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Simulator-Based and Hands-On Methods for Marine Engineering: A Descriptive and Comparative Analysis

Dominic Rey Y. Singuit[1], Betaliano S. Villalas[2] and Rey Q. Aranzado[3]
[1]BS Marine Engineering-Faculty, [2]BS Marine Engineering-OIC Chairperson, [3]Quality Assurance Manager,
Maritime Education, University of Cebu Lapu-Lapu and Mandaue, Philippines
E-mail: drsinguit@uc.edu.ph, bvillalas@uc.edu.ph, braranzado@uc.edu.ph

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Abstract - **This study assessed the simulator-based and hands-on methods of selected third-year marine engineering students at the University of Cebu Lapulapu and Mandaue. This study determined the respondents' age, gender, and grade point average profile. Furthermore, it defined the subjects' performance levels and the difference between simulator-based and hands-on methods in Propulsion Ancillary System and Gas Turbine (PASGT). This study used the descriptive-comparative method. The researchers used a convenient number as subjects of the total number of enrollees in the course. The investigation was carried out by the researchers in University of Cebu-Lapulapu and Mandaue. The study used a scenario-based researcher-made assessment tool to gather the data needed. The researchers used frequency count, percent, mode, and weighted to treat the data. The study revealed that in the simulator-based method, the subject's performance in the chosen competencies of the course PASGT obtained a much higher mean interpreted as very satisfactory. It also established a significant difference between the subject's performance in the simulator-based and the hands-on methods. The findings concluded that the simulation-based methods in teaching and learning the PASGT course have substantial educational effects. With particular consideration to the students' psychomotor domain, the medium provides learning in a manner that is very suitable to the current practices of the younger generation.**

Keywords: **Simulator-Based, Hands-On, Propulsion Ancillary System, A Gas Turbine, Performance Level**

I. INTRODUCTION

In maritime education of the Philippines today, there is a need for maritime higher educational institutes to expose maritime students to simulated shipboard scenarios so that the students will be able to understand better the fundamental theories and principles of seafaring. Furthermore, the obligation to provide optimal practical exercises constructively aligned to the ideas and regulations to ensure conformance of acquired skills to established shipboard practices and international standards set forth by the Standards of Trainings, Certification, and Watchkeeping (STCW). These two competing needs nowadays pose a dilemma in maritime education that administrators must address. This concern is incredibly genuine in the marine engineering discipline, which is a skill-based science. It needs repeated exposures with an enhanced experience and constant practical exercises.

The growing complexities of a modern ship's daily engine operation require future marine engineers not only knowledge and procedural skills but also the ability to effectively communicate with the entire team about various engine watchkeeping activities. Engineers must be good team players, so their training programs must systematically teach these skills.

Simulation is a technique for practice and learning that can be applied to many different disciplines and trainees. It is a method (not a technology) to replace and amplify real experiences with structured and guided ones, often "immersive" in nature, that evoke or replicate substantial aspects of the natural world in a fully interactive fashion. Simulation-based learning can be the best way to develop knowledge, skills, and attitudes while protecting the students from unnecessary hazards and risks. It can be a platform that will provide a valuable tool in learning to mitigate ethical tensions and resolve practical dilemmas. Simulation-based training techniques, tools, and strategies can be applied in designing structured theoretical and practical learning experiences and as a measurement tool linked to desired individual and teamwork competencies and learning objectives.

It is frequently used in industries including aviation and the military. In maritime education, specifically in marine engineering, simulation offers good scope for training individuals and teams in engine room operations. The realistic scenarios and equipment allow for training and practice till the student can master the procedure or skill. Teamwork training in the simulated environment may offer an additive benefit to the traditional didactic instruction, enhance performance, and possibly help reduce errors.

To produce a graduate compliant with the amended STCW Code and competitive with the maritime shipping industry's needs, a maritime higher educational institute must therefore consider that maritime education and training (MET) should be enhanced in terms of facilities, equipment, and curriculum design, and learning methodologies. This action ensures a pool of highly qualified and competent future marine engineers. As the IMO Secretary-General stated in one of his keynote addresses: In order to provide safe, secure, hygienic, and effective operations, the human element at sea is essential. Only through effective education and training, founded on scientific and academic rigor, the development of a clear link between practical skills and management techniques, and an unwavering focus on quality, is it possible to secure and preserve suitably qualified human resources for the maritime industries (The Gleaner, 2015).

