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Original Paper

A comparative study on video training and lecture-style training for apprentice engineers of training ships

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Abstract: The ship's cadet for the engine part shall execute boarding training (practice education) on a training ship or on board the merchant ship of a shipping company. Training ships have limitations in terms of educational effectiveness, such as limited training space, a small number of instructors compared to a large number of trainees, and cost burden for expensive training equipment. In this study, we intend to confirm the improvement of educational effectiveness by providing tutorial videos to the cadet on the training ship. The survey was conducted twice for students majoring in engineering at Maritime High School who participated in onboard training. To verify the difference in understanding between the two groups of students, mean difference verification was performed, and statistical analysis was conducted below the significance level of 0.05. Consequently, it was verified through the statistical analysis that training efficiency was improved by incorporating practical training using videos in the existing practical education method that combines theoretical lectures and practice.

Keywords: Training ship, Onboard training, Tutorial video, Educational efficiency, Survey

1. Introduction

Pursuant to the Notice of the South Korean Ministry of Oceans and Fisheries, and the International Convention on Standards of Training, Certification, and Watch-keeping for Seafarers (hereinafter referred to as the STCW Convention), domestic maritime engineering educational institutions selectively conduct, targeting students from boarding-related departments, both on-site practice on a training ships and the hands-on practice entrusted to an external merchant ship to foster merchant ship engineers.

As for national maritime high schools (hereinafter referred to as maritime schools), with the application of the learning modules of the National Competency Standards (hereinafter referred to as NCS), a total of one-year onboard training during the first semester of the second year and the second semester of the third year is conducted in tandem with the requirements of the STCW Convention and the NCS's educational operation **[1]**. As noted from preceding studies concerning on-site practical training, it was verified from their analysis results on the effectiveness of practical training in relation to the students' education period on board a training ship that the understanding and familiarization of maritime capabilities were enhanced as the training period lengthened **[2]**.

The necessity of follow-up research was put forth to analyze the current status of the NCS-based curriculum for marine high schools through a total survey by school and department or to grasp the status through interviews **[3]**, and policy research was conducted to develop improvement measures through review of the education system on the onboard practice training ship **[4]**. Furthermore, the appropriate number of trainees and measures to improve the hands-on training environment were suggested, and it was proposed that qualitative growth should be tailored to become familiarized with equipment operation and to build up expertise **[5]**. Although several studies have been conducted on education environments such as the training period and process, education facilities, and personnel, there are still very few studies regarding the learning effect and satisfaction level in relation to onboard practical training processes.

As pointed out in many previous studies, there is a ceiling to increasing education efficiency owing to the limited size of on-site practice groups, and the cost burdens arising from a lot of

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practical training time, a large number of educational personnel, and expensive be used as a tool to minimize such limitations and improve the effectiveness of practical education. Education methods utilizing hands-on practice video materials with the added stimulation of video footage and sound are more effective in enhancing learners' concentration and understanding, and memory retention capabilities in comparison with using print media **[6]**.

Previous studies on practical education have confirmed that case-based learning utilizing video footage is a learning method geared toward strengthening professional competency compared to traditional theoretical learning **[7]**, that video-based education prior to on-site hands-on practice should be actively utilized as it enhances the efficacy of knowledge transfer **[8]**, and that self-learning through video training reduces uncertainty and increases training satisfaction **[9]**. It was also verified that training satisfaction obtained from video-based self-education, compared to existing paper-based training, turned out to be quite prominent **[10]**, and that the effectiveness of repetitive learning using videos was excellent **[11]**. In the comparison between video education and lecture-style education for adolescents, video education had a stronger influence on enhancing an accurate understanding and recognition rate **[12]**. Additionally, it was found in the case of nursing students that the practical education method using video footage was more effective in improving their work performance than the existing scenario-based practical education method **[13]**. This study aims to assess the influence of video-based practical training proven effective in various land industries on the understanding level of the maritime knowledge of the prospective engineers hoping to on board a merchant ship. This is made feasible through a comparison between the existing method of practicing equipment after the theoretical class using PowerPoint slides for institutional trainees and the method of conducting equipment practice classes after basic classes through device video data.

