have different names, such as XCELL, SLAM, WITNESS, and MAP/1.

Simulations are used for different purposes. For example, when the system is unsuitable for experimentation, If the system is still in the design phase, if the system/problem is complex, if the system's behavior is to be analyzed, and if a computer is available.

On the other hand, researchers discuss the traits of a good simulator. They decided that a good simulator should be easily understood by the user, be goal or target-oriented, and be easy to control and operate by the user. It should also be complete and easily adaptable for model modification and updating. It should be evolutionary; that is if it starts simple and becomes increasingly complex.

Applying the simulation method in the classroom is based on Piaget's theory of individual learning. According to Piaget, the individual receives information, reconstructs it according to his/her experience, changes it, and ultimately assimilates it. Simulation provides a suitable learning environment for this process (Simulasyonların Eğitimde Kullanımı, 2022).

Sometimes simulation methods and role-playing can be confused with each other. However, there are significant differences between them, especially in terms of the behaviors exhibited during the application and the purposes of the application. In simulation, it is determined what the students should do around a certain scenario, and they must act accordingly. However, in role-playing, students are expected to display their talents and creative powers in creating the content of the role played. In other words, the role to be exhibited is told, but the free expression of the students is more at the forefront in the creation of its content. However, in simulation, how to fulfill the role is based on certain principles, and the student is expected to act accordingly.

People intend to use simulation techniques in several ways. For example, identifying problem areas before making investments, revealing the effects of changes, ensuring that all system variables are available, leading ideas, identifying inefficiencies, developing new ideas, and encouraging new thinking.

The following list shows some of the features for simulation use.

* Simulation can be used to study the internal structure of a complex system or a subsystem within a complex system.
* Changes in information, organizational hand, and environmental changes can be simulated, and the effects of these changes on the behavior of the model can be studied,
* The knowledge gained from the design of a simulation model contributes greatly to the development of the system under study,
* By varying the simulation inputs and examining the results, one learns about which variables are more important and how they affect each other,
* Simulation can be used as an informative tool supporting the analytical solution methodology,
* Simulation can be used to see what the situation will be by trying new designs and policies before implementation,
* Simulation can be used to test analytical results.

As the last part of the study on the general use of simulators, their benefits and limitations will be studied.

**3. Benefits of Simulators**

* Simulation allows a system to be studied over a long period and the results analyzed.
* Simulation can be used when system data is not detailed.
* Data for later analysis on the simulation model is often cheaper to obtain than in real life.
* Simulation provides the opportunity to analyze and experiment with the complex interactions inherent in a system.
* Detailed observation of the simulated system can lead to a better understanding of the system, the elimination of previously unseen deficiencies, and the establishment of a more efficient physical and operational system.
* Simulation can be used to experiment with new situations where we have little or no data about how the system will behave under different conditions.
* Simulation forces analysts to think more generally.
* The learners can be familiarized and adapted to new technologies.
* The training provides confidence to cadets who have not experienced different emergencies. They may adapt easily to the environment and react the emergencies.
* Simulation training is critical for seafarers because it can help them understand the consequences of actions if they make the wrong decisions. It also helps cadets get real-life experience without endangering the lives of those on board destroying the ship or exposing it to extreme conditions.
* The simulators imitate approximately the real situation at sea. The participants strongly believe that a bridge simulator is the most suitable manner to prepare bridge team duties onboard.
* Nowadays, the state-of-the-art simulators are very similar for equipment onboard and suitable for team training onboard. Widespread use of simulators will enable cadets and young officers to familiarize themselves with the devices on their assigned ships. They can adapt more easily to the environment and do not feel humiliated for their lack of experience in front of their colleagues (Demirel & Albayrak, 2022)

**4. Limitations of Simulators**

* Simulation models are expensive and difficult to develop.
* The stochastic nature of simulation models only allows predictions about the real system.
* Simulation models compare alternative solutions instead of finding the best solution to the problem.
* The model's validity is crucial for simulation results accurately reflecting the system under study.
* The dependence on the computer in simulation causes the study to be long and expensive.

