

# The Influential Features of an Effective Model of Anchoring Training in Maritime Education

Yoshiaki Kunieda, Hideyuki Kashima, Koji Murai

Tokyo University of Marine Science and Technology, Tokyo, Japan

Shojiro Niwa

Japan Agency of Maritime Education and Training for Seafarers, Yokohama, Japan

Ship-handling significantly improves when anchoring exercises are practiced on training ships were proved by Kashima H. et al. Kunieda Y. et al. proved that practicing on training ships also develops critical thinking and problem-solving skills. In order to perform more effective maritime education and training, we analyzed the feature of the training effect of the anchoring training considered to be effective training. As a result of the questionnaire about the anchoring training, 95% or more of trainees have answered “the anchoring training was helpful”. The trainees’ comments about the anchoring training were analyzed, affinity diagram as well as the Steps for Coding and Theorization (SCAT). The affinity diagram was able to group and integrate comments written by the trainees into five distinct labels. The theorization attempted via the SCAT analysis demonstrated the influential features of the anchoring training. This investigation aimed to ameliorate the training model proposed by the authors of the current study, intending to ensure safety through automation to eliminate human error. The conception of more efficacious manpower education and training programs is critical because the advancement of automation also escalates the need for talented human resources to manage seafaring vessels.

*Keywords:* anchoring training, Plan-Do-Check-Act (PDCA) cycle, dialog, active thinking

## Introduction

It has been noted that around 80% of all marine accidents are caused due to human errors by navigators of seafaring vessels. Minamigawa (2014) showed the importance of education of non-technical skill in the aviation field. And Gordon (2013) also showed the importance of non-technical skill training in the medicine field. Thus, one of the ways of preventing or minimizing such human errors, not only in the maritime field but also in the domains of aviation and medicine, is to ameliorate the nontechnical education and training imparted to personnel. Ahvenjärvi S. (2016) showed the advancement of science and technology enables quick investigations of the operations of automated vessels. These rapid assessments aim to ensure safety by avoiding human error through automation. Campbell, Naem, and Irwin (2012) described that the increased application of automated processes that do not require human intervention, however, requires appropriate training and education to be provided so that skilled human resources are available to manage and operate the modernized

---

Yoshiaki Kunieda, Ph.D., Professor, Tokyo University of Marine Science and Technology, Tokyo 135-8533, Japan.

Hideyuki Kashima, Bachelor, Professor, Tokyo University of Marine Science and Technology, Tokyo 135-8533, Japan.

Koji Murai, Ph.D., Professor, Tokyo University of Marine Science and Technology, Tokyo 135-8533, Japan.

Shojiro Niwa, Master, Lecturer, Japan Agency of Maritime Education and Training for Seafarers, Yokohama 231-0003, Japan.

vessels. Mariners who are onboard automated vessels, as well as off-site managers of these ships, must now inculcate adequate knowledge of Information Communication Technology (ICT) and Artificial Intelligence. Also, all responsible personnel must be made to master appropriate decision-making capability to make a suitable judgment according to a situation quickly that is required, and the education for mastering these is needed.

The authors of this paper conducted a study aiming to develop techniques to impart more effective and pertinent maritime education and training. Kunieda, Kido, Kashima, and Murai (2017), Kunieda, Osaka, Kashima, and Murai (2018), and Kunieda, Murai, Kashima, and Oi (2019) reported the effects of the anchoring training applied in training vessels and it involved: (1) the participants' self-evaluation of the effects of the training; (2) the influence of group work and team management on the efficacy of training; (3) the methods of assessing the training module and how they impact the anchoring training. Based on the stated objective and investigations, the authors proposed and implemented a training model that was deemed to be superior to the existing processes. This anchoring training was conducted for four years from 2016 to 2019. The study evidenced the efficacy of anchoring training in enhancing circumstance-based, quick decision-making capabilities as trainees were able to attain intimate knowledge of vessel operations. The subsequent analyses of the questionnaire administered to the trainees and the comments recorded by the participants enabled researchers to extract the most efficacious attributes of the anchoring training. The features of the surveillance study that were found to be the most effective for the acquisition of the requisite knowledge and skills were examined further to generate another improved training model that can be utilized and enforced more efficiently.

### **Anchoring Training**

Anchoring training encompasses the actions of weighing the anchor, increasing ship speed, navigating a predetermined route, decreasing ship speed, and applying a planned anchorage using an actual ship. This research project aimed at training participants by including the stages of prior preparation and the post-training reflection of the actual training that was conducted onboard.



