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Ship Handling Training for Collision Avoidance: Education via Group Work

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ABSTRACT

In shipping, which is one of the drivers of the world's economy, many marine accidents continue to occur, such as ship collisions and grounding. To prevent marine collision accidents, there is a strong demand to improve seafarers' skills through training. Therefore, practical and simulation training sessions are carried out. However, these cannot be considered sufficient because of cost and time constraints. Therefore, the authors proposed a training method in which a group of students set the situation themselves by adding restrictions on actual cases of ship handling for collision avoidance and then discuss and present it. In this training method, ship training instructor assessment and an anchoring experiment were carried out, both of which obtained good evaluations. The anchoring experiment showed a difference of up to 27.5% in the achievement rate between the proposed training and previous training. Regarding ship handling for collision avoidance, as much as a 45.5% difference in achievement rate was observed. These are considered to have the effect of encouraging active thinking by the proposed training method. In addition, the effect of considering the ship handling for collision avoidance for many situations can be thought. Furthermore, it was considered to be the effect of discussions in group work.

Keywords: Ship handling for collision avoidance; Group work; Additional restriction in group work; Evaluation of the educational effect.

INTRODUCTION

Trade and logistics have continued to develop along with the world economy. For an island country such as Japan and many other countries, the centre of logistics is sea transportation

using vessels that can transport large quantities of cargo at a low cost. Meanwhile, many marine accidents such as collisions and groundings continue to occur because of human factors, and the importance of seafarer education and training has been highlighted [1].

According to Japan Coast Guard statistics, about 2,000 marine accidents occur annually in Japan. In 2019, the Japan Coast Guard recorded 2,058 ship accidents [2], of which 57% were collisions. To prevent collision accidents, it is imperative to improve and strengthen seafarer education and training, develop and disseminate relevant equipment and facilities and build and implement management and systems. In this study, we focused on education and training to eliminate improper manoeuvring that causes collisions.

PURPOSE OF THE STUDY

In ship manoeuvring training using a ship handling simulator, Kobayashi et al. developed ship handling skills as elemental techniques. Their purpose was to adapt education and training content to target personnel and showed that their education and training method and evaluation were accurate [3]. Inoue et al. also proposed an objective assessment method for improving ship handling skills for collision avoidance via ship handling simulator training [4]. In addition, Kunieda et al. and Koyano et al. discussed an effective ship handling training scheme that combined on-board ship handling simulator training and ship training [5][6]. All these education and training programmes require large-scale equipment such as actual ships and ship handling simulators. Hence, this study aims to help prevent marine accidents by proposing an education/training method that does not require the aforementioned equipment and minimises the number of teaching personnel.

A PROPOSED SHIP HANDLING TRAINING METHOD FOR COLLISION AVOIDANCE

A New Ship Handling Training Scheme to Avoid Collisions

We propose an education and training method in which students established their own scenarios by adding restrictions to actual cases of collision avoidance, after which they discussed and presented them to the group. This method is called Additional restriction in group work (ARGW).

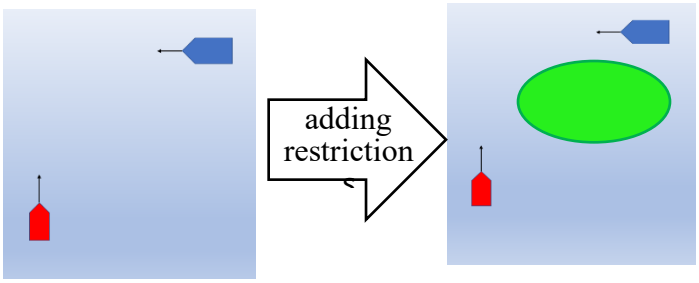

Figure 1. An example of ARGW.

Figure 1 shows a simple example of ARGW. The left side shows a case where the red ship risks colliding with the blue ship, which is a simple crossing situation in the 1972 Convention on the International Regulations for Preventing Collisions at Sea (COLREGs). For instance, the student imposes restrictions such as the presence of a group of fishing boats as shown on the right of the figure. Afterwards, the students discussed among themselves how to avoid collisions.

From the group work, ARGW was chosen considering the following effects:

(1) It can be conducted on a desk

Practical ship training and ship handling simulation training require equipment such as vessels and simulators. Meanwhile, ARGW can be conducted on a desk, and ship handling training for

collision avoidance may be accomplished without such equipment. In addition, many scenarios can be constructed without spending much time and effort, and effective training can be carried out.

(2) It allows diverse ideas to be shared through group work

Students can learn different ways of thinking within a group and express their own thoughts. There is more than one method of collision avoidance, and students can learn many.

(3) It deepens thinking through discussions

Students can strengthen and improve their ideas through discussions within the group. From many collision avoidance methods, students can choose the best one.

(4) It fosters new awareness through discussions

Group discussions enable students to create new awareness, as well as integrate and develop their ideas. Through group discussions, students may learn new patterns of collision avoidance and discover new ways.