In summary; "Simulation is a modeling technique that creates an infrastructure for monitoring the properties of the real system by moving the data of a physical system that exists in the real world to a virtual environment." It provides advantages in terms of time, cost, and risk management, as it can make the development of processes traceable. The purpose of the simulation is to observe the possibilities in the virtual world in advance and to plan the necessary preparations. A successful simulation is possible when the physical system's data can be modeled in a digital environment. Today, it has become a method that can be used in every field from manufacturing to management, from health to education, to provide the necessary reactions to the new situations encountered thanks to the plans prepared (Çelen, 2017).

**5. Use of Simulators in MET**

Simulations can work in many subjects: economics, physics, chemistry, mathematics, nursing, political science, and education (Kent State University, 2023). Although the quality of training is important in all fields, it is particularly important in certain fields, including maritime. The maritime sector is characterized by very challenging conditions, especially for those working at sea. Ships in the maritime sector carry out high-risk operations, maintenance, and activities. It is important that the training provided for the competence of the seafarers who will be responsible for processes such as navigation, cargo and ballast operations, fuel operations, deck and machinery maintenance, and activities should be realized with minimum risk and maximum reality. Ensuring safety in the maritime sector is of great importance not only for the ship's employees and the cargo it carries but also for the environment. These disadvantages include taking responsibility for many people, being away from home and land for long periods, setting foot in foreign lands, and constantly adapting to different cultures.

For this purpose, gaining skills in a risk-free environment is a great advantage to avoid unforeseen events at sea (Bolat, 2021). To be successful in such an environment, it is necessary to have a strong education as well as a genuine love for the environment and a desire to work. All these features are increasingly reinforced by the experience gained.

In the maritime sector, where experience is so important, different and effective training methods are being developed to introduce students to the ship environment before they go on board and to ensure that they start to gain the experiences they will gain on board at school. The increasing need for distance education, especially during the pandemic period, has also contributed to the diversification of these methods. Today, simulators are used in almost all maritime universities to provide students with real ship-handling experience. In maritime education, simulations such as bridge simulation, GMDSS, ECDIS, engine room, and liquid cargo handling are used. Figure 2 shows bridge and machinery simulators, respectively.

According to the research conducted by Bolat, there are 674 simulators used in maritime education all over the world. Of these 674 simulators, 163 are bridge and 125 are engine simulators. The remaining 386 simulators include other simulator types such as GMDSS, ECDIS, RADAR, etc. (Bolat, 2021). Simulation related to the management of ships is a virtual system with the increased reality created by integrating developing technology into education (Arslan & Kocamanoğlu, 2022). They also found that when demographic information such as age and education levels are considered, ship simulation contributes to business life, provides knowledge and skills, and increases students' self-confidence by enabling them to use the information actively.



Figure 2. Bridge Simulator and Engine Room Simulator

Within the scope of STCW, simulators are used in seafarer training. The main purpose of these simulators is, first, to provide operational processes in a non-hazardous and economical virtual environment. Likewise, simulators are widely used in refresher and type training, especially in studying accident and destruction incidents (Arslan & Kocamanoğlu, 2022).

**6. Why are simulators used in maritime?**

Simulators are used not only in maritime but in all fields where practice is important and theoretical education is not enough to work professionally. People try to experience the solutions that they foresee for emergencies we may encounter in real life, such as fire, impact, collision, malfunction, etc., through drills. Drills are indispensable for field experience. Drills are a training process in which all personnel, from the lowest level to the manager, are involved according to their scope. However, drills involve expensive and time-consuming planning activities. In addition, real-life events are simulated with limited/low-hazard scenarios, the effects of adversities or wrong interventions are limited, and instant scenario changes are very limited. In this case, tactical and operational level simulations, which can partially replace drills and partially be used in the planning of drills, can close our training gap. In these simulations, situations that are impossible or too dangerous to be simulated in drills can be simulated, and scenarios to be played with multiple users can be defined and tested. For example, in the emergency response simulation, which we developed with domestic and national facilities for fire brigades and emergency response organizations to plane crashes, scenarios such as hospital, subway, industry, plane fires, man rescue from wells, traffic, and plane crashes, etc. are simulated in a virtual environment. In these environments, where dynamic forces such as wind, fire, smoke, and water are modeled in addition to the vehicles, personnel, equipment, and processes of the institutions, the aim is for the trained personnel to accurately analyze the simulated emergency, to discover the most appropriate response methods according to different weather, environment, and emergencies, and to experience the positive and negative effects during the application (Marine Deal, 2018).