*Figure 1.* The planning stage of ship-handling for anchoring.



Figure 2. The ROC at the onboard experiential training stage.

### Planning of Ship-Handling

Before beginning the actual experiential aspect of the training module, the trainees were provided with pertinent information by an instructor. This content included the identification of good land targets and a review of aspects that required attention. Trainees were then asked to design a ship-handling plan by considering nautical charts and other published material. This part of the anchoring training was usually conducted with teams of four members, each of whom was assigned 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). The ROC was tasked with leading the team planning of ship-handling and of regulating the opinions of the other members. Figure 1 shows this planning phase of the ship-handling training for anchoring. The trainee teams elucidated their ideas for the anchoring to the instructor using a chart, obtained the instructor's feedback and advice, and corrected their plans as required. All team members were initially required to actively engage in the description of their team's navigation plan. The ROC then finally presented the corrected ship-handling plan to both the team members and instructors. This exercise of self-directed planning of ship-handling for anchoring, triggers and inculcates intensive and active thinking in the trainees. The active and deep cognition is further strengthened in the trainees by the requirement of explaining the ship-handling plan to their instructors.

### Actual Onboard Training

As part of actual ship training, trainees had to pass the training ship through predetermined route points to execute a planned anchorage. In the process, they practiced using the sternway, reducing the speed of a ship, stopping the vessel, and anchoring it properly. The ROC instructed the other team members, who executed the entire process until they were dismissed by their leader after the anchoring had been satisfactorily accomplished.

Figure 2 illustrates the ROC engaged in the onboard experiential training phase. The planned route and a sample track are demonstrated in Figure 3. An instructor would intervene to advise the trainee acting as the captain only in the event of the danger of a collision or grounding. Since the trainees were required to accept the entire anchoring process on their own, they had to accept substantial onus and achieve independent cogitation.

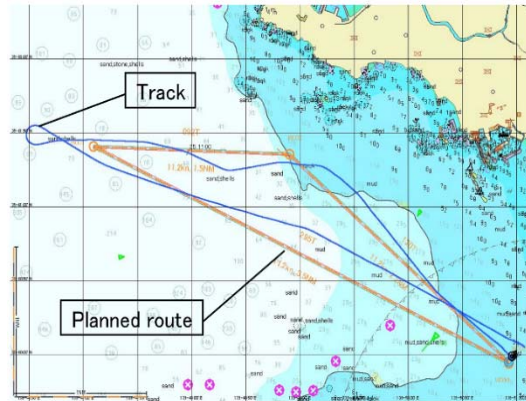


Figure 3. The planned route and a sample track.

### Reflection

Once the onboard anchoring training was experienced, the trainee groups were asked to discuss the aspects of their planning and training that had worked and the facets that required further improvement. Some of the issues that were addressed included: How did the actual performance results differ to the ship-handling plans that were made before the onboard training? Why did the differences occur? How did the trainees react to the differences? How did they respond to phenomena that they had not previously considered at the planning stage? Did they react suitably to the unexpected fishing boat? Did they respond appropriately to other vessels? Were their reactions to the wind and tidal current conditions apt? The groups examined the outcomes of the training module from various angles and discussed the results they had obtained. Group members exchanged ideas and produced proposals for the improvement of their plans.

### Presentation

Each ROC was tasked with the presentation of the summary of the final group session, asked to enumerate the aspects of the actual ship training that worked and the attributes that required further improvement. The beneficial features of the onboard training were circulated to the full class of trainees, who also identified facets that should be improved. Finally, the instructors presented their comments and issued further instructions about ship-handling. Deliberating about the strengths and weaknesses of their plans and implementation efforts improves the knowledge and skills of trainees, and thus leads to the enhancement of their prospective handling of ships.

### Questionnaire Outcomes and Consideration

A questionnaire on the anchoring training they had received was administered to the trainees every year from 2016 to 2019. The questionnaire included items about (1) the planning stage before the actual onboard ship-handling training, (2) the experiential anchoring training aboard the vessel, (3) the reflection activities conducted after the onboard training, (4) the anchoring training module as a whole, and (5) feedback comments on the anchoring training. Items 1 to 4 required participants to respond on a five-point Likert-like scale that ranged from 1 = very helpful to 5 = unhelpful. Item 5 mandated free commentary by the respondents.