Training Materials Used in ARGW

We decided to use actual cases for the ARGW training materials. We also collected actual ship handling for collision avoidance data in the sea area of training ships operated by the Japan Agency of Maritime Education and Training for Seafarers (JMETS). In about two months, we collected 26 cases of ship handling for collision avoidance from two training ships.

Figure 2 shows the ship handling for collision avoidance survey sheet.

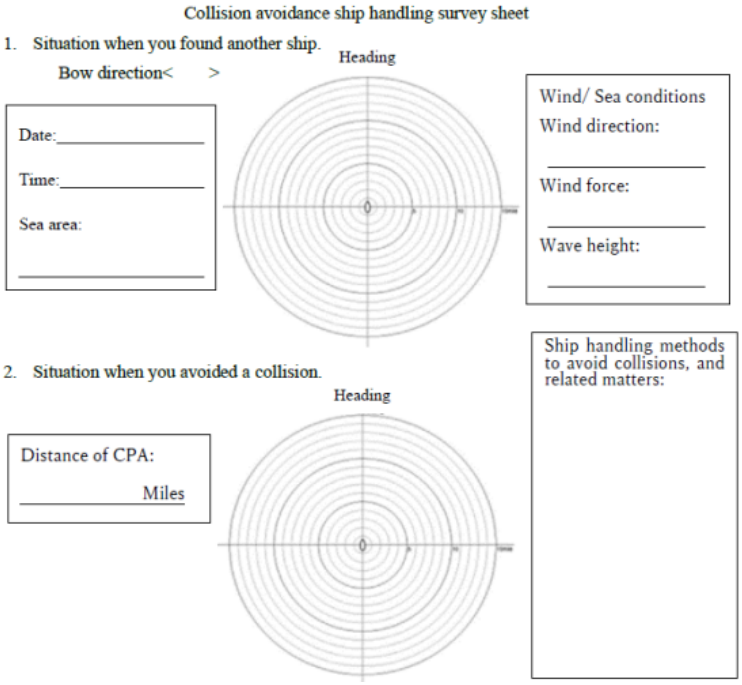

Figure 2. Ship handling for collision avoidance survey sheet.

Evaluating the Educational Effect of ARGW

To assess the educational effects of ARGW, we conducted a questionnaire survey of 29 training ship instructors belonging to JMETS. The questionnaire consisted of three questions focusing on the characteristics of ARGW: (1) In this education and training method, would it be educationally effective to consider an avoidance method by adding restrictions that each person has considered? (2) Do you think it would be effective to discuss ship handling for collision avoidance in groups of 4–6 students? (3) Do you think it would be effective to present the results to the whole group and exchange opinions? These questions were evaluated using a five-point rating scale (1 - not effective at all, 2 - not effective, 3–neither effective nor ineffective, 4 - effective, 5 - very effective). For each question, we also asked for free-form opinions.

Questionnaire Results

Figure 3 shows the respondents' distribution of years of experience as a training ship instructor. Most respondents have worked for 21 years or more, and at least four instructors are in each experience range. It can be said that there is little bias in the number of years of instructor experience.

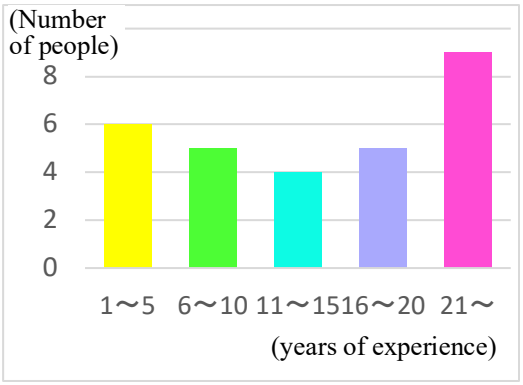

Figure 3. Distribution of training ship instructor experience.

Figure 4 shows the answers to each question. For all the questions, most ratings were 'effective' and 'very effective'. Regarding the educational effect of question 1, 'Training method in which students impose restrictions', 28 people, or 96.6%, answered 'very effective' or 'effective'.