For example, in a traffic accident scenario, while aiming to rescue injured victims trapped in the vehicle, scenarios such as fuel leakage, slipping, explosion, bleeding, assessing risks such as ensuring the safety of the victim and intervening personnel, and dealing with problems such as loss of life or an explosion while taking precautions against risk are simulated. These scenarios can then be replayed to observe the mistakes made during the intervention and their effects, or a completely different scenario or the same scenario with different parameters can be simulated and retrained. These tactical simulations can be integrated with CBT-supported LMS and simulators. In addition, VR and AR-supported applications can enable the training of personnel who can serve at all levels.

Simulator training in maritime has started with the same thought and to serve the same purpose. Personnel training continues throughout their entire professional lives with the adaptation of technological possibilities and capabilities to platforms. The cargo and personnel on million-dollar platforms must be prepared for unexpected situations that no one else has ever encountered. Although safety issues have been tried to be increased with new technological facilities and capabilities, the solutions to the problems encountered on these new platforms have never been tried or have been tried only to a limited extent. The International Maritime Organization (IMO) established the maritime community to develop technical standards for simulators (Cross, 2011). The community, which includes important maritime organizations and classification societies such as the International Marine Simulator Forum (IMSF), International Maritime Instructors Association (IMLA), and Det Norske Veritas (DNV), has established simulation classes (Board, 1996). Accordingly, marine simulators are classified into four main groups. The first category includes simulators with advanced maneuvering capabilities that can perform all tasks, such as Unified Bridge Simulators, where pilot training can also be provided. The second category includes simulators that include only visual navigation and real-time operating capabilities, which are classified as multi-mission. The third category includes simulators with capabilities classified as limited missions, such as the RADAR simulator. The fourth category includes simulators classified as special missions, such as computer-based training simulators (CBT) (Board, 1996). Various simulators are used in maritime training under the Standards for Training, Certification, and Watchkeeping of Seafarers (STCW). Some of them are bridge, engine, RADAR, Global Maritime Distress and Safety System (GMDSS) simulators, computer-based simulators, and tanker simulators (Bouras, 2000). Many maritime education and training institutions worldwide, especially in Japan, are professional centers established with modern professional development theory and practices. Many advanced maritime nations worldwide have widely reported that simulator training is effective, efficient, and safe. For more than 25 years, they have proven to be a reliable tool for training and post-research when properly used and understood. However, each institution has developed its simulator-based training course and program that does not always fit seamlessly into the comprehensive training program. There are accepted ideas that training effectiveness is enhanced not only by the capabilities of equipment, such as simulators, but also by how the training methodology is applied (Bouras, 2000). The simulator facility to be selected for training in a training center is important. According to the simulator facility established, the use of all mission simulators in the use of the pilots and instructors and the entire operation up to the complexity of a simulator can change. According to the simulator obtained, the training module and program are formed, the teaching technique is developed, and the competence of the training institution is determined. Despite the improvements in simulator use in maritime, the evaluation of the survey conducted by Demirel (2022) shows that additional measures are needed to provide a better contribution of simulators and laboratories in support of education. It was also found that (Demirel, 2022)