Figure 4 displays the results of the analysis concerning the participant responses received about the prior planning group task related to the subsequent ship-handling stage. Between 82% and 91% of students of each year were “Extremely” to “Moderately” satisfied. Only two trainees in 2017 and one student in 2018 were

“Moderately” dissatisfied. The results disclose that the trainees were able to grasp the message that planning and reflection should take 80% of their time and effort while the actual execution of the anchoring training should only take the remaining 20%. The trainees were able to appreciate that their performance in the onboard training was augmented by their initial planning and preparations. If their preparation was insufficient, trainees were able to apprehend the errors they made during the experiential part of the training as a result of their faulty or inadequate planning. For most students, this planning activity represented their first experience of designing a ship-handling procedure. It was thus challenging for students to create their plans without any initial input from the instructors. However, it is believed that the trainee who found the training program to be unhelpful was unable to participate in the actual activity, possibly because of seasickness.

After the anchoring training was completed, the results of each team were reviewed and the positive aspects were discussed along with the areas that needed improvement. The results of the analysis of the questionnaire responses about the post-training group reflection exercises are displayed in Figure 5. Between 92% and 99% of the trainees every year found the post-training contemplation very helpful or helpful, the consistently high results prove a testimony to the efficacy of the third phase of the training module. This phase of group work, in fact, was evaluated higher for its effectiveness than the initial planning phase. Perhaps this outcome can be explained by the fact that the trainees could not visualize the entirety of the training program in the first phase of training. Since they had already undertaken the complete program and had understood the training content before the group reflection phase, the trainees were able to appreciate the improvement and growth they had experienced and thus tendered an even more positive evaluation of the post-training contemplation phase. It could further be conjectured that the positive evaluation of the third phase also reflected the trainees’ sense of accomplishment due to the successful completion of the actual onboard training stage.

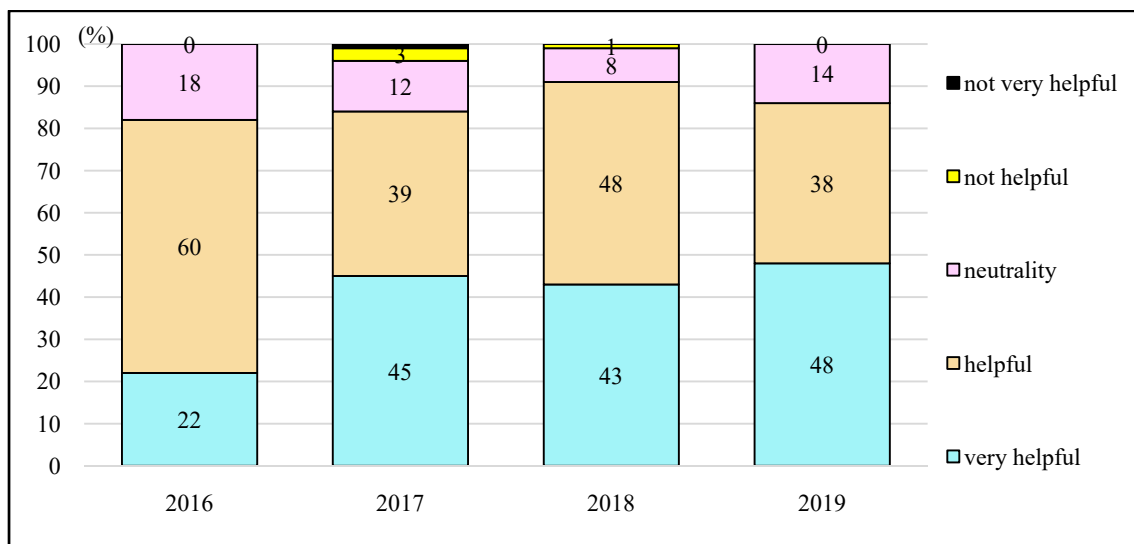


Figure 4. Questionnaire responses to items about the pre-training group work.

