Original Paper

An Effective Training and Evaluation Method for Anchoring Training in Maritime Education

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Abstract

Captain Kashima et al. showed that ship handling skills significantly improve when anchoring exercises are practiced on training ships. And Kunieda et al. showed that the practicing on training ships also develops critical thinking and problem-solving skills. We created an evaluation scale for elementary ship handling skills to measure the effects of different anchoring training methods. We assessed the training methods using a rubric evaluation list containing nine evaluation items. Group work was arranged before and after the anchoring training sessions based on the results from student questionnaires and instructor evaluations. Our results reveal the most effective training model for developing ship handling skills.

Keywords

maritime education and training, anchoring training, rubric evaluation list, group work, training model

1. Introduction

In recent years, researchers (Akifumi Kobayashi, Kayo Matsushita et al.) in the field of education have shifted their focus on active learning as an important element in the "conversion to the study from education". Educators are beginning to see active learning as a more effective educational method. The Central Council for Education in Japan defines active learning as follows: "The general term for teaching and learning methods which involve the participation of the student in active study unlike one-way lectures from a teacher". Active learning engages students cognitively, ethically, and socially through the use of culture, knowledge, and experience. Discovery methods, problem-based learning,

experience learning, and investigation learning are all examples of effectual active learning. Group classroom discussion, debate, and group work have also proven to be effective forms of active learning. Professor Mizogami at the Kyoto University Center for the Promotion of Excellence in Higher Education states the following about the benefit of active learning: "Active learning overcomes passive one-side knowledge transfer-type lessons". Active learning is an educational process that cognitively engages students through specific forms of writing, talking, and presenting students practice purposeful actions.

In maritime education and training, the transfer of knowledge and skills is achieved through both classroom and practical shipboard training. Classroom training generally consists of lecture-based lessons. To achieve the desired effect, classroom activities combine exercise assignments and experiments. Conversely, shipboard training requires that trainees perform tasks without instruction's input in accordance with an active learning process. Compared to attending lectures, practical shipboard training is more effective in developing necessary skills. The effectiveness of shipboard training is not solely a result of practicing course content but also practical training.

Mastering active thinking and problem-solving requires effective training. Kashima et al. (2001) demonstrate that anchoring training on a training ship has a significant effect on the acquisition of ship handling skills while Kunieda et al. (2018) show that anchoring training is effective in developing active thinking and problem-solving skills. In this paper, it was determined that anchoring training includes everything from planning ship handling to post-training debriefing. Group work was analyzed to find whether it improves relevant education and training. In addition, the effects of on-board anchoring training were examined, the results from which were used to outline an effective training model.

2. Anchoring Training

Anchoring training, which is performed by student teams without instructor assistance, is an efficient exercise to improve ship handling skills through various maneuvers. Anchoring training is generally performed in four-person teams, each of whom has defined roles such as captain (Role of Captain—ROC), first officer (Role of 1st Officer—RO1O), third officer (Role of 3rd Officer—RO3O), and quartermaster (Role of Quartermaster—ROQ). Since the training is conducted in teams, the group work involves peer-to-peer learning. First, students heave up the anchor and begin sailing a planned route. Then, after passing planned waypoints, the students anchor at a planned anchorage. At that point, the training process goes as follows:

13

Figure 1. Students Planning the Ship Handling for Anchoring

(1) The ROC takes the lead and develops a navigation plan for the anchoring. This type of active student planning of ship handling is designed to develop leadership skills for the ROC and to facilitate peer learning. The ROC explains the navigation plan to his or her teammates and instructors, who then offer advice and feedback to improve the plan. After finalizing the navigation plan, the ROC briefs the team members and instructors, who then refer to their notes and study their specified roles. Figure 1 shows the students planning the ship handling for anchoring.

(2) The ROC positions the leaving anchorage station, directs the RO3O to prepare the main engine, and then heaves up the anchor.

(3) When the anchor is aweigh, the ROC sets off on a predetermined course using the main engine and rudder.

(4) The ROC corrects the course appropriately to ensure that the planned route can be navigated. The ship then passes two scheduled waypoints and navigates a predetermined route. Figures 2 and 3 indicate students in anchoring training as they sail toward the planned anchorage.

(5) The ROC slows the main engine, adjusts the course, and stops the ship by applying the main engine to the sternway to ensure that it is anchored correctly at the planned anchorage.

Figure 2. Students during Anchoring Training

Figure 3. Student during Anchoring Training

(6) At the planned anchorage, the ROC lets the anchor go, releases the cables to a predetermined length, stops the main engine, and, finally, dismisses the anchoring station.

(7) The students self-evaluate their performance based on an evaluation rubric shortly after the end of training.