The Andragogy Theory of Knowles stated a set of assumptions about adult learners. The adult learner, according to this theory, is motivated to learn by internal, as opposed to external factors, factors, and moves from dependency to increasing self-directedness as they mature and can direct their learning; makes use of their extensive life experiences to support learning; and is prepared to learn when they take on new social or life roles. These presumptions come with practical repercussions (Knowles, 1984).

In addition to the Andragogy theory, David Kolb's experiential learning theory also supports the study. Kolb's theory promotes that learning involves acquiring abstract concepts that can be applied flexibly in various situations. According to Kolb's idea, a novel experience serves as the catalyst for the creation of novel thoughts. Learning, therefore, is the process whereby knowledge is created through the transformation of experience (Kolb, 1984).

According to Lave and Wenger's contextual learning theory, learning often depends on the activity, context, and culture that it takes place in (i.e., it is situated). This idea contrasts with most classroom learning activities which involve knowledge that is abstract and out of context (Lave & Wenger, 1990). A general theory of information acquisition through social interaction is called situated learning, and it is frequently characterized by critical self-reflection on the learners' experiences. It is essential for learners in a professional program where they are expected to actively organize their framework of knowledge and apply it to new situations.

Songoro (2000) noted that traditionally, monitoring was based on manual' hands-on, where a piece of machinery equipment was to be stripped off for inspection and determination of its lifetime by visual inspection and physical measurements. Compression (piston) rings, for example, were to rely on the engineering experience of the personnel on board and the manufacturer's instructions before they could be opened up for the necessary actions. Manual operations for equipment on board were an ideal traditional engineering practice. Time and cost were unimportant elements in shipboard operations because labor was relatively cheaper.

According to Juhary & Manan (2014), simulations are among new technologies that receive praise and criticism. Because of their potential, many educational institutions are attracted to implement and use them. On the other hand, many academics are skeptical about these new tools because of their costs. Besides the costs, many scholars argue about the effectiveness of using digital technologies to improve students' grades. There is no guarantee that any learning and teaching approach or tool could help students perform better academically. Because of this, combining teaching and learning methodologies is usually a good idea.

For these reasons, the researchers study the effectiveness of simulator-based training in developing competencies vis-a-vis STCW structured manual training in selected marine engineering functions. The objective is to identify what competencies may be developed by simulator-based training traditionally conducted through manual training.

II. OBJECTIVES OF THE STUDY

The study aims to assess the performance of simulator-based and structured hands-on methods of selected third-year marine engineering students. The study also seeks to discern the subjects' profile in terms of age, gender, and grade point average of PASGT. Furthermore, the study aims to determine the significant difference between the subjects' performance levels. Based o the findings, the researchers will design an action plan to improve the department's educational management.

III. METHODOLOGY

In the assessment of the performance of simulator-based and structured hands-on methods of selected third-year marine engineering students, the researchers utilized descriptive-comparative quantitative research in the method of inquiry. Concerning its objectives, the researchers organized this study under the descriptive type of research. The implementation of this investigation is under the applied research category.

The researchers conducted this performance assessment at the University of Cebu Lapulapu and Mandaue (UCLM) campus. The University's site is near the entrance of the old Mactan Bridge going to Lapulapu City. The University offers several courses, including a Bachelor of Science in Marine Transportation (BSMT) and a Bachelor of Science in Marine Engineering (BSMaRE). At first, UC-LM was only a satellite campus of UC-METC for the maritime courses, but in 2010-2011, the school was granted a permit by CHED to operate third-year level.

The subjects of this study were the BS Marine Engineering cadets who enrolled in the Propulsion Ancillary System and Gas Turbine (PASGT) course. A total of three hundred fifty-six 3rd year students enrolled in the course in 2019-2020, and the researchers used a convenient sample for this study. The content of the PASGT course was delivered through structured manual training and simulation-based scenarios. This scheme allowed the researchers to accomplish the primary goal of this study.