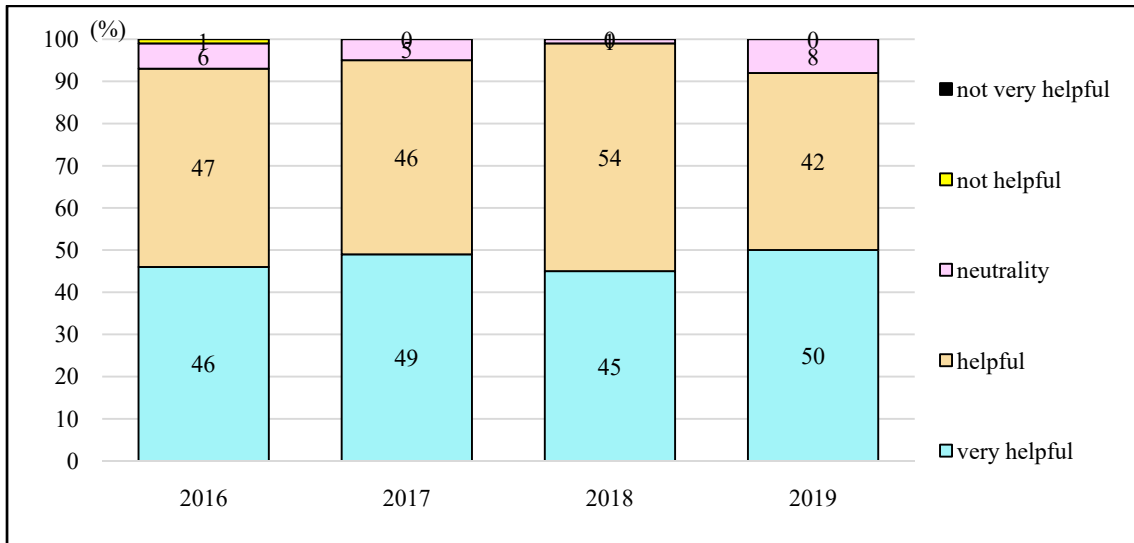


Figure 5. Questionnaire responses to items about the post-training group work questionnaire response.

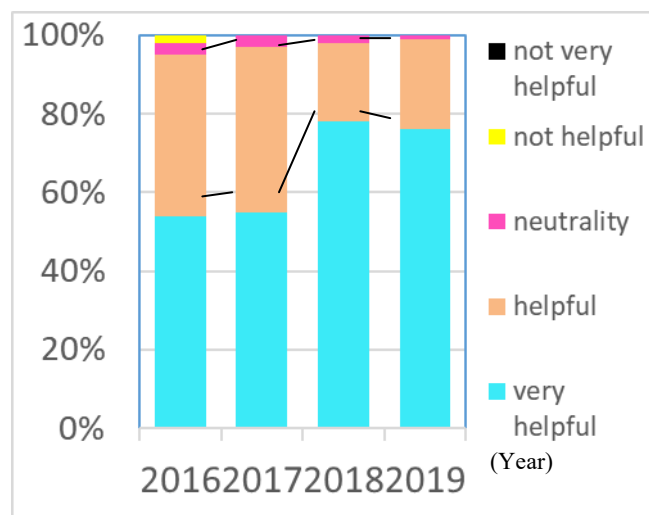


Figure 6. Trainee evaluations of the full anchoring training module.

The questionnaire results pertaining to the full anchoring training module from planning to reflection and final presentation are exhibited in Figure 6. More than 95% of the respondents agreed that the program was very helpful or helpful, proving that the trainees felt extremely positive about the anchoring training module as a whole. Thus, the training program was able to make participants think actively and trainees were able to acquire a sense of accomplishment by accomplishing the tasks required for the training on their own through all the stages of the anchoring training. The researchers believe that the self-development and hands-on approach was one of the major reasons for the positive evaluation received from the trainees. Also, longitudinally speaking the percentage of responses that the training was very helpful was higher in 2018 and 2019 in comparison to 2017 and 2018. It is possible that the improved evaluation rubric utilized by the instructors and training since 2018 has contributed to this increase in satisfaction. Until 2017, there were nine evaluation items. Five evaluation items were increased from 2018 and it was made 14 items. It is thus surmised that as they advanced their understanding of ship-handling, self-evaluation and mutual assessment became easier for the

trainees after the increasing of the evaluation items.

### Analyses of Trainee Comments

#### Results and Discussion of the Analysis Conducted Through an Affinity Diagram

Widjajaa, Yoshii, Haga, and Takahashi (2013) showed that creating affinity-diagram augments users' ability in qualitative analysis. So, the comments about the anchoring training recorded by the trainees were scrutinized using an affinity diagram. The feedback comments were first categorized on the basis of the proximity (affinity) of their significations. Next, each category was accorded a name (group label) that expressed its characteristics. An affinity diagram was subsequently created and associated with the whole, extracting the essence of the trainee assessments of the anchoring training.