2. Research Methods

2.1 Research subjects

This study is a comparison group study conducted to compare the effects of video-based training on maintenance work, along with the existing theoretical education for third-class engineers of a ship. It was conducted for engineering trainees in the third grade of high school, who had no onboard experience, boarding Hanbandoho, a merchant training ship of the Korea Institute of Maritime and Fisheries Technology. They were divided into two groups, that is, 36 control and 38 experimental groups, to delve into the educational effectiveness of utilizing videos. The video used was the maintenance video footage of an engineer running and maintaining the equipment installed on the ship. This equipment is the same as that for trainees to practice group maintenance with, and was built for the ship in accordance with the NCS learning goals, as shown in **Figure 1(a)**.

(a) Video production (b) Video lecture

Figure 1: Video production and lecture of refrigerant charging

Table 1: Specifications of the device

Subject	Specifications	Maker
Aux. boiler	VWH-1600E, 1600kg/h	Miura
Refrigeration plant	2N.2/CRNC221014, R407C	HI AIR KOREA
Fresh water generator	DX-α-15, 12Ton/day at M/E NCR	DongHwa Entec
Air conditioning plant training	HID-40WDS, R407C	HI AIR KOREA
Oil filtering equipment	GRS-20EB, 2.0m^3/HR	Georim Engineering

Five devices, that is, a boiler, freezer, fresh water generator, air conditioner, and oil filtration machine, were selected as the subjects to be used for education, the specifications of which are listed in **Table 1**. The experimental group conducted lectures using PowerPoint presentations, watched videos on each device, and operated and maintained the devices at the site. After providing theoretical lectures and references using the PowerPoint presentations that were previously implemented, the control group was directed to conduct practice. Both the experimental and control groups were given identical PowerPoint presentations, references, and practice content.

The pre-questionnaire was prepared prior to the implementation of the training, and the post-questionnaire was prepared after the device maintenance practice training was completed. The post-questionnaire was conducted in the same manner as the pre-questionnaire.

2.2 Research tools

The questionnaire used in this study was composed by researchers with more than five years of onboard experience as merchant ship engineers through the selection of 25 items among the learning goals of the NCS competency units in consideration of the operation and curriculum of the training ship. They were classified into five devices (E1 to E5), of which third-class engineers are in charge, such as a boiler, a freezer, a fresh water generator, an air conditioner, and an oil filtration machine, and theoretical and practice items were designed as detailed sub-surveys of five questions, respectively, as shown in **Table 2**.

Table 2: Composition of survey items

Subject	Learning Objectives	Code
Aux. boiler	1) Boiler burner type and working principle 2) Understanding burner trips and alarms 3) Boiler manual operation 4) Boiler water test 5) Blow down operation	E1
Refrigeration plant	1) Refrigeration principle 2) The role of the refrigeration system and its parts 3) Refrigeration plant operation 4) Refrigerant replenishment and shift operation 5) Lubricating oil replenishment and replacement	E2
Fresh water generator	1) The principle of the water generator 2) The role of the Fresh water generator and its parts 3) Fresh water generator operation 4) Adjustment of fresh water flow and salinity 5) Inspection and adjustment of safety devices	E3
Air conditioning plant training	1) Understanding the air conditioning system 2) Understanding the air conditioning unloading system 3) Air conditioning plant training operation 4) How to control the temperature on ship 5) How to change the filter of the air conditioner	E4
Oil filtering equipment	1) International Law on Oil filtering equipment 2) Working Principle of Oil filtering equipment 3) Oil filtering equipment operation 4) 15ppm alarm device test 5) Oil detection device test	E5