In collecting the facts essential for the realization of the objectives of this study, the researchers utilized a researcher-made instrument that went through validation by the pool of selected BSMARE instructors and assessors. The research instrument contained two parts. The first part is about the profile of the subjects accomplished by the subjects. The second is the simulator-based and hands-on assessment checklist used by the researchers during laboratory exercises and assessments. Statistically, the research instruments were sound. For the treatment of the profile data, the researchers used simple frequency and percentage. The researchers assessed the level of performance using the following rating scales; 4 – very satisfactory, 3 – satisfactory, 2 – less satisfactory, and 1- not satisfactory.

In the conduct of the gathering of data, the researchers strictly followed the standard ethical principles of research. Four basic principles were observed: the principle of respect for persons, beneficence, informed consent, and justice. For the observance of respect to persons, the researchers treated the respondents as autonomous agents, and the respondents with diminished autonomy were entitled to protection. In affording beneficence, subjects were treated ethically by respecting their decisions and protecting them from harm, but also by ensuring to secure their well-being. For informed consent, the subjects were given the appropriate information about the research comprehensively without duress or inappropriate inducement. Lastly, the principle of justice was applied. The researchers followed fairness in the distribution, or "what is deserved" was observed in the treatment of the subjects. Careful consideration was given to the overall societal impact of the study in selecting the participants and the benefits and burdens arising from it.

The researchers notified the subjects about the study's aims, methods, and anticipated benefits. They were also informed of their: (a) right to abstain from participation, (b) right to terminate at any time their participation, and (c) the confidentiality of their answers. No student became a subject of this study unless they had given the notice mentioned above and freely given their consent to participate. Pressure or inducement was not applied to encourage the student to become a subject. The researchers ensured confidentiality by strictly following the principles of keeping the responses private and for study use only.

IV. RESULTS AND DISCUSSION

This section present interprets and analyzes the data collected during the research. The data pertain to the profile, the performance of the subjects, and the difference in the subjects' performance in simulator-based and structured hands-on training.

A. Profile of the Subjects

Table I presents the profile of the subjects in terms of age, gender, and grade point average.

TABLE I PROFILE OF THE SUBJECTS

Sl. No.	Age	Frequency	Percent
1	18	24	32
2	19	40	53.33
3	20	8	10.67
4	21	2	2.67
5	22	1	1.33
	Total	75	100
Grade Point Average			
6	1.0 – 1.5	1	1.33
7	1.6 – 2.0	42	56
8	2.1 – 2.5	31	41.33
9	2.6 – 3.0	1	1.33
	Total	75	100

As shown in Table I, most subjects are nineteen years old, comprising 53.33% or 40 of the total respondents. On the other hand, two subjects are already 21 years old, representing 2.67%, and one is 22 years old, 1.33 % of the total number of subjects used. On the grade point average (GPA) of the subjects, the study determined that one subject had an average of 1.0 to 1.5, while the lowest had an average of 2.6-3.0. The rest were in the ranges of 1.6 to 2.0.

B. Subjects Performance in Simulator-Based Method and Structured Hands-On Method under Competence 1

Table II reflects the determined performances of the subjects in the tasks under the competence operate main, auxiliary, and associated control system. Out of the eight tasks, there are three that have garnered the same interpretation of very satisfactory. The rest are in favor of the simulator-based method.

Task 1, though having a different mean, has the same interpretation, which is very satisfactory mainly because, in both methods, the subjects need to pass through them before going to the following tasks. It is tantamount to saying that they have to be knowledgeable in both knowledge and skill in this task before the subjects can proceed to task number two, whether in the simulator-based or hands-on method. Since it is a sort of pre-requisite, the subjects got higher performance ratings resulting in a statistical interpretation of very effective.

The andragogy theory of Knowles supported the findings. The theory states that the adult learner moves from dependency to increasing self-directedness as he or she matures and can direct his or her learning. Draws on his or her accumulated reservoir of life experiences to aid learning. Is ready to learn when he or she assumes new social or life roles. Problem-focused, eager to put new knowledge into practice, and motivated more by internal than external causes, these people learn. These presumptions have practical ramifications that are inherent.