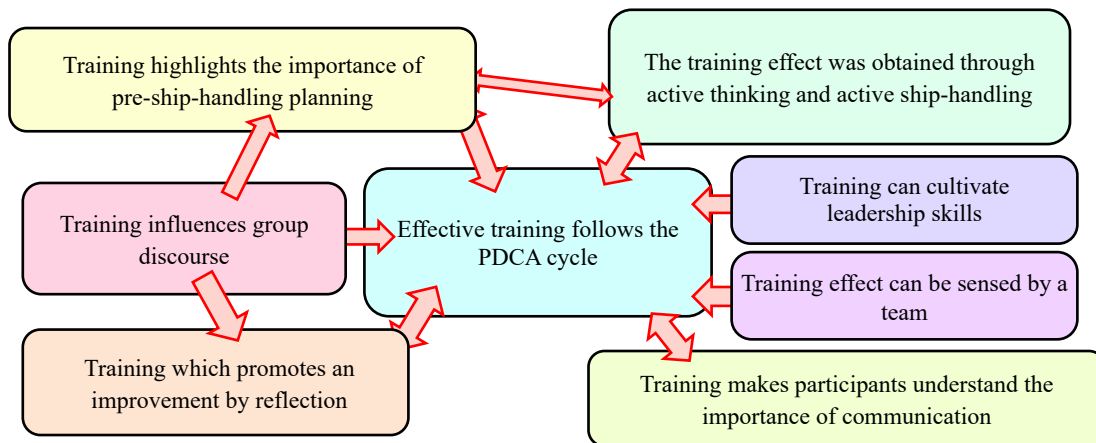


Figure 7. The affinity diagram of the comments registered by the trainees about the anchoring training.

Figure 7 presents the affinity diagram of the comments recorded by the trainees of the anchoring training. The feedback comments could be integrated and placed into eight groups. The group labels for the entirety of the anchoring training including the group work conducted before and after the actual ship training included: “Effective training follows the PDCA cycle”, “The training effect obtained through active thinking and active ship-handling”, “Training can cultivate leadership skills”, “Training effect can be sensed by a team”, “Training makes participants understand the importance of communication”, “Training promotes improvement through reflection”, “Training influences group discourse”, and “Training highlights the importance of pre-ship-handling planning”,

Each group label was related to the other. For example, the PDCA comment applied to the training program as a whole and was followed at every stage of the module; similarly, the group discourse label applied both to the pre- and post-training planning and reflection exercises.

This training is not necessarily conceived in terms of the PDCA cycle; however, it conformed to the typical PDCA cycle because it aimed at becoming more. When they responded to the questionnaires, the participants observed that the training module incorporated the PDCA cycle and sensed the beneficial impact of the methodology. The researchers believe that the positive influences of this module of anchoring training were appreciated because the trainees understood the effects of the PDCA cycle. From the pre-training ship-handling planning to the post-training reflection, the trainees were encouraged to always think and execute plans actively; thus, they probably felt responsible and were motivated to perform. Moreover, their understanding



progressed through each stage of the module and they were able to better visualize the task of ship-handling. The participants thus became aware of and acquired the varied aspects of ship-handling. For example, at the planning stage before the actual ship-handling experience, the trainees were positively influenced by the training module because they had thought about the topic intensely and could visualize the steps they would take when they were onboard for the ship-handling exercise. During the actual onboard training, the trainees were able to enjoy a sense of fulfillment as they accomplished the anchoring training despite conditions of considerable strain. At the reflection phase, the trainees could sense their development by reviewing the results of their accomplished tasks. Thus, the participants were believed to have attained the advantageous effects of this model of anchoring training.

### Results and Discussion of the Analysis Conducted via SCAT

The trainee comments were also examined through SCAT which is proposed analysis method by Otani (2008). First, the trainee comments were indicated as text data. The subsequent analysis followed the following procedure: (1) The collection of noteworthy words or phrases from the text; (2) The collected words and phrases were paraphrased; (3) Concepts were interpolated to account for the paraphrased terminology; (4) Themes were constructed in consideration of the obtained contexts; and (5) Appropriate questions and tasks were assigned, themes and constructs were compounded, a storyline was described, and a theoretical description was finally generated. Table 1 summarizes the SCAT analysis.

