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Evaluation methods for students on learning by simulating environment based on marine power plant simulator

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Abstract

In the article, we point out that learning on marine power plant simulators is not only a faster or cheaper way to learn but also a method of active teaching and learning. In modern simulators, reality is imitated, thanks to which the student has experiences similar to those that will be carried out in the real world. We also emphasize that teaching on simulators is easier to organize or less dependent on meteorological conditions, which is particularly important in the case of work at sea. We characterize mechanical simulators as devices that give the possibility of departing from the traditional teaching method. An unquestionable advantage of the considered training method is the possibility to simulate failures and critical events in a ship's engine room without the need to expose personnel and equipment. The article analyzes the advantages and limitations of the introduction of a simulation environment for training the manning of machinery departments of sea-going ships. We present the methodology of assessment in the process of operating devices with the use of a simulator and an example of verification of competencies acquired in this way in an environment similar to the real one. As part of the verification, the procedure for operating an air compressor in the simulator environment and in a real object with similar parameters was presented.

1. Introduction

Nowadays, work and learning are two elements that are constantly present in the biography of every seafarer. They are both a formal requirement resulting from many regulations that must be met in order to be able to work as a seafarer and an individual awareness that the process of continuous training is necessary for professional functioning in the constantly changing world of the maritime economy. All of these formal requirements are described in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW). According to International Maritime Organization (IMO) website [9], *"The 1978 STCW Convention was the first to establish basic requirements on training, certification and watchkeeping for seafarers on an international level. Previously the standards of training, certification and watchkeeping of officers and ratings were established by individual governments, usually without reference to practices in other countries. The Convention prescribes minimum standards relating to training, certification and watchkeeping for seafarers which countries are obliged to meet or exceed".* The convention is constantly updated, imposing on shipowners and crew members the need for continuous training and verification of the effects of this training. This presents a seafarer with the difficult task of continuous professional development and learning new rules and principles of work. Therefore, teaching seafarers is subject to the "classic" conditions of adult learning - determined both by the needs of the ship and the institution but also by the implementation of the postulate of a creative approach to one's own educational path, including self-education [6]. Moreover, the job of a seafarer is not characterized by permanent

employment. In order to maintain it, it becomes necessary to develop new competencies, including learning about new technologies. However, adult education has its specificity that should be taken into account if you want to conduct training in an effective way and be able to evaluate it effectively. This specificity results from the accumulated over the years baggage of experience, knowledge, beliefs, stereotypes and routine behaviours. In order to be able to effectively prepare the didactic process of adult learners, it is, therefore, necessary to take into account the factors that determine the specificity of adult education. Adopting appropriate methodological solutions certainly enables the effective and optimal organization of education, and at the same time, makes the didactic process effective. Training on simulators allows the use of computer technology as a didactically attractive and adequate training technique for adults. It allows them to raise the level of their training, faster mastering of the assumed skills, and developing the necessary professional habits to create real situations similar to those they will encounter at sea.

2. Seafarers' education

Professional vocational education of seafarers should fulfil several functions related to lifelong learning [4] such as:

- adaptive function, the purpose of which is to adapt to the working environment and changes occurring in it caused by technical and technological progress, which is particularly visible in the automation and mechanization of work at mechanical positions on ships and ships;
- reconstruction function, which increases the flexibility and mobility of the employee in the work environment at sea, in the engine room, meeting the frequent changes of the units on which the seafarer works;
- compensatory function, which consists in supplementing knowledge in connection with hierarchical changes in the structure of the organization, i.e. promotions to higher positions following the years of work at sea.

In the face of constant technical and technological changes aimed at improving navigation and automatization in the engine room department, the readiness to shape new competencies becomes a permanent element of work, especially of seafarers working in the navigation or mechanical departments. As the ICS Diversity Tracker (2020) reports [2], tasks that previously required a highly skilled worker are now automated, so training seafarers should include learning about new technologies, including digital technologies. Nowadays, training with the use of marine engine room simulators makes it possible to achieve this goal. The individual effects that should be achieved as a result of simulator courses are precisely described in the documents issued by the IMO. These aspects are the focus of the Sub-Committee on Human Element, Training and Watchkeeping (HTW) [9]. This committee regularly publishes changes to the applicable regulations and requirements relating to training on simulators. With respect to the engine room simulators, such a document is, for example, the Model Course on Engine-room simulator 2.07. All manufacturers of this type of simulators, in order to obtain the proper certificate, must meet the minimum requirements specified in these regulations.