TABLE II PERFORMANCES OF THE SUBJECTS IN SIMULATOR BASED METHOD AND STRUCTURED HANDS-ON METHOD IN TERMS OF OPERATING MAIN AND AUXILIARY MACHINERY

Sl. No.	COMPETENCE: Operating main and auxiliary and associated control system	Simulator Based Performance		Structured Hands-on Performance	
		Mean	Interpretation	Mean	Interpretation
1	Check to start the air compressor and prepare to start the air system	3.59	Very Satisfactory	3.28	Very Satisfactory
2	Record pressures, temperatures, and valve positions for normal running	3.45	Very Satisfactory	3.22	Satisfactory
3	Adjust the main engine and or auxiliary machinery for continuous running	3.31	Very Satisfactory	3.28	Very Satisfactory
4	Take power readings and or estimate mean effective pressure and the indicated power	3.39	Very Satisfactory	3.24	Satisfactory
5	Check the security of the steam pipes and provision for expansion	3.23	Satisfactory	3.12	Satisfactory
6	Check the correct functioning of all boiler condition indicators and alarms	3.31	Very Satisfactory	3.14	Satisfactory
7	Check that the correct boiler water level is maintained	3.45	Very Satisfactory	3.19	Satisfactory
8	Start up and operate ship's refrigeration plant	3.31	Very Satisfactory	3.23	Satisfactory
	Overall Mean	3.38	Very Satisfactory	3.21	Satisfactory

According to Hailikari, T. *et al.,* (2008), prior knowledge from previous courses significantly influenced student achievement. Procedural knowledge was primarily related to student achievement. Prior knowledge has long been seen to have the greatest impact on learning and student progress (Dochy, FJRC, 1992; Tobias, S., 1994). Knowledge acquisition and the ability to use higher-order cognitive problem-solving abilities are both positively influenced by the quantity and quality of prior knowledge (DeCorte, E. 1990; Dresel, M. *et al.,* 1998).The result revealed that prior knowledge from previous courses indeed contributed to learning in a more advanced marine engineering course.

For task number 2, the subjects' performances do not have the same interpretation, which favored the method of the simulator. The researchers believe that this is because the subjects found it easier to locate the point of reference in the computer window or panel compared to the actual machine in which they have to move around in order for them to find the thermometer, pressure, gauges, and other control mechanisms.

According to the study by Taher M.T. & Khan, A.S. (2015), simulated learning of complex and dynamic engineering systems is acknowledged as an efficient and successful method. In a simulation-based learning environment, students can gain experience and take into account past outcomes (Nahvi, M. 1996). In particular, the gaming approach utilizing interactive media and or simulation has shown to be effective in improving teaching and learning various subjects (Hsieh, S., & Hsieh, P.Y. 2004).

In task number 3, the simulator-based and the hands-on methods, although they have slightly different results, still get the same very satisfactory interpretation. The finding may be that adjusting the main engine and auxiliary machines for continuous running can be performed effectively in both methods. However, considering the lesser risk factors and the chance to repeat the process without too much time, the simulator-based method has a higher mean than the hands-on method.

Moorthy, Vincent, & Darzi (2005) and Brooks, Moriarty, & Welyczko (2010) stated that simulation allows trainees to purposely undertake high-risk activities or procedural tasks within a safe environment without dangerous implications. Simulation can improve trainees' skills and allow them to learn from errors. Learners can better understand the consequences of their actions and the need to reduce errors.

The subjects' performance in task number 4 reveals a different interpretation favoring the simulator-based method. The variance is mainly because, in the simulator-based method, the learner will only have to touch or press a button for the needed parameters to be shown or displayed, meaning it is already there for the students to partake. While in the hands-on method, the student should have to be fully knowledgeable in the operation of the equipment indicator and be able to interpret it before he can come up with a power reading.

Task number 5 shows that both methods have the same performance interpretation satisfactory, but a closer look shows that the simulator-based method has a slightly favorable mean. It may be because, in the simulator-based method, the subjects were not afraid to fiddle with the simulator's controls to simulate the effect of high pressures to check the security and implication of the pipes and their provisions for expansions. While in the structured hands-on method, subjects are hesitant to create high pressures due to the high risk of incurring accidents and general safety purposes. In task number 6, the study determined a difference in the performance interpretation between the two methods. The researchers believe that this is because, in the simulator-based method, the alarms can be re-set by pressing only a button, and they will become readily available. On the other hand, in the hands-on method, the subjects must go to the machine and calibrate some control mechanisms before it becomes operational and ready. There is the possibility that the sheer size of the actual machine will add to the challenge of the subjects.