The following theorization statements were obtained through the SCAT analysis: “The dialogs and discussions held during the initial planning phase for the ship-handling training were effective in facilitating the acquisition of the required knowledge and skills”; “The validity of the pre-training group work comprising interchanges and debate vis-à-vis the planning for the ship-handling phase can be confirmed”; “An understanding and awareness of ship-handling can be obtained through the advice offered by instructors and the knowledge and skills of the participants can consequently improve”; “This type of training can recognize the significance of calm judgment in circumstances that can arise in a voyage”.

Table 1

#### *Steps for Coding and Theorization (Summary)*

No.	Text	<1> Noteworthy words or phrases from the text	<2> Paraphrased from <1>	<3> Concepts extracted from the text paraphrased in <2>	<4> Themes and constructs attained from the consideration of the contexts	<5> Questions and tasks
1	I understood the importance of creating a plan, of team communication, of briefing, and of debriefing. Eighty percent (80%) of the plan and twenty percent (20%) of the execution were understood. During the voyage, when unpredicted and unplanned situations arose, I understood	The ship-handling plan; 80 percent of the plan and 20 percent of the execution; Talks in the team; Importance of the debriefing; Calm judgment.	Importance of a prior plan; Dialog in the team; Importance of the subsequent reflection; Importance of calm judgment under sailing.	The ship-handling plan which draws up in a team in advance; A dialog and a discussion in a team; Importance of a plan and a briefing; Importance of the reflection in debriefing; Judgment and response according	The dialog and discussion at the time of ship-handling planning; Confirming of the validity of group work; Recognition of the importance of prior preparation; Importance of calm judgment according	Why is it important? What kind of effect does it have?



	that it is important to maintain my calmness.			to circumstances.	to circumstances under voyage.	
2	At first, although I did not know what I should do in ship-handling plan, I conversed with the team member, and then I understood. I obtained advice from instructors at a briefing, so I understood deeply, and I was able to have good preparation for the training.	A ship-handling plan; The talks with team members; Advice from instructors; Deepening of an understanding of ship-handling; Good preparations.	Planning of a ship-handling plan; Dialog within a team; Effective prior preparations.	Planning of the ship-handling plan by the dialog in a team, and the effect of a dialog; Improvement in an understanding by the advice from an instructor, and improvement of ship-handling skill.	The effect of the dialog in a team; An understanding of the importance of a ship-handling plan; An awareness by the advice from an instructor, and promotion of an understanding.	
Storyline	The dialog and discussion at the time of the ship-handling planning in the anchoring training are effective for acquisition of knowledge and skill, and can recognize the validity of group work, moreover, reflecting the whole training and being able to recognize the importance of prior preparations, and it is the training which can recognize the importance of calm judgment according to circumstances under voyage. Moreover, an awareness of ship-handling by the advice suitable timely from an instructor is obtained, and it is the training which an understanding and an improvement promote.					
Theory writing	The dialog and discussion at the time of ship-handling planning are effective for acquisition of knowledge and skill. The validity of the group work which has a dialog and a discussion at the time of ship-handling planning can be confirmed. An understanding and awareness of ship-handling can be obtained by advice from instructors and trainees' knowledge and skill improved. It is training which can recognize the importance of calm judgment according to circumstances under voyage.					

In addition, the following theorized texts were acquired: “This training applies the PDCA cycle and executes a spiral development”; “This training implements reflection and promotes improvement”; “This training cultivates initiative and determination through which trainees consider actions and evaluate their performance on their own”; “The group work required in this training enhances peer-learning”; “This training grasps the importance of teamwork, leadership, and communication skills, and participants are trained in these soft skills”. Such postulations evince the positive impact of the entire training module while also exhibiting the effects of each phase of the training. Moreover, they demonstrate that each stage of the training module is effectively related to the others.

The results of the SCAT analysis can thus be posited as the following statement: “An understanding and awareness of ship-handling could be obtained through the advice offered by instructors at the time of the briefing, and the knowledge and skills of the trainees could be enhanced by these inputs”. Content such as this was included in the assertions of the validity of the pre-training ship-handling planning phase in the affinity diagram and was overlooked. Although this type of content should essentially have been assigned the group label of “minority opinion”, it is believed to have been incorporated into the pre-training ship-handling planning phase. In such an event, the SCAT analysis proves that the training model proposed by Kunieda, Ito, Murai, and Kashima (2019) is an improvement on the existing structure. The ameliorated training model is visualized in Figure 8: it develops the pre-training group planning phase, adding facilitation and advice from the instructors. This enhancement ensures the self-development of the trainees while incorporating inputs that intensify their understanding of ship-handling. Moreover, the components of the PDCA cycle are more consciously encompassed with the addition of the elements of “advice from instructors” and “self-improvement” after every presentation, ensuring that the improvement of the participants is reflected in the next level of

training.