In the auxiliary boiler (E1), the type and operating principles of the boiler burner, theoretical items of whether the burner trip and alarm items can be understood, and practical items on manual boiler operation, water test, and blowdown operation measures were constructed. In the freezer (E2), both a theoretical item that can explain the freezing principles and freezing system and the names and roles of each part, as well as practical items such as starting and stopping the freezer, refrigerant supplementation and shift operation, and lubricant supplementation and exchange. In the fresh water generator (E3), both theoretical items, ranging from the principles of the fresh water generator to the names and roles of each part, and practical items regarding starting and stopping the fresh water generator, adjusting the tidal volume and salinity, and checking and adjusting safety devices. In the air conditioner (E4), both the theoretical part of a heating ventilation and air conditioning (HVAC) and an air conditioner unload system, and the practical part covering starting and stopping the air conditioner, methods to regulate on-board temperature, and methods to exchange filters of the HVAC were designed. In the oil filtration machine (E5), theoretical parts including international law on oil filtration devices and the operating principles, practical parts concerning starting and stopping oil filtration devices, methods for testing a 15 PPM alarm device, and methods for testing an oil detector. The questionnaire was designed on a 5-point Likert scale, with one point for "not at all," two points for "not so," three points for "somewhere in the middle," four points for "generally yes," and five points for "very much so."

Table 3: Composition of questionnaire

Code	Competence	N of questions	Cronbach's α
E1	Aux. boiler	5	0.935
E2	Refrigeration plant	5	0.834
E3	Fresh water generator	5	0.841
E4	Air conditioning plant	5	0.790
E5	Oil filtering equipment	5	0.823
Overall		25	0.930

Reliability analysis was conducted to verify the consistency of the questions in the questionnaire. The reliability is mainly determined by calculating the Cronbach's alpha coefficient (Cronbach's α), and in general, if it is 0.7 or higher, the reliability is judged to be good. Cronbach's α for the 25 questions of the questionnaire was higher than 0.7 (0.930), and the reliability of the main variables in this study was judged to be good. Therefore, it was determined that there were no questions that undermined reliability, and the analysis was conducted without excluding any of the questions. The evaluation results from the reliability of the questionnaire by detailed competency unit are shown in **Table 3**. The auxiliary boiler (E1) recorded the highest points of 0.935, and the air conditioner (E4) recorded the lowest points of 0.790, which is still a significant value.

2.3 Data analysis

Data collected through the survey were analyzed using the SPSS 19.0 statistical program, and statistical verification of the results was conducted at a significance level of ≤ 0.05. The homogeneity test between the two groups was performed by analysing the survey data prepared prior to training. After training, the questionnaire data were analyzed, and the difference between the two groups was identified. Furthermore, a one-way analysis of variance (ANOVA) was conducted to ascertain the effectiveness of the video-applied education by equipment, and post-analysis was performed using the Tukey HSD method.

3. Research Results

3.1 Homogeneity verification

Prior to the implementation of this curriculum, a t-test was performed on the survey response results by subject to test homogeneity between the experimental and control groups during the education on ship familiarization and safety.

The results of the homogeneity test by subject between the experimental and control groups are shown in **Table 4**. Homogeneity verification was confirmed as there was no significant difference between the two groups in terms of the education levels of the auxiliary boilers (t=0.028, p=0.978), freezer (t=-0.115, p=0.909), fresh water generator (t=0.104, p=0.917), air conditioner (t=0.547, p=0.586), and oil filtration machine t=-0.199, p=0.843).

Table 4: Homogeneity test of subject between control and experimental group before training

Code		Mean	Standard deviation	t	p
E1	C.G.	1.450	0.4095	0.028	0.978
	E.G.	1.453	0.4045		
E2	C.G.	2.161	0.3201	-0.115	0.909
	E.G.	2.153	0.3134		
E3	C.G.	1.7389	0.4190	0.104	0.917
	E.G.	1.7474	0.2699		
E4	C.G.	2.006	0.1393	0.547	0.586
	E.G.	2.037	0.3149		
E5	C.G.	1.106	0.2366	-0.199	0.843
	E.G.	1.095	0.2313		

C.G.: Control group, E.G.: Experimental group

3.2 Effects of the video-applied practical training between the groups

After the training was completed, the average difference verification by each item between the two groups was conducted to compare the practical education using the video and classroom training. To compare the detailed items of the device group, the average difference verification was performed by dividing it into five detailed items by group.