The result of task number 7 subjects' performance interpretation shows that it favors the simulator-based method with an interpretation rating of very satisfactory, a mean of 3.45 and 3.19, respectively. This difference suggests that the subjects are more inclined to use the simulator in areas and activities involving risk or if there is a real presence of danger. Furthermore, it is because the younger generation is more comfortable with computers. Thus, even though they have already familiarized themselves with the actual equipment. They still favor doing the task in the simulator machine to allow repetition in case of error.

Like task number 7, task 8 indicates a performance interpretation favoring the simulator-based method. This finding may be because students realized that simulator activities or tasks in a simulator are easy to manipulate without the danger of having an accident. They can also repeat the task without much physical exertion. Thus the subjects' performance in refrigeration activities becomes more satisfactory through a simulator than the actual or real refrigeration equipment. The overall performance interpretation under competence favors the simulator-based method.

A previous study by Kim, Te., Sharma, A., Bustgaard, M. *et al.,* (2021) supports this finding. The study states that the trend for the simulator-based MET have been towards increasing the fidelity of the simulators. Whereas also focuses on matching the simulator's appropriate scale and suitability to the seafarer's ever-changing role. The classical definition of the term "fidelity" can be described as the ability of the simulator to closely replicate the natural environment, which is central to any discussions regarding simulators (Hays, 1980; Kinkade & Wheaton, 1972). Prior research has synthesized the relevant studies and found that the fidelity term has four dimensions which include physical, functional, behavioral, and perceptual (psychological) fidelity (Hays, 1980). Depending on the ability of simulators to accurately replicate the technical characteristics, tasks, and social factors for the targeted operations. The term physical fidelity pertains to the physical properties of the simulator and the degree to which the simulator could replicate the physical appearance of the actual system (Allen *et al.,* 1986; Kinkade & Wheaton, 1972; Liu *et al.,* 2008). Functional fidelity, on the other hand, refers to the functional similarity and the degree to which the simulator could replicate the functions and experience of the operational setting in question (Hays, 1980).

At present, the full-mission simulators are considered to be the most versatile in use and best support the MET facilities in meeting the regulatory requirements and training objectives. Their replicability of operational experience and the ability to train technical and non-technical skills for the trainees in a highly controlled and quasi-real environment is unmatched at the moment (Kim, T. *et al.,* 2021).

C. Subjects Performance in Simulator-Based Method and Structured Hands-On Method under Competence 2

This section presents the subjects' performance in the simulator-based training and the structured hands-on training scenarios. Table III summarizes the subjects' performance operating the jacket water cooling pump and associated control equipment.

TABLE III PERFORMANCES OF THE SUBJECTS IN SIMULATOR BASED METHOD AND STRUCTURED HANDS-ON METHOD IN TERMS OF OPERATING PUMPING SYSTEMS AND ASSOCIATED CONTROL SYSTEMS

Sl. No.	COMPETENCE: Operate jacket water cooling pump and associated control equipment	Simulator Based Performance		Structured Hands-on Performance	
		Mean	Interpretation	Mean	Interpretation
1	Open all suction valves of the cooling pump.	3.50	Very Satisfactory	3.32	Very Satisfactory
2	Open all discharge valves of the cooling pump.	3.38	Very Satisfactory	3.24	Satisfactory
3	Check that the cooling medium is available.	3.41	Very Satisfactory	3.31	Very Satisfactory
4	Engage pump supply breaker and contactor breaker.	3.41	Very Satisfactory	3.26	Very Satisfactory
5	Press the run button switch to run the cooling pump.	3.46	Very Satisfactory	3.28	Very Satisfactory
6	Check the suction side to ensure the pump is taking in water.	3.45	Very Satisfactory	3.28	Very Satisfactory
7	Stop the pump and inject/prime water into the suction side if water is absent.	3.41	Very Satisfactory	3.24	Satisfactory
8	Check discharge side pressure to ensure the pump is delivering water.	3.53	Very Satisfactory	3.18	Satisfactory
9	Check for abnormal motor bearing temperatures and system leaks.	3.47	Very Satisfactory	3.22	Satisfactory
	Overall Mean	3.44	Very Satisfactory	3.26	Very Satisfactory

Table III shows that the conventional interpretation of the subjects' task performance under competence operating jacket water cooling pump and associated control equipment is more or less equal except for tasks two, seven, eight, and nine. Task 1 of table III shows that although the subjects got a different mean of 3.50 and 3.32, respectively, the subjects still have the same interpretation, which is very satisfactory.