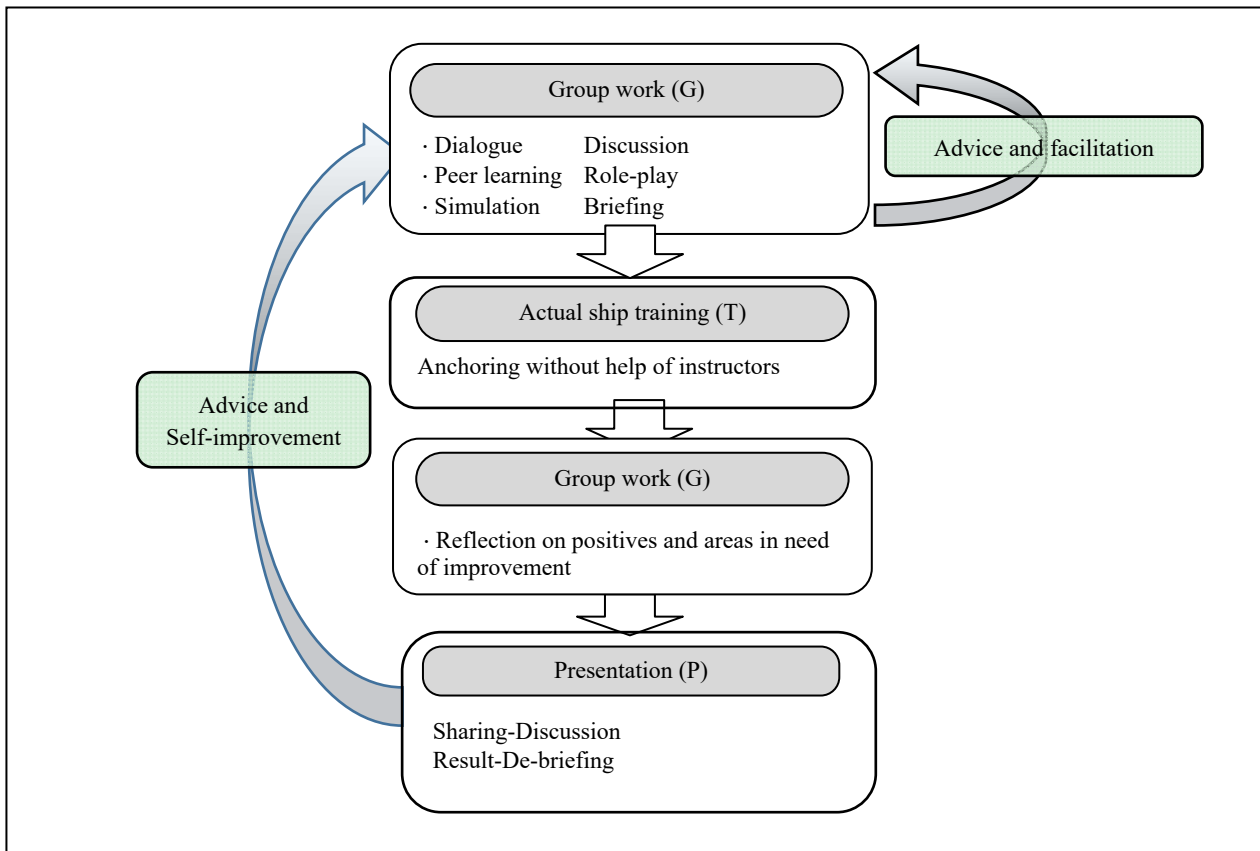


Figure 8. Revised training model.

## Conclusion

The pre-training group planning phase of ship-handling and the subsequent reflection stage scored highly on participant evaluations as obtained through annual post-training questionnaires administered longitudinally over four years. Trainees reported improvement in the relevant ship-handling knowledge and skills and acknowledged the beneficial effects of the proposed training module. It is thus believed that the desired result was achieved. Further, the trainee evaluations of the module as a whole were also extremely encouraging. It is assumed that the trainees sensed the impact of each training stage, and also felt positively about the manner in which each phase was related to the next. It was observed that the trainee evaluations varied slightly from year to year. The reasons for these small disparities may be the following: (1) the improvement of the evaluation rubric used for self-evaluation and mutual assessments; and (2) the differences in the motivations of trainees and their consequent effects on the training dynamics. Further investigation is mandated in prospective years to probe such disparities.