* MET programs need to be overviewed and developed are needed for prepare the seafaring cadets for their profession in light of the rapid developments in the technology
* To maintain the quality of the education more emphasis needs to be given to recruiting and retaining qualified maritime lecturers with both vocational and academic qualifications.
* The social elective courses are necessary for cadets’ personal development. Also, vocational electives should be rearranged to meet future requirements of the profession.
* Delivery of vocational courses throughout the academic program in English will facilitate improving spoken and written communication in English and better use of maritime phraseology.
* The sea training conducted under the flag states supervision is a complementary part of the academic program. IMO, those responsible for ensuring Safety at Sea should establish stringent rules for sea training and enforce all respective maritime authorities. Inclusion of these rules should be included in the forthcoming STCW development studies having priority.
* One of the university's missions is social activities to assist the development of the students’ social interactions as well as the improvement of their soft skills, which have become rather important in the time being.
* Enhancement of the capabilities of the university library (information center) is necessary to provide better knowledge support.
* The university’s responsibility for developing the research skills of the student should be considered seriously as well as enhanced contributions of students in the research activities.

Traditionally, the training needs of seafarers are commonly met by classroom training with an experienced instructor and the personnel in need of training. This training method, which we can define as the classical education approach, aims to transfer the knowledge and experience of the instructor to the students firsthand. The quality of education is directly related to many factors, such as meeting the standards related to the course, the lecturer's knowledge, the number, level, and interest level of the students, and the facilities, capabilities, and comfort of the classroom environment. The classical classroom education approach is still the most intensive, with technological facilities such as computers, projectors, smart boards, and the enrichment of course content with video and animation.

"To be prepared for emergencies where the platform, personnel, and nature are alone!" In this context, while drawing your attention to the importance of training conscious personnel, we should aim to reduce the sector's foreign dependency with new-generation solutions for the training needs of the maritime sector and to produce domestic and national technological solutions for the software needs of maritime institutions in this environment of intense international competition.

Different types of simulators have been produced for Ship Engine Room Training. The main purpose of all simulators is to simulate the machinery and systems in the Ship's Engine Room as much as possible and to be used in training.

The advantages of using simulators in training are as follows (Çicek & Uchida, 2002):

* Repeated training for normal and abnormal situations,
* Low operating costs,
* Effective preparation time for training,
* The ability to prepare the syllabus as desired with scenarios and the controllability of the syllabus,
* Students can be assessed using scenarios prepared in advance,
* Making it possible to prepare a standard program in Naval Architectural Engineering Education.

To learn from the problems encountered, training contents are updated with the "Evidence-Based Training" approach, especially in the maritime sector. In addition to possible sensor and control failures, there is limited time to quickly comprehend and make the right decision in an emergency such as an automatic pilot failure (e.g., an Air France accident), and the training and experience of the personnel are directly proportional to the possible loss of life and property.

Using simulation in maritime education requires the instructor to have some leadership qualities. For example, a transformational leader must be empathetic, inclusive, consistent, technologically advanced, pedagogically competent, and ethically sensitive (Ozdemir, Albayrak &Popa, 2023). A leader with these characteristics will be able to lead students effectively in simulator training as in every field.

**7. What is the Evidence-Based Learning Method?**

Evidence-Based Learning is a learning method teachers use to help students acquire critical thinking skills to think about and process information from their previous experiences. (Bozkurt, 2018) Bozkurt's research on evidence-based learning has shown that evidence-based learning can improve pre-service teachers' skills of "establishing cause and effect relationship", "evidence-based reasoning", "perceiving change and continuity", "communication", "decision making", "critical thinking", "higher order thinking" and "empathy". The results of the study also indicated that evidence-based learning practice helped the educator to adopt more student-centered approaches and a more democratic classroom atmosphere than the traditional role and classroom environment. In this method, teaching is built on evidence from previous studies. This ensures that the evidence is practical. An assessment approach is applied in which learners evaluate their learning and compare their learning outcomes with the results of previous scientific research. Evidence-based learning is not simply a learning process in which the results of scientific research are used but has a complex structure in which the findings of scientific research are used practically, and the learner is self-monitored. In this respect, the results of scientific research are very important in evidence-based learning approaches. According to Cournoyer and Powers (2002), evidence-based work specifies two interconnected rules guided by professional judgment and behavior. The first is to use the results of previous empirical studies to arrive at useful and effective results, and the second is to evaluate the practice at regular intervals to determine whether the predicted results are the results of the practitioners' work. In this context, the question is: "How should the research results be translated into practice? What other factors are influential in translating evidence into practice?" (Efendioğlu& Yanpar Yelken, 2009).