(8) The anchoring training is then discussed within each group. Each team member presents their ship handling notes as other students listen and engage in active thinking. The positive aspects and points for training performance improvements are then discussed within each team, after which it is presented to all teams. Lastly, the instructors' comment on the performance based on the evaluation rubric.

(9) The students consider and offer ways to improve the self-evaluation rubric.

To summarize, in this training process, the required self-evaluation and evaluation rubric improvements were introduced to the content to be applied to active thinking.

3. Evaluation Method

Concrete evaluation items were determined, and a rubric evaluation was adopted to scale each evaluation item through an initial assessment of the overall anchoring training. Tanaka outlines five reasons why a rubric is indispensable for the evaluation of learning:

a) A rubric evaluates student performance using many perspectives.

b) A rubric demonstrates a shared viewpoint and standard of evaluation among students and teachers.

c) Different evaluation levels can serve as the students' desired values.

d) A rubric evaluates based on a clear standard rather than a teacher's intuition.

e) A rubric can standardize the evaluation items and criteria of judgment among two or more teachers.

As a result, it can evaluate with high validity and reliability.

Moreover, a rubric places the educational objective before the student, thereby clarifying the aim of the lesson. Finally, studies show that rubric evaluations are effective. In this study, the rubric evaluation list

15

that the instructors and students used contained the following nine items and was evaluated by a four-step evaluation indicator:

Table 1. The Rubric Evaluation List (Extract)

No.	Evaluation Item	Excellent (90%-full marks)	Good (70%-90%)	Passing mark (60%-70%)	Failure (Less than 60%)
1	Procedure for heaving up anchor	The procedure for heaving up anchor was fully understood, ordered clearly, and had responded to the report.	Although the procedure for heaving up anchor was understood, there was one slight mistake that it was not ordered clearly.	The procedure for heaving up anchor procedure was not fully grasped and there were two to three mistakes.	Since the procedure for heaving up anchor was not fully understood, most of the order depended on a memo.
2	Course setting	The gap from the plan route was appropriately corrected.	The gap from the plan route was corrected. However, there was one mistake.	The gap from the plan route was somehow corrected. However, there were two mistakes.	The gap from a plan route was not corrected three or more times.
3	Lookout	Continuous lookout, such as direction change, was completed appropriately.	Continuous lookout, such as direction change, was not carried out or misidentified one time.	Continuous lookout, such as direction change, was not carried out twice. In the case of others, the lookout was appropriately carried out.	Continuous lookout, such as direction change, was not carried out three or more times. It cannot be said that sufficient lookout was carried out.

1) Procedure for heaving up anchor

2) Course setting

3) Lookout

4) Give-way or stand-on ship handling

5) Position fixing and anchoring position

6) Anchoring procedure

7) Gradual speed decrease

8) Bridge Resource Management (BRM)/Bridge Team Management (BTM)

9) The whole of the training

The extract of a rubric evaluation list is shown in Table 1.

The rubric evaluation list simplifies the evaluation criteria to demonstrate and judge the concrete numerical value. For example, a "good" grade for heaving up anchor means "although the procedure for heaving up anchor was understood, there was one slight mistake that it was not ordered clearly"; one mistake is acceptable.

4. Implementation and Results of the Anchoring Training

At Tokyo University of Marine Science and Technology's (TUMSAT) undergraduate maritime system engineering course, third-year students engage in anchoring training aboard the training ship, Shioji

Maru. Anchoring training is evaluated according to a questionnaire rubric created in 2016. Table 2 shows the number of students who participate in the program between 2016 and 2019.

Table 2. Number of Participating Students per Year

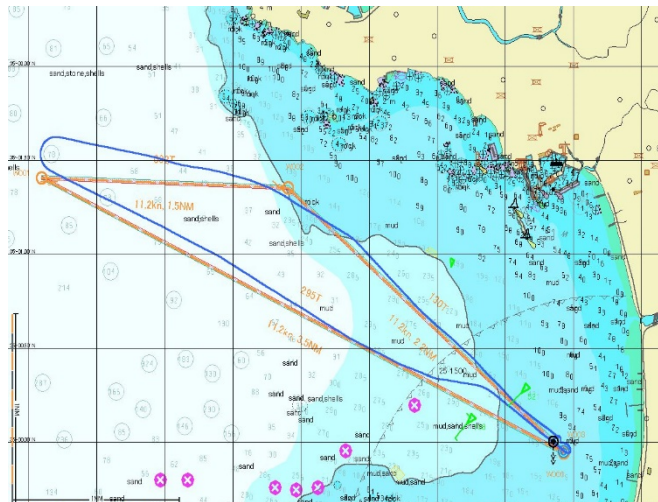| Year	2016	2017	2018	2019
Number of students	68	67	65	66

Figure 4. Planned Route and Training Track

The planned route and an example of an actual course taken by one of the ships are illustrated in Figure 4. The orange line is the planned route and the blue line is the course taken. In training, the use of Electronic Chart Display and Information System (ECDIS) is forbidden. The ship's position is determined by a crossing bearing. Therefore, the bow target, the target of a right transverse direction and the target for determination of the ship's position have been set up in the planning stage.