The affinity diagram and the SCAT analyze trainee comments. The affinity diagram yielded the above-mentioned eight group labels.

The researchers believe that the trainees perceived the entire training module in terms of the constituents of the PDCA cycle and that the participants found the efficacy of the training program to result from this aspect. Also, the trainees are asked to think, judge, and act on their own and to be proactive throughout the training

program. It is estimated that the sense of accomplishment experienced by the participants also contributed to the enhanced effects of this training module.

The SCAT analysis resulted in the following theorizations:

1. The dialogs and discussions conducted during the pre-training group planning stage were effective for acquisition of the requisite knowledge and skills pertaining to ship-handling;
2. The validity of the pre-training group work comprising interchanges and debates at the ship-handling planning stage can be confirmed;
3. An understanding and awareness of ship-handling can be obtained through the advice of instructors and the knowledge and skills of trainees can consequently improve;
4. This type of training can recognize the significance of calm judgment in circumstances that can arise in a voyage;
5. This training applies the PDCA cycle and executes a spiral development;
6. This training implements reflection and promotes improvement;
7. This training cultivates initiative and determination through which trainees consider actions and evaluate their performance on their own;
8. The group work required in this training enhances peer-learning;
9. This training grasps the importance of teamwork, leadership, and communications skills and participants are trained in these soft skills.

The above statements evidence the advantageous effects of each stage and the proposed training module as a whole. The results of the analysis accomplished using the affinity diagram similarly underlines the success of the model described in this paper. The training model initially proposed by the authors was amended on the basis of the outcomes of the abovementioned analyses and a modified model was postulated. These training effects of these enhancements will be verified in the future through the implementation and testing of the newly proposed training model. The validation of the beneficial training effects of the new training model will also be accomplished through its application on other aspects of training besides anchoring.

## References

- Ahvenjärvi, S. (2016). The human element and autonomous ships. *International Journal on Marine Navigation and Safety of Sea Transportation (TransNav)*, 10(3), 517-521.
- Boyd, D. E. (2014). The growth mindset approach: A threshold concept in course redesign. *Journal on Centers for Teaching & Learning*, 6, 29-44.
- Campbell, S., Naeem, W., & Irwin, G. W. (2012). A review on improving the autonomy of unmanned surface vehicles through intelligent collision avoidance maneuvers. *Annual Reviews in Control*, 36(2), 267-283.
- Gordon, M. (2013). Non-technical skills training to enhance patient safety. *The Clinical Teacher*, 10(3), 170-175.
- Kashima, H., Kunieda, Y., & Takemoto, T. (2001). About the training effect of ship handling training. *Journal of the National Institute for Sea Training*, 1, 17-38.
- Kunieda, Y., Kido, H., Kashima, H., & Murai, K. (2017). Active learning in maritime education. *International Journal on Marine Navigation and Safety of Sea Transportation (TransNav)*, 11(1), 367-374.
- Kunieda, Y., Osaka, A., Kashima, H., & Murai, K. (2018). Study on effective training for anchoring. In *Proceedings of 2018 CIN-JIN-KINPR Joint Symposium (Asia Navigation Conference 2018)*, pp. 1-4.
- Kunieda, Y., Ito, Y., Murai, K., & Kashima, H. (2019). Training model based on the anchoring training. In *International Association of Maritime Universities 20th Annual General Assembly Proceedings*, pp. 135-142.
- Kunieda, Y., Murai, K., Kashima, H., & Oi, K. (2019). The effect of group work and team management training in anchoring training. *Proceedings of 2019 CIN-JIN-KINPR Joint Symposium (Asia Navigation Conference 2019)*, C6-1, pp. 554-560.

- Minamigawa, T. (2014). Education which aimed at improvement in nontechnical skill. *Journal of Safety Engineering*, 53(3), 173-180.
- Otani, T. (2008). "SCAT": A qualitative data analysis method by four-step coding: Easy startable and small scale data-applicable process of theorization. *Bulletin of the Graduate School of Education and Human Development*, 54(2), 27-44.
- Widjajaa, W., Yoshii, K., Haga, K., & Takahashi, M. (2013). Multiple user real-time digital sticky-note affinity-diagram brainstorming system. In *Proceedings of the 17th International Conference in Knowledge Based and Intelligent Information and Engineering Systems-KES2013*, pp. 113-122.