This result is because opening all the suction valves of the cooling pump is an essential requirement by which the students have to perform to continue working with the pumping system in either the simulator-based or hands-on methods.

Task 2 performance results demonstrated the inclination of the subjects to work with computer-generated learning equipment. It is indicated by the 3.38 weighted mean in favor of the simulator-based method – which is interpreted as very satisfactory as against the subjects' weighted mean using the hands-on method, which is only 3.24 of which the interpretation is satisfactory only.

According to Crichton (2017), as we know them in the present-day industrial context, simulators have been used for many years in safety= critical industries. Such as aviation, process, health care, nuclear, maritime, and rail, to prepare the personnel in these domains for their job roles and to ensure that they perform optimally as a team in instances of highly stressful situations (Kim, Te., Sharma, A., Bustgaard, M. *et al.,* 2021). One of the main advantages is that it provides a non-threatening environment in which trainees are allowed to exercise their skills with the freedom to fail. Moreover, to practice their job roles, in the presence of instructors and peers, without any possibility of their errors translating to economic costs, environmental pollution, or in worse cases, fatalities (Sharma *et al.,* 2019; Håvold *et al.,* 2015).

The performance results of task three indicate that the subjects are generally comfortable understanding the two methods as indicated by the respective mean, which does not have a considerable margin and thus was interpreted as very satisfactory. Technological advancement has steadily increased the effectiveness of simulators and brought many advantages to prospective seafarers.

Like task number 3, task 4 performance results shows that the subjects have almost the same mean. Thus, it also has the same interpretation, which is very satisfactory. This output may be because both methods can efficiently perform the task.

Task 5 is an activity intended to allow the students to practice how to press the run button switch to run the cooling pump. The results show that both methods got the same very satisfactory interpretation. However, the simulator-based method has a slightly higher mean because the activity is easier to manipulate, thus, the difference in the mean.

Like task 5, task number 6 performance results indicate a similar interpretation which is very satisfactory. This interpretation means that both methods are beneficial in providing the needed tool for developing the subjects.

Performance results of task number 7 favor the simulator-based method as it generated a higher mean interpreted as very satisfactory. The reason is purely due to the capability of the simulator to allow the students to repeatedly perform the activity without safety problems and time constraints in preparation.

Task number 8 requires the subjects to check discharge side pressure to ensure the pump delivers water. The performance result of the subjects indicates a very satisfactory interpretation of the simulator-based method because the simulator will allow the students to perform the activity without the risk of damage to the pump in case of malfunction or loss of pressure. As a result of this advantage, students find it easier to keep on repeating the process compared to the hands-on method.

According to the study by Szczepanek M. (2015), using the simulator as a tool for training staff connected is a key issue due to the practical application of acquired skills. Practice on the most corresponding to reality object with the possibility of supplying scenarios based on use at work procedures, tools, and potential emergencies allows the trainees to perform technological operations safely and learn from their mistakes without any influence on reality.

Software simulators make the training process for E.R. crews easier and faster due to learning from one's mistakes without the cost of damaging or destruction of an actual device. That plays a vital role in acquiring proper maintenance skills for a future E.R. operator.

The performance results of task 9 show that the simulator-based method in checking for abnormal motor bearing temperature and system leaks got a very satisfactory interpretation compared to the hands-on method. This interpretation could be because the students are more comfortable using the simulator as the basis for practice since the possibility of repeating the process without further preparation is higher than the hands-on. Furthermore, the simulator offers a safer environment when dealing with this activity.

The overall performance results of the tasks under competence number two show that the simulator-based method got a higher mean than the hands-on method. Although the interpretation of both means is very satisfactory, the difference suggests that the subjects are more comfortable using the simulator to ensure the application of theoretical knowledge in a practical setting.