4.1 Implementation and Results of the Anchoring Training

Two teachers with a great deal of captain experience in training vessel used the evaluation rubric to assess the anchoring training. The instructors used a four-point scale to evaluate the nine items as well as the procedure for weighing anchor and anchoring position in accordance with the fixed evaluation criteria. The average evaluation scores for all items in each year are shown in Figure 5; the scores were highest in 2018, followed by 2019, 2017, and 2016.
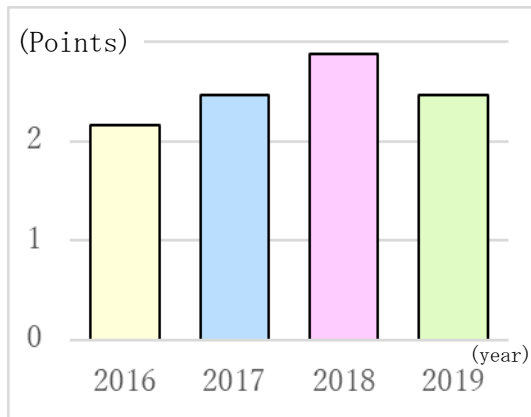
17

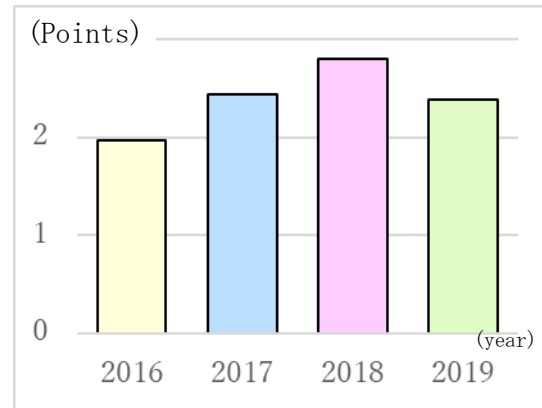**Figure 5. Average Evaluation Scores of All the Items**

Figure 6. Average Evaluation Scores of Evaluation Item BRM/BTM

Figure 6 illustrates the average evaluation score for Bridge Resource Management/Bridge Team Management (BRM/BTM). It shows an identical trend to all other average evaluation scores.
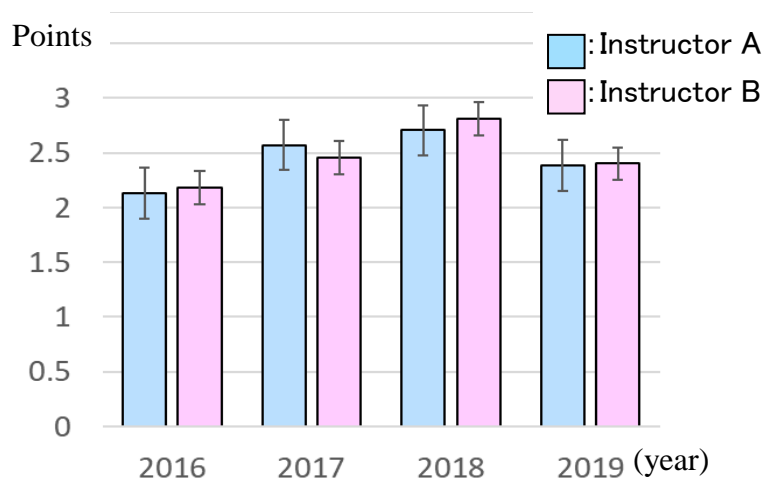

Figure 7. Average Comparison of both the Instructors of Each Year

The highest score, recorded in 2018, may be the consequence of an explanation that emphasized the bridge teams. All scores see an increase as a result of increased BRM/BTM scores.

Figure 7 shows the scores of two independent instructors for the years 2016-2019. The difference in the evaluation scores between instructors for each year is small, with a standard deviation of 0.3-0.5. The instructors gave the following comments on the evaluation criteria and rubric:

(1) Since the evaluation criteria are clear, it is easy to evaluate the training result by a rubric evaluation list.

18

(2) Since the rubric evaluation list had valuation criteria, even if time differed and the year changed, it is believed that the same evaluation can be performed.

(3) Since a rubric evaluation list has evaluation criteria, it is assumed that there are few differences in the evaluation mark by the difference in an evaluator.

(4) All the contents that should be evaluated by using a rubric evaluation list can be evaluated.

