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IMPACT OF ENGINE ROOM SIMULATOR AS A TOOL FOR TRAINING AND ASSESSING BSMARE STUDENTS' PERFORMANCE IN ENGINE WATCHKEEPING

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Abstract. Ship engine room simulator is a tool used by maritime academies that offer the Marine Engineering Program. According to the Standards of Training Certification and Watchkeeping for Seafarers (STCW), to provide physical realism in training and assessment, simulators are employed. Assessment programs have the intent of providing results that educators will utilize to improve their teaching strategies and improve learner performance (Klinger et al. 2008). This study aimed to (1) Determine the level of competencies of the Bachelor of Science in Marine Engineering cadets in Engine Watchkeeping with Resource Management before and after their exposure to the training on the use of the simulator as a tool for learning, and (2) To find out if there is a significant difference in the level of competencies of the cadets in Engine Watchkeeping before and after the training on the use of the simulator as a tool for learning. Mean and Wilcoxon tests were utilized to analyze the data. It was found that a significant difference in the level of competencies of the cadets in Engine Watchkeeping before and after the training, which implies that the Engine Room Simulator is a tool for learning and assessing the competencies of students in Engine Watchkeeping is effective. The study recommends that instructors should maximize the use of the available simulators in teaching the course. Students shall have a hands-on experience as supplementary to the theories that they learn.

Keywords: simulators; engine watchkeeping; marine engineering; assessment

Introduction

Ship engine room simulator is an effective and valuable tool used by maritime academies and training centers that offer courses for those who graduated or enrolled in the Marine Engineering Program. The Standards of Training Certification and Watchkeeping for Seafarers (STCW) 2010 Convention has partially defined the specification and application of simulators (Tsoukalas et al. 2014).

According to the Standards of Training Certification and Watchkeeping for Seafarers (STCW) Section A-I/12, because of its ability to imitate the operation of shipboard equipment, a simulator will be used to give physical realism in the conduct of training and evaluation.

In the study of (Vasilakis et al. 2012), it was found that the participants were interested in learning more from the process of simulation, and they were focused on looking into more ways to draw more benefits from it. Furthermore, the results of their study showed that simulator courses accelerate knowledge. The participants felt comfortable with the simulator and were ready to use their knowledge to learn by trial and error and ensure their thoughts about the operation of the engine room.

According to (Chen et al. 2017), students are provided with more comprehensive training for topics related to Marine Engineering by the use of the simulator. It will lead to the reduction of pressure in practical competency assessment and will allow the students to operate on their own.

As an effective tool in ensuring safety and efficiency in the operation of the marine engine plant, it is highly recommended that the engine room simulator is to be utilized. Furthermore, the competencies defined by the STCW for marine engine officers as further guided by the code should be met in classroom training and discussions (Bouras 2000).

(Millar 2004) argued that as we act in the world with how we currently understand things and collate them with the results of these actions, we create increasing and sophisticated representations. Our actions would turn into sensory data that can be adjusted into the existing schemes or be altered to conform to the new data to attain balance between the inner and outer realities. We develop a perspective of the elements in this reality, how they are formed, and what can be constructed with them, through these acts. Understanding requires the practical experience of witnessing and performing an action in the real world.

Assessment programs have the intent of providing results that educators could use to improve their teaching strategies and increase student performance (Klinger et al. 2008). The teachers' assessment practices affect students' learning, including their self-monitoring and regulation of their learning process (Hume et al. 2009). The assessment practices play a crucial role in the teaching and learning functions (Gardner 2006).

According to (Gregory et al. 2010, 62), "education aims to widen and extend people's horizons. The goal is to expand an individual's future options while also increase the range of possible approaches to each of those prospects."

It is crucial to train human elements. A country that does not give importance to training its human resources is in jeopardy. Well-educated and trained maritime professionals are essential for a robust and powerful marine transportation system (Efanga et al. 2012).

The researchers are motivated to conduct this study because they are marine engineering professional instructors who may handle Engine Watchkeeping with Resource Management. In the advent of the new curriculum imposed by the

Commission on Higher Education (CHED) and the Maritime Industry Authority (MARINA), innovations must be used to train and assess the performance of Marine Engineering students enrolled in the course as mentioned above. This ensures that students will be equipped with the desired course outcomes mandated by CHED and MARINA.

Theoretical Framework

Simulation-Based Education is guided by some academic learning theories and conceptual models. This form of education takes a learner-centered framework based on constructivist learning theories. Students create their own truth and facts. Conversation, self-reflection, and questions are among the activities used in this form of learning to encourage learners to be more active (Kriz 2010).