The value of simulator training can be observed innately and practically. Generally, as one of the training methods, simulations allow the trainees to make decisions resulting in outcomes that mirror what would occur if the trainee were on the job as simulators replicate the environment used for actual tasks (Al Shahin, R. 2017). The decisions' impact in an artificial, risk-free environment teaches skills inclusive of production, process, management, and interpersonal aptitudes (Noe, Hollenbeck, Gerhart & Wright, 287; Noe, 270).

Stan (4522) cited that the "artificial experience" enhances professional judgment and offers the trainee manifold ways of tackling problems, particularly those which require the management of risk and crisis.

Simulation training does not just contribute to the trainees' efficiency and experience as confidence in the job situation is also promoted (Stan, 4522).

D. Difference between the Performance of simulator-based Method and the Structured Hands-On Method

This section presents the difference in the performance of the subjects in the simulator-based method and the structured hands-on methods. Table IV summarizes the subjects' overall performance in operating main and the auxiliary and associated control systems operating jacket water cooling pump and associated control equipment.

TABLE IV DIFFERENCE BETWEEN THE PERFORMANCES OF THE SUBJECTS IN SIMULATOR BASED METHOD AND STRUCTURED HANDS-ON METHOD

Variables		Mean	Description	p-value	Alpha	Decision on Ho	Interpretation
COMPETENCE: Operate main and auxiliary and associated control system	Simulator Based	3.38	Very Satisfactory	0.00	0.05	Reject Ho	Significantly Different
	Hands-on Training	3.21	Satisfactory				
COMPETENCE: Operate jacket water cooling pump and associated control equipment	Simulator Based	3.44	Very Satisfactory	0.00	0.05	Reject Ho	Significantly Different

Table IV reveals the difference in the subject's performance in the two pre-selected competencies. Incompetence one, the simulator-based method got a statistical description of very satisfactory if translated to numerical grades. Most of the subjects were able to attain satisfactory to above satisfactory ratings. Incompetence number two, the simulator-based method still got the advantage over the hands-on method with an overall mean rating of 3.44, which has a statistical interpretation of very satisfactory even though most of the tasks under this competence are more or less having the same results. On the other hand, the performance results for the hands-on methods suggest that the younger generation of students no longer consider doing any actual tasks that a simulator can duplicate.

The study's findings clearly show the effectiveness of simulator-based training as an alternative method for conducting teaching and learning within the laboratory. Simulator-based training had become considerably more realistic concerning the operations and processes on board ships. Simulation is a realistic imitation, in real-time, of any ship- handling, radar and navigation, propulsion, cargo/ballast, or other ship system incorporating an interface suitable for interactive use by the trainee or candidate either within or outside the operating environment and complying with the performance standards prescribed in the relevant parts of the STCW Code.

Simulator training allows a student to build a mental model of a real-world scenario and test the solution safely without fear of injury and damage to the equipment. Simulator programs can be developed or upgraded using software to suit any training environment. This method allows students to exercise variable operating conditions of any engine room machinery or system that could be completely inadmissible in realism (Moorhead, K. & Pinisetty, D. 2020).

V. CONCLUSION

The study's results suggest that simulation-based methods in teaching and learning the PASGT course have strong educational effects, with particular consideration to the psychomotor domain of the students as the medium provides learning in a manner that is very suitable to the current practices of the younger generation. The findings of this study satisfy the theory espoused by Malcolm Knowles. According to the andragogy theory, effective instruction includes the student in addressing real-world problems since adult learners are good problem solvers and learn best when the material is immediately applicable. Thus, educators should set a cooperative climate for learning, assess the learner's specific needs and interests, and develop training objectives based on the learners' needs, interests, and skill levels. Additionally, educators should choose techniques, tools, and resources for instruction together with the student, analyze the effectiveness of the learning experience, and make necessary improvements while determining the need for additional learning.

VI. RECOMMENDATIONS

The researchers firmly recommend the following actions based on the findings and conclusion of the study.

1. The researchers hope that future researchers undertake similar to obtain more researched-based ideas regarding the enhancement of the student's learning through modern technology to address issues like.

   a. risks and safety when conducting the actual operation of pumps, valves, and gauges.
   b. short circuit, electric shock, or electrocution when performing electrical tasks and other control systems; and
   c. proximity and time constraints when doing an actual reading and monitoring of the processes of the auxiliary power engines.

2. To adopt the appropriate action plan intended for continual development of the marine engineering program.

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