In the auxiliary boiler category, in particular, in the category of understanding both the boiler burner and its operating principles (t=1.750, p=0.085), and the boiler burner trip and alarm (t=1.916, p=0.059), the training combined with video footage did not make a significant difference compared to paper-based training. However, there was a significant difference in practical items such as manual boiler operation, water test, and blowdown ($p<0.05$). The auxiliary boiler of a vessel is difficult to install at a hands-on practice center in school because of the initial costs for building a facility and the difficulties in establishing relevant equipment for environmental pollutants that are pumped into the air during operation. Thus, pre-practice education was conducted mainly on theoretical education, and theoretical education was conducted as repetitive learning even onboard a vessel; thus, the video-applied training was found to be much more effective because the practice of operating a boiler was first conducted.

As for the freezer, there was a significant difference between the two theoretical and three practical items ($p<0.05$). As for the alternating operation items of a freezer among the practical training items, there was a significant difference (t=7.213, p=0.000), and the experimental group (M=4.868) was higher than that of the control group (M=4.222). As for the practical training item of operating a freezer, the effectiveness of video-applied education was found to be noticeably prominent because it is not possible to operate the entire system of a freezer, although theoretical aspects compared to an actual device could be understood as each system module of a freezer was installed at a practical training center of maritime schools.

As for the fresh water generator, there was also a significant difference in all items ($p<0.05$). Similar to other devices, there was a significant difference in the three practice items; in particular, the experimental group (M=4.316) was much higher than the control group (M=3.722) in the theoretical part of each of the fresh water generators (t=5.504, p=0.000). Although fresh water generators are installed and theoretical education is conducted at on-land practical training facilities at schools, various types of fresh water generators such as the plate and tube types of low-pressure evaporation, and reverse osmosis types used in merchant vessels are difficult to install on land, it is conjectured that a vast difference in the names and roles of each device occurred as video-applied training was only conducted onboard a vessel.

Table 5: Homogeneity test of subject between control and experimental group after training

Code		C.G.(N, %)		E.G.(N, %)		*t*	*p*
		M	S.D.	M	S.D.		
E1	B1	4.167	0.3780	4.342	0.4808	1.750	0.085
	B2	4.194	0.4014	4.395	0.4954	1.916	0.059
	B3	4.111	0.3984	4.632	0.4889	5.032	0.000
	B4	4.083	0.4392	4.579	0.5004	4.535	0.000
	B5	4.111	0.4646	4.605	0.4954	4.428	0.000
E2	R1	4.333	0.4781	4.684	0.4711	3.179	0.002
	R2	4.306	0.4672	4.579	0.5004	2.426	0.018
	R3	4.250	0.4392	4.842	0.3695	6.288	0.000
	R4	4.222	0.4216	4.868	0.3426	7.213	0.000
	R5	4.306	0.4672	4.895	0.3110	6.350	0.000
E3	F1	4.056	0.2323	4.342	0.4808	3.291	0.002
	F2	3.972	0.1667	4.447	0.5039	5.504	0.000
	F3	3.778	0.4216	4.158	0.3695	4.130	0.000
	F4	3.722	0.4543	4.316	0.4711	5.512	0.000
	F5	3.806	0.4014	4.184	0.3929	4.101	0.000
E4	A1	4.028	0.1667	4.684	0.4711	8.073	0.000
	A2	4.056	0.2323	4.737	0.4463	8.299	0.000
	A3	3.639	0.4871	4.158	0.5939	4.097	0.000
	A4	3.694	0.4672	4.105	0.5594	3.419	0.001
	A5	3.722	0.4543	4.079	0.5393	3.069	0.003
E5	O1	3.500	0.5071	3.868	0.3426	3.642	0.001
	O2	3.444	0.5040	3.921	0.2733	5.018	0.000
	O3	3.833	0.3780	4.500	0.5067	6.437	0.000
	O4	3.889	0.3187	4.342	0.4808	4.803	0.000
	O5	3.833	0.3780	4.447	0.5039	5.950	0.000

C.G.: Control group, E.G.: Experimental group
M=Mean, S.D. = Standard deviation

Significant values were found for the five items of an air conditioner (p<0.05). This was due to the fact that, although each device of a freezer can be observed during practical training at school, it is difficult to install HVAC systems such as an air handling unit owing to space constraints, the first hands-on operation of an actual machine onboard a practice vessel made such a huge difference.

In the oil filtration machine, there was a significant difference in all five items (p<0.05). Operating a machine after watching a video clip depicting the operation of a machine in an actual field was much higher in points than operating a device after being explained through a PowerPoint presentation.