3. Simulation as a pedagogical method

One of the digital technologies is a computer simulation. The foundations for understanding simulation as a method are visible, among others, in the report of T.M. Taylor [7] who describes it as carrying out experiments on a created, abstract model of a system mapped to some extent on reality. Therefore, it can be said that a simulation is a situation in which a student has the opportunity to play roles mapped on the basis of a real social environment, in our case, a professional one. It is a miniaturized image of a fragment of reality, a kind of model of the process of a certain situation.

In the following years, due to the innovative method, various ways of imitating reality and various ways of using simulation in pedagogical practice, problems with definition appeared (simulations, simulation games, didactic games). Currently, in the 21st century, the issues of modelling and simulation are widely used with the use of computers [1, 3, 5]. It is referred to as computer or digital simulation. The development of computer technology has allowed for a wider and more perfect use of utility computer programs in this method, increasing the realism of mapping the situation and dynamics (animations, interactivity of simulations). This made it more attractive in the process of teaching students living largely in virtual reality. Simulations have become one of the many determinants of the effectiveness of the didactic process and the activation of students. It can therefore be noted that

"simulation as a pedagogical method gives the opportunity, in stress-free conditions, to master and acquire basic professional skills, alternative activities, solve problems related to the work performed, it teaches to predict the effects of decisions made, to recognize the mutual relations of various professional situations, independence, creativity. , assertiveness. The knowledge and experiences acquired on the basis of this model of education can be easily transferred to similar situations in the working reality" [3]. Among the selected fields of simulation application, in work [3] author focusing on engineering sciences and the ship simulators used in them.

4. Normative documents and realities

According to the IMO model course 2.07 aspects connected with training on engine room simulator is extremely important [9]; "*The nature of this course will involve all the trainees and instructors in an ongoing process of individual and group evaluation. However, formal evaluation is a very important aspect of all simulator training because it provides the means to determine whether or not the trainee has achieved the prescribed standard of competence. This competence is needed during normal watchkeeping and operation and can be vital in emergency situations. Formal evaluation should, therefore, be emphasized and conducted as soon as the trainee is ready and always at the end of the simulator exercise*". IMO model courses allow the use of various methods of assessing learning outcomes with the use of simulators. One of the simplest is an evaluation based on facts, it does not take into account the time needed to solve the problem. The biggest disadvantage of this method is the possibility of using routine solutions included in the simulator induction by the examined persons without involving knowledge of the functional connections of the individual marine engine room devices. The next is an evaluation based on the time taken and the process made. In this case, both the achieved effect of the task, the method of reaching the set goal and the time in which this goal was achieved are included in the final grade. The last type of assessment given in [9] is an evaluation based on observation in this method, instructors evaluate trainees by observing their performance. Usually evaluation criteria are prepared in advance however, instructors experience, knowledge and ideas are likely reflected in the evaluation. IMO model course 2.07 provides many examples of exemplary exam scenarios that allow to assessment the attainment of various competencies achieved by trainees in the field of operating engine room devices and systems.

However, each engine room simulator manufacturer provides its own solutions of trainee's competencies evaluation methods [10-13]. Of course, all of them have to meet the minimum requirements described in IMO documents. The reason why scenarios are not the same is very simple and is strongly connected with the diverse type of machinery equipment that can be found in marine power plants. Another issue is that simulator manufacturers do not always have access to full documentation of individual devices, or they cannot infringe the copyrights of their manufacturers. The ideal solution would be to prepare simulators for the shipowner at the time of building a new type of vessel. However, it would significantly increase the costs necessary to be borne by the contracting authority. Therefore, it seems that the currently existing solutions are optimal. Training centers can choose from several simulator suppliers, each with its own strengths and weaknesses. It should be remembered here that training with the use of simulators is only one of the stages of education. This should be an intermediate stage between purely theoretical training and practical training in laboratories or marine engine rooms of real ships.

Taking into consideration evaluation methods for students on learning by simulating environment based on marine power plant simulator, most of the simulators manufacturers provides at least below support:

- exercise editor;
- fault simulations possibilities;
- online monitoring and recording of trainee's work;
- integrated communication system.

These features are used to achieve [13] few main goals:

- learn ship's engine room typical operating routines;
- train in ship's engine room operation;

- the accomplishment of any operational task starting from different setups, both pre-prepared and saved by a user.
- To conduct correct action when faults occur.

Thanks to the above it is usually possible to run an existing scenario to create your own depending on the needs according to which the exam should be carried out. A scenario is a chain of events that introduces or removes faults and unexpected situations in the engine room. The task of the trainee is to find a correct way to prepare the engine room for operation.