Kolb's Experiential Learning theory is often used as a model in the development of Simulation-Based Education. Concrete experience, reflective evaluation, abstract conceptualization, and productive experimentation are the four stages in this theory. They establish a never-ending rhythm. Tangible experiment happens when learners or students engage in simulation scenarios in the context of Simulation-Based Learning. They consider their results when debriefing on their success during the simulation and recognizing differences at the conclusion. The Simulation-Based Learning facilitator assists the learners in creating and implementing a mental model that integrates what they have experienced during abstract conceptualization. This is the part where learning occurs and where knowledge is put into practice. The active experimentation step refers to the process by which students apply new mental models (Kolb 1984 cited in Zigmont et al. 2011).

Conceptual Framework

While others are worried about reaching the learning objectives and meeting the criteria of the STCW convention, most maritime professionals have favorable impressions of simulation-based training and see simulators as having apparent promise for educating both technical and non-technical skills (Hanzu-Pazara et al. 2008; Malik et al. 2015; Pekcan et al. 2005).

Human activities support the capacity of simulators for teaching skills such as situation understanding and decision making. The efficiency of simulator-based training is investigated using an experimental research approach (Chauvin et al. 2009; Saus et al. 2012). However, the conclusions produced in empirical studies analyzing the actual usage of simulators in maritime training are sometimes framed as cautions that simulator-based instruction and assessment are being badly implemented in maritime education (Sampson et al. 2011). Both simulator misuse and a lack of information about how to provide effective training and legitimate assessment simulators have been noted as issues. Several studies have highlighted the necessity of quality instruction during simulator-based training in achieving learning goals (Hontvedt et al. 2013). As a result of the review's findings, research is needed to give guidance for a) marine simulator instructors during training and b) how to conduct simulator-based evaluations of competence to ensure the validity and reliability of simulator-based exams in order to address what has been highlighted as a potential safety threat for the shipping sector.

(John et al. 2016), in order to train marine English for communication and decision-making in bridge teamwork, compared the usage of a low-fidelity simulation with a high-fidelity simulation. Their findings are consistent with earlier studies, demonstrating that low-fidelity simulations allow students to strengthen their conversational abilities in a cost-effective and user-friendly manner. (Dahlstrom et al. 2009). (Castells et al. 2016) report on developing a simulator-based model course to train, demonstrate, and revalidate the competencies and certificates of professional seafarers in accordance with the STCW convention. The 37 separate courses for deck officers specified by the STCW convention are assessed and certified using an IMO model course, which includes both learning objectives and a foundation for assessment and certification.

By extending, updating, and augmenting current simulator-based training materials, the study Model Course to Revalidate Deck Officers' Competencies Using Simulators (Castells et al. 2016) is provided. (Benedict et al. 2017) reported on developments in simulator technologies by describing the development of a new tool for briefing and debriefing maneuvering skills in a novel way. The tool is specifically developed to provide demonstrations of a ship's motion characteristics, as well as fast responses via rudder, engine, or thruster orders. The tool has the potential to facilitate discussions on the impact of various environmental variables on maneuvering, as well as other methods and alternative maneuvers, which will be valuable during both the briefing and debriefing phases of training. Finally, (Baldauf et al. 2016) compare simulator-based exercises to the principles for this sort of training provided in the STCW convention to investigate aspects of crisis management and team training for emergencies at sea in simulated environments. Their findings reveal that the scenario's dynamic unfolding is partially dictated by the trainees' activities and interactions inside the simulator environment, rather than being totally predicted by the scenario. According to (Baldauf et al. 2016), the simulation environment aids in the training of abilities such as communication and leadership by delivering accurate and increased feedback of the current scenario. (Baldauf et al. 2016) emphasize the need of continuous, real-time feedback in the simulator-based training process to meet learning objectives based on their findings.

Given the concepts mentioned above and findings as supported by the literature, this study explores how the use of an Engine simulator could enhance the competencies of Marine Engineering students after they are exposed to it as a tool for learning for a certain period. The concept of this study is shown in Figure 1.