4.2 Examination of a Training Model

The anchoring training evaluation results and instructor and trainee comments and observations were used to propose a more effective Guide to Good Practice (GTGP) training model as shown in Figure 8. The effect of group work is proven to be beneficial in other fields. An effective training model combines group work before and after actual ship training. Additionally, as demonstrated by Uno et al., the incorporation of student presentations seems to improve the overall effectiveness of the training effect.

During the planning of ship handling, dialogue, discussion, and peer learning through group work can help solidify a student's understanding of the overall procedure. Prior to the ship handling exercise, students should engage in a planning session to ensure that everyone fully understands the procedures by engaging in dialogues, discussions, role plays, simulations, group peer learning and authentic briefing practice, with the emphasis being on group/teamwork learning (G). Next, during the actual ship training, trainees should practice memorized procedures and demonstrate their ship handling skills based on the given situation using the knowledge and technologies discussed in the first session.

Training at sea on a ship is the most effective form of training because it involves students applying their knowledge to an actual team situation (T). After the ship training, each group reflects on the good points from the training exercise and identifies those areas in which improvements could be made, all of which requires the students to reflect on their individual as well as team knowledge and skills (G). Finally, based on the group discussions, each group assesses their own performances. They then present their findings to the other groups and come to understand the results from the other groups, thereby further deepening both individual and team understanding, all of which improves their own knowledge and skills (P).

Although this training model is specifically based on anchoring training, it could be adopted for other types of practical maritime-based training, such as lifeboat lowering, on-board work procedures, emergency procedures, and accident investigations. The key aspect of this type of peer learning (jigsaw method) is that the trainees get the opportunity to reflect on their experiences and learn from others' experiences as well. This training model has trainees review their training and understand their role within the groups that enhances critical thinking and decision-making skills, both of which are vital for effective on- and off-board maritime operations.
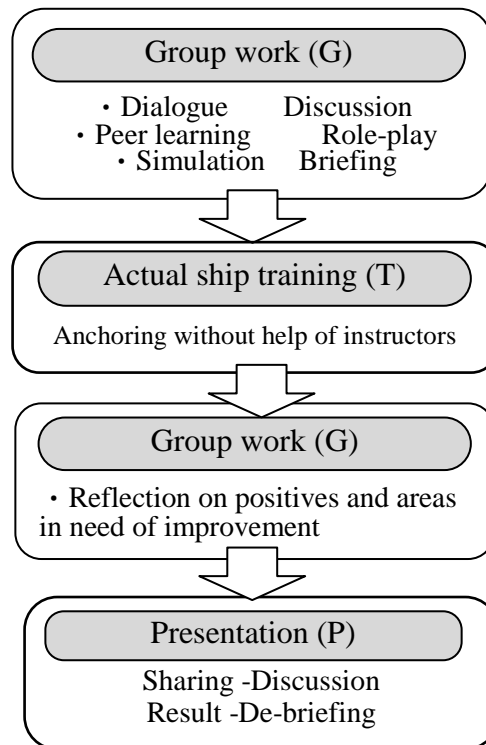
Group work (G)

· Dialogue   Discussion
· Peer learning   Role-play
        · Simulation   Briefing

↓

Actual ship training (T)

Anchoring without help of instructors

↓

Group work (G)

· Reflection on positives and areas
in need of improvement

↓

Presentation (P)

Sharing -Discussion
Result -De-briefing

Figure 8. Composition of Anchoring Training

5. Conclusion

This paper examined the evaluations of anchoring training conducted between 2016 and 2019 at the Faculty of Marine Technology, Tokyo University of Marine Science and Technology. While conducting anchoring training, we found that a rubric evaluation list was effective in the evaluation of training. We can evaluate all the required assessment by a rubric list, which eases the evaluation process; the difference of evaluation is small even if implementation schedules of training vary.

Despite the aforementioned advantages, a standardized rubric cannot quantify unexpected training situations. On the contrary, the contents of evaluation and the evaluation criteria need to be examined and improved after the implementation of the training sessions based on trainee and instructor comments. That a trainee improves an evaluation list has an education effect good for trainees. (2)

A rubric evaluation list is beneficial not only for anchoring training but also a variety of marine-based training. If it combines with the rubric evaluation and the evaluation which harnessed the experienced person's knowledge, we think that it becomes better evaluation.

The results of high-scoring trainees demonstrate that it is possible to correctly perform ship handling procedures during training without direct instruction. It allows trainees to think for themselves and allows them to be better prepared for unknown situations at sea. From the results of the anchor training effect evaluations, a revised training model was proposed with four primary stages:

20

• group work that includes peer learning, discussion, dialogues, role plays, and simulations;

• actual ship training to improve problem identification, problem-solving, and decision-making capabilities;

• group reflection on the training and identification of the strong and weak aspects;

• presentations and overall class discussions on the results.

The aim of each identified training stage is to develop a trainee's ability to think for themselves and respond confidently in all situations. We wish to apply the proposed training model to various other training and verify the training effect in future.

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