If curriculum developers consider the evidence (findings) from educational research and develop their curricula based on this evidence, they can also improve students' learning outcomes and, consequently, increase the financial allocation to educational research.

When developing an evidence-based instructional system:

* The results of previous basic and practice-based scientific research related to the program to be developed should be obtained. These results are very important for the program to be developed. The most important point is finding the best among these results (Zayas et al., 2003). The evidence obtained from scientific research is integrated into the program, and the program is started to be implemented.
* The experiences of those who are trained in this program, the workplaces where they will work when they graduate from the program, or the people or institutions operating in their fields of work are shared, and changes and corrections are made in the program in the light of the evidence (findings) obtained from these experiences. Thus, it is aimed to increase the effectiveness of the program.

This system works in a continuous cycle. It is necessary to systematically review the evidence (findings) obtained from research. Evidence-based education principles are developed based on these findings. The training program continues to be implemented. While the training is being implemented, the previously determined and evidence-based training principles are transformed into practices, and this cycle is subjected to an audit from the end to the beginning. Thus, it is aimed to eliminate deficiencies.

The following questions are posed to teachers and administrators to determine what perspective is needed to develop evidence-based practice.

1. What must be done to identify innovations (analysis, evidence of results)? For example, increasing students' learning goals and culture and preventing absenteeism.
2. Thinking about innovations together. Asking new questions to reflect on the impact of innovations to identify what has changed with these innovations. What tools should we use for teaching? How should we group students? How should we use technology?
3. Analyze, synthesize, and organize these innovations into a written document and thus prepare the pedagogical plans of the school.
4. Encourage teachers to explain what they did in their previous work and what was unsuccessful.
5. Share these innovations and the information gathered so that everyone can discuss and understand these innovations and definitions.
6. Observe different classrooms using this plan and observe whether the reflections of the innovations in the plan are positive.
7. Reach a common opinion on the types of evidence introduced by the innovations (Efendioğlu& Yanpar Yelken, 2009).

**8. Steps in Evidence-Based Use of Simulators in Maritime Education and Training**

The following steps can be taken for using simulators in evidence-based methods.

1. *The goal of the simulator training should be determined. The scenario should be prepared by taking the target skills into account. What skills will be taught to whom, where, and how many students will be in the group?*
2. *What are the new technologies to be used? Do students have adequate knowledge about these technologies? How can these new technologies be taught to students? What innovations do these technologies reflect? What previously inaccessible information will they enable?*
3. *Which best case studies or scenarios can be developed for new technologies to provide the targeted skills?*
4. *What are the failures of previous implementations? How can these failures be overcome? Which measures can be taken to ensure more success?*
5. *To what extent do all students who will be trained in simulators know the latest developments in the field? Are there any points they do not understand or are unfamiliar with?*
6. *When the scenarios created by taking all these into account are used in simulator applications by different student groups, what differences or similarities are observed in the way the groups apply or the results they achieve?*
7. *What inferences or generalizations can be drawn from the results?*

This method can provide information about the learning styles of students from different backgrounds and, more broadly, about learning differences between generations or how they approach technology and innovation.

To use evidence-based teaching methods effectively in simulators, first, scientific evidence on the subject should be collected. This evidence can be collected and stored with the help of computers. Once the evidence has been collected what kind of approach to take (using effect sizes) is determined. The approach determined in the light of evidence is integrated into the program. In this way, it is ensured that students benefit better from education programs and learn better.

**9. Conclusion**

The practices accepted worldwide as effective on students' learning should be adapted into the education programs and implemented in the teaching process, and they should be evaluated continuously during the teaching process. If students' learning can be supported positively with new approaches and their perspectives and attitudes towards learning can be changed positively, the gains in the field of education will increase. Because the positive attitude developed towards a behavior also positively affects the desire to use it. An evidence-based approach to teaching may serve this purpose, so it could be tested, evaluated, and adapted to the system if it proves useful.

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