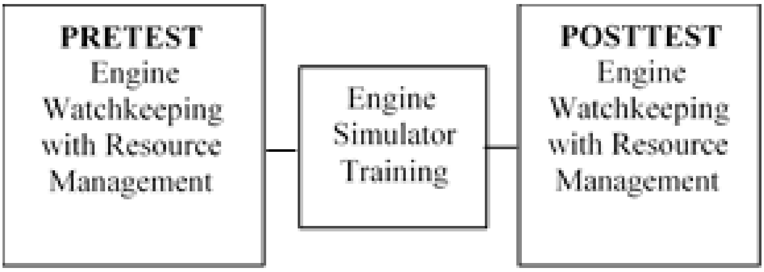

Figure 1. Schematic Diagram of the study

Statement of the Problem

This study aimed to determine the effectiveness of the Engine Room Simulator as a tool for learning and assessing the competencies of BSMarE 4 graduating students in Engine Watchkeeping with Resource Management. Specifically, this study aimed to answer the following questions:

1. What is the level of competence of the BSMarE 4 graduating students in Engine Watchkeeping with Resource Management before the training on the use of the simulator as a tool for learning?

2. What is the level of competence of the BSMarE 4 graduating students in Engine Watchkeeping with Resource Management after their exposure to the training on the use of the simulator as a tool for learning?

3. Is there a significant difference in the level of competence of the BSMarE 4 graduating students in Engine Watchkeeping before and after the training on the use of the simulator as a tool for learning?

Hypothesis

There is no significant difference in the level of competence of the BSMarE 4 graduating students in Engine Watchkeeping before and after the training on the use of the simulator as a tool for learning.

Methodology

Research Design

This study employed a one-group pre-test post-test design. A one-group pretest-posttest design is a type of research design is most often utilized by behavioral researchers to determine the effect of a treatment or intervention on a given sample. This research design is characterized by two features: (1) a single group of participants is involved, and (2) the assessment of a dependent variable before and after treatment is implemented (Allen 2017). In the one-group pre-test post-test design, a single group is measured or observed after being exposed to the treatment of some sort and before (Fraenkel 2011).

Participants

The participants of this study were 23 BSMAR-E 4 graduating students under the Norwegian Shipowner's Association (NSA) Cadetship program who were enrolled for the School Year 2019 – 2020 in a maritime education institution in the Philippines.

Research Instrument

The instrument utilized in this study was adapted from the 24-hour scenario simulation training material of the Norwegian Training Center (NTC) and the Integrated Maritime Practical Assessment Center and Technical Solutions. It is composed of two forms, the Assessment Monitoring Form and the Answer Sheet. The assessment focused on three main areas: handling the watch, taking over and accepting the watch, and maintaining machinery space logs. Each topic had its corresponding set of competencies and their respective KUP's, Performance Outcome, Performance Criteria, and a breakdown of performance standards and scored on their proficiency level. The assessment system had set a passing score of 70%. The assessment monitoring form included the criteria for scoring and guidelines used in the conduct of the assessment. Furthermore, the monitoring form is based on the topics involved in the subject of Engine Watchkeeping. The answer sheet contained spaces where the students were asked to reflect their answers based on the questions provided in the monitoring form.

Data Gathering Procedure

The researchers conducted a pre-test to the participants at the beginning of the semester using the research instrument. In line with this, they were fully aware of the criteria and the guidelines provided in the instrument and the assessment monitoring form, which contained the instructions for the conduct of the assessment. The pre-test scores were kept after the conduct of the assessment. After the Pre-test was conducted, the assigned instructor then used the simulator to teach the subject. After the semester, a post-test was conducted to determine whether there is an improvement in the students' performance.

Statistical Tools

Mean was utilized to assess the participants' level of competence. To interpret the results, the following table of interpretation was used.

Scale	**Interpretation**	**Description**
2.00 – 3.00	Competent	70% and above (Passed)
0.00 – 1.99	Not competent	Below 70% (Failed)

Wilcoxon test was employed to determine the difference in the level of competence of the participants in Engine Watchkeeping before and after the training on using the simulator as a tool for learning.

Results and discussion

Table 1 shows the level of competence of the participants in Engine Watchkeeping with Resource Management before the training on using the simulator as a tool for learning. The data reveal that before the training, the students failed with a score of 1.66, which is interpreted as not competent. This implies that the students' performance in Engine Watchkeeping with Resource Management before applying the intervention turned out to be below 70%.

Table 1. Level of Competence of the Participants in Engine Watchkeeping with Resource Management before the training on the use of the simulator as a tool for learning

Competency	Score	Interpretation	Description
1	1.67	Not Competent	Failed
2	1.50	Not Competent	Failed
3	1.80	Not Competent	Failed
Total	**1.66**	**Not Competent**	**Failed**

The need for an effective intervention to improve the students' level of competence is evident based on the pre-test result. According to (Klinger et al. 2008), to have a good result in assessment, the instructors need to improve their teaching strategies to improve students' performance. It is also clear that the assessment practices play a crucial role in the teaching and learning functions (Gardner 2006). Hence, the teachers' assessment practices affect students' learning, including their self-monitoring and regulation of their learning process (Hume et al. 2009).