3.3 Educational effects per subject

After the training, one-way ANOVA was performed to determine the difference in understanding of five engine equipment for the experimental group with significantly improved educational effect, and Tukey's test (honestly significant difference) was executed for post-verification. The results of the one-way analysis of variance by the equipment are summarized in **Table 6**.

Table 6: One-way ANOVA of competence

Code	M	S.D.	F(p)	Tukey HSD
E1	4.535	.4292	21.778 (0.000)	a
E2	4.327	.4928		b
E3	4.084	.3657		c
E4	4.097	.4566		c
E5	3.965	.4139		C
Overall	4.202	.4650		

As seen from the results of analyzing the survey on the understanding level by equipment, it was confirmed that the value F was 21.778, which was statistically significant (p<0.001). The results of Tukey's post-test analysis revealed that three subsets were formed in the first questionnaire and were marked as *a* to *c*. The subsets were formed in the order of E1 (auxiliary boiler) for *a*, E2 (freezer) for *b*, E4 (air conditioner), E3 (fresh water generator), and E5 (oil filtration machine) for *c*. E1 showed the highest understanding level, compared to other subjects, followed by E2. It was observed that the understanding levels of E3 to E5 were the lowest.

Although air conditioners, fresh water generators, and oil filtration devices are installed at a hands-on training center in school for pre-practice to be conducted, main and auxiliary boilers installed on ships are quite large and difficult to install owing to space constraints, unlike small boilers used on land; thus, for most trainees, it was their first-hand experience on such devices.

As in **[12]**, where the effect of the video was high in unfamiliar situations such as cardiac arrest, it is judged that the effect of video education is high in equipment that is encountered for the first time in practical training onboard a vessel.

In terms of trainees' understanding, the post-satisfaction effect of education through videos was significantly higher in the experimental group than in the control group. This was consistent with the study providing the surgical process as video footage **[14]**, and a study verifying the development effect of video education programs for spinal surgery patients **[9]**.

As seen thus far, the reason for video education making a significant difference in the aspect of understanding is that a vessel's engineers shoot the film on site while operating, and provided an explanation on the devices installed on a ship, so that trainees' needs were readily met.

4. Conclusion

To identify the improvement of educational effects by providing video training materials to the vessel geared toward fostering merchant maritime engineers, this study conducted two surveys targeted on Busan Maritime High School Engineering students (36 control groups, 38 experimental groups) who participated in the maritime onboard practice training course, and the understanding level of maintaining equipment was analyzed based upon such outcomes, and thus the summarized results are given as follows.

As a result of conducting the t-test on the understanding of each equipment item, there was a significant difference for most categories; however, for the theory-related areas such as boiler burner types and operating principles, the understanding of boiler burner trips and alarm items, compared to general lecture formulas, no significant difference was found even when watching video footage.

Based on the results of a one-way analysis of variance regarding the difference in terms of the understanding level of each of the five equipment, it was confirmed that the value F was 21.778, which is statistically significant.

As seen from the result of Tukey's post check, it was verified that, for the boilers and freezers, there was a high level of understanding, and that for the air conditioner and the fresh water generator, there was a relatively lower level.

In this study, it was verified through statistical analysis that trainees' understanding of device maintenance practice knowledge was enhanced by adding practical vessel device training using video footage to the practice training methods conducted in tandem with both existing theoretical lectures and practical exercise. Similar to that identified in previous studies, it was found that adding video education to maritime engineering practical education conducted onboard a practical training vessel increased the educational effect of trainees even onboard a merchant vessel. It would be difficult to generalize the findings from this study to all maritime trainees because the research subjects who participated in the study were limited to high school students. It is anticipated that more utility can be added to future studies if they are targeted for college students and adult trainees.

Author Contributions

Conceptualization, J. J. Hur and K. Y. Han; Methodology, J. J. Hur; Validation, J. S. Kim; Formal Analysis, H. B. Kim; Investigation, J. S. Kim and H. B. Kim; Writing—Original Draft Preparation, K. Y. Han; Writing—Review & Editing, J. J. Hur; Supervision, J. J. Hur.

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