In the author's opinion, relying only on theoretical training in the training process and replacing practical training with training on simulators is not correct. Although most training centres, in accordance with the requirements of the STCW Convention, strive to have technical facilities that enable practical training also in conditions similar to real ones (in laboratories), there are still well-known situations when centres without adequate equipment in the form of real mechanisms make an effort to educate seafarers. The complexity of most of the mechanisms used in marine engine rooms is so great that it is practically impossible to recreate all combinations of possible malfunctions in a systematic way in a simulator environment. An example of the fact that such an approach is not correct may be the comparison of a fragment of one of the simulators, specifically concerning the air compressor, with its real counterpart - Fig. 1.

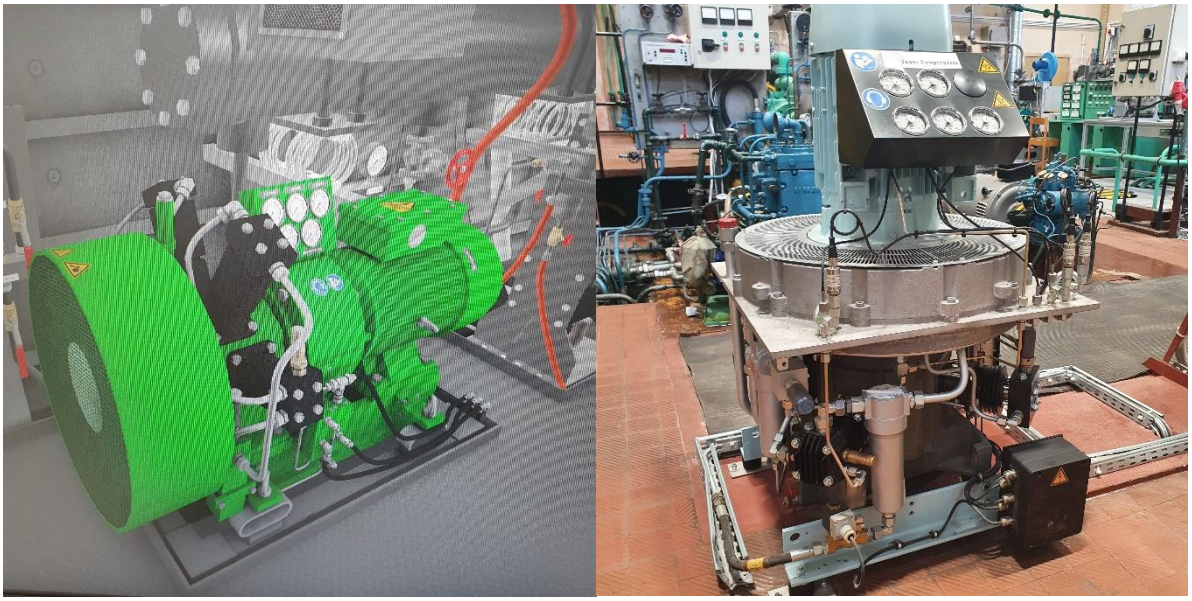

Fig. 1. On the left - air compressor in the simulation environment [13], on the right – real air compressors of the same type.

Due to the fact that simulators are a kind of simplification of reality and even though the graphic possibilities are increasing, they still do not accurately reflect the simulated object. This applies to both its appearance and the possibility of simulating individual malfunctions. Of course, with the increase in computing power of computers, simulators become more and more perfect, however, despite their very positive impact on the education process, a lot of emphasis should also be placed on practical training with the use of real mechanisms. Therefore, the use of any method of assessing the training effects obtained with the use of the ship engine room simulator does not provide full knowledge about the student's readiness to operate the actual equipment. the necessity of uniform criteria for assessing the effects achieved with the use of simulators remains important. Currently, their proposals presented in the IMO documents seem be sufficient.

5. Summary

Nowadays, mechanical simulators might be treated of as devices that give the possibility of departing from the traditional method of teaching towards creating individuals, based on the application

of knowledge and experience of adults in solving professional problems. Training on simulators allows the use of computer technology as a didactically attractive and adequate training technique for adults, allowing to raise the level of their training, faster mastering of the assumed skills and developing the necessary professional habits to create real situations similar to those they will encounter at sea. Learning on mechanical simulators is not only a faster or cheaper way of learning but most of all it is a method of active teaching and learning in which reality is imitated, thanks to which the student has experiences similar to those that will be carried out in the real world. We also emphasize that it is easier to organize or less dependent on meteorological conditions, which is particularly important in the case of work/service at sea.

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