Furthermore, the level of competence of the BSMarE 4 graduating students in Engine Watchkeeping with Resource Management after their exposure to the training improved. Data in Table 2 reveal that after their exposure to the training, the participants passed with a mean of 2.80, interpreted as competent. This implies that the utilization of the simulator as a instrument for learning has improved the cadets' level of competence after their exposure to it, rejecting the null hypothesis that there is no significant difference in the level of competencies of the BSMarE 4-NSA cadets in Engine Watchkeeping before and after the training on the use of the simulator as a tool for learning.

Table 2. Level of Competence of the Participants in Engine Watchkeeping with Resource Management after the training on the use of the simulator as a tool for learning

Competency	Score	Interpretation	Description
1	2.82	Competent	Passed
2	2.86	Competent	Passed
3	2.72	Competent	Passed
Mean	2.80	Competent	Passed

(Vasilakis et al. 2012) had emphasized the positive contribution of simulators in students' learning. According to them, students are interested in learning more from simulation, and they are focused on looking into more ways to draw more benefits from it. Furthermore, the results of their study showed that simulator courses accelerate knowledge. In this study, the participants have felt comfortable with the simulator, which allows them to use their knowledge to learn by trial and error and ensure their thoughts about the operation of the engine room.

Moreover, (Benedict 2000) specified that to acquire maximum advantage, it is essential that individuals who face a maritime simulation program have to move through an internal realization process, change, and acceptance. The environment, surroundings, and ambiance of understanding play a major role in the cadets' competence. Also, trust is required to be developed between the instructor and students/cadets. An assessment can support simulation exercises to evaluate cadets' skills involving command clarity, leadership, communication abilities, situational awareness, task prioritization, efficient delegation, capability to plan, techniques of problem-solving, anger and stress management, communication abilities, and response to unexpected emergencies and situations.

As indicated in Table 3, there is a significant difference in the level of competence of the participants before and after the training on using the simulator as a tool for learning with a mean difference of 1.14, z-value of -0.36, and p-value of 0.00. This implies that the training on using the simulator as a tool for learning has been proven effective.

Table 3. Difference in the level of competence of the participants before and after the training

Competency	Mean	z – score	p-value	Interpretation
Pre-Test	1.66	-3.06	0.002218	Significant Difference
Post Test	2.80			

p-value<0.05 Reject null hypothesis

(Kongsberg 2009) said that using a maritime simulator is beneficial in educating the participants since it provides a much-structured process of enhancing greater competence levels than conventional training. Hence, using a simulator provides a much-organized method of improving greater competence levels than traditional training.

(Chen et al. 2017) stressed that students are provided with more comprehensive training for topics related to Marine Engineering by the use of the simulator. This leads to a reduction of pressure in practical competency assessment and allows the students to operate independently.

(Noe 2010), (Goldberg 2013), and (Salman 2013) cited some reasons why simulations can be practical. First, trainees can use it electronically, allowing them to learn hands-on under a controlled learning environment as they strive to meet the target skills and competencies. Second, they get the trainees involved and emotionally engaged in learning, increasing the trainee's willingness to practice, promoting retention, and improving their skills. Moreover, many of the benefits of simulations lead to better retention and application of knowledge (Nielson 2017). Simulations improve professional judgment and offer the trainee many ways of tackling problems, particularly those which require the management of risk and crisis (Stan 2014). Simulation training does not just contribute to the trainees' efficiency and experience but also their confidence in simulated job situations. Moreover, the benefits and advantages of using simulations cover not only the participants (trainees) but also the moderators (instructors), the training organization, and the organization as a whole (Nielson 2017).

Conclusions

Based on the study's findings, it can be concluded that the use of Engine Room Simulator is effective for learning and assessing the competencies of BSMarE 4 NSA graduating students in Engine Watchkeeping with Resource Management. These innovations are used to train and assess Marine Engineering students' performance and ensure that students will be equipped with the desired course outcomes mandated by CHED and MARINA.

Using the Engine Room Simulator is an effective intervention to improve the level of competence of the cadets in Engine Watchkeeping with Resource Management and serves as a way of training them to perform their tasks more independently while maximizing the use of their decision-making and problem-solving skills. A pre-test was discovered to be a viable method for shaping group-specific education programs. It provides a diagnosis of the cadets' weak areas in terms of competencies. Furthermore, comparing the post-test outcome to the pre-test result statistically will serve as an accurate evaluation to assess whether or not what occurred in the teaching and learning phase when the intervention was implemented was successful.

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