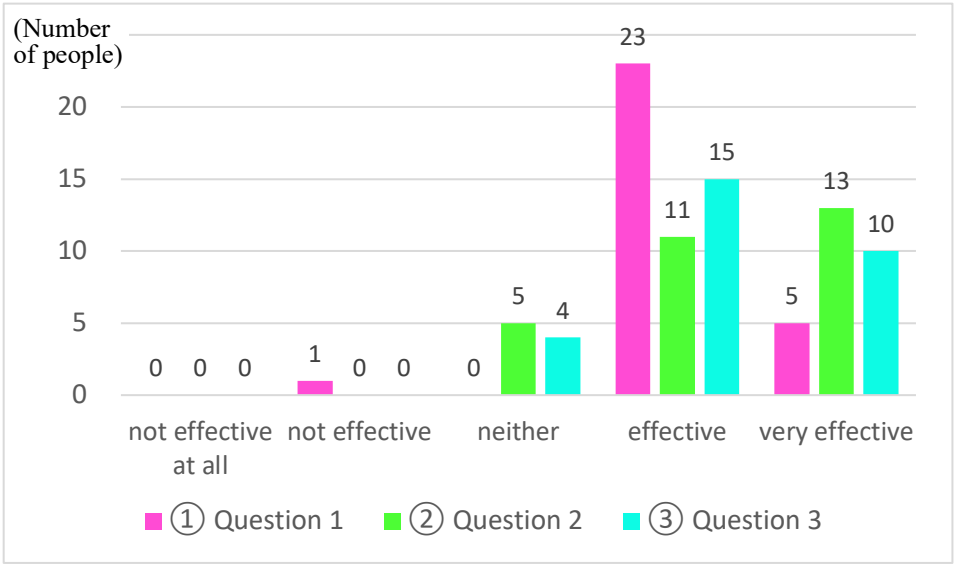

Figure 4. Results of questionnaire responses.

For question 2, 'effect of group work', 82.8%, or 24 people, responded 'very effective' or 'effective'. Furthermore, regarding the training effect of 'presentation to all' in 3, 25 people, or 86.2%, were "answered 'very effective' or 'effective'.

For question 1, the most common answer was 'effective', while one participant responded, 'not effective'. This was because it would be difficult for less experienced students to impose realistic restrictions. Similarly, under 'effective', the following opinions were found: 'It would be more effective if there was an instructor who would evaluate whether the added restrictions were realistic', and 'If it is difficult for students to think of any restrictions, the instructor should add them'. Meanwhile, the respondents provided the following reasons as to why their response was 'effective': 'By learning how to avoid collision in various situations through group work training, students can learn appropriate ship handling methods for collision avoidance in actual voyages', and 'Activities that carry out active learning that is thinking about restrictions on their own are effective'.

Meanwhile, for question 2, the most common answer was 'very effective', the reasons for which included the following: 'The experience of getting in touch with the opinions of others is effective because it makes them aware of new ship handling methods of collision avoidance'.

As for the reason for the participants' 'effective' responses to Question 3, as in Question 2, 'the experience of touching the opinions of others is effective because it makes them aware of a new ship handling method for collision avoidance'. One of the respondents stated that 'in order to make a presentation, it is necessary to organise the ideas firmly, which leads to an accurate understanding of the presented cases and clarification of the avoidance action'.

Training Ship Instructors' Opinions on ARGW

The opinions of the training ship instructors on ARGW can be summarised as follows:

(1) A highly effective training can be expected when students place themselves in various situations and actively think about ship handling strategies for collision avoidance for each scenario.
(2) By assuming many situations, many ship handling methods to avoid collisions can be expected to have an effect during training.
(3) Since ARGW is based on real scenes in the actual sea area, it will be an effective training strategy, as it does not deviate from reality.
(4) By sharing opinions and communicating ideas, training participants may learn various ideas and deepen their knowledge.
(5) Depending on the discussions and dialogues, appropriate advice and facilitation from instructors would be required, which further enhances the educational effect.

COMPARATIVE EXPERIMENT

After ARGW implementation, anchoring training was conducted, and the effect of ARGW was verified by comparing it with a case in which ARGW was not applied.

Anchoring Training

Anchoring training, which is performed by student teams without instructor assistance, is a suitable exercise for improving ship handling skills through various manoeuvres. First, students heave up the anchor and sail a planned route, and after passing waypoints, they anchor at a set anchorage. Anchoring training is suitable not only for learning manoeuvring procedures based on actual performance but also for learning various elemental manoeuvring techniques, for information exchange and management skills and for improving abilities associated with those skills [7]. Anchoring training is generally performed by a team of four, each with defined roles: captain (role of captain, ROC), first officer (role of first officer, RO1O), third officer (role of third officer, RO3O) and quartermaster (role of quartermaster, ROQ). Thus, anchoring training is considered effective group work, which adheres to the following process:

(1) Taking the lead, the ROC develops a navigation plan for anchoring. This active student planning of ship handling is designed to develop the ROC's leadership skills and create opportunities for peer learning. The ROC explains the navigation plan to teammates and instructors, who then provide advice and feedback to correct the plan. After making corrections to the navigation plan, the ROC briefs team members and instructors, who then review their notes and roles.
(2) Actual ship training is conducted as follows:

(a) The ROC positions the leaving anchorage station and, before heaving the anchor chains, directs the RO3O to prepare the main engine and then directs the heaving up of the anchor.
(b) When the anchor is aweigh, the ROC sets off on a predetermined course using the main engine and rudder.
(c) The ROC appropriately corrects the course to ensure that the planned route can be navigated. The ship then passes two scheduled waypoints and navigates the predetermined route.
(d) The ROC slows the main engine, adjusts the course and stops the ship by applying the main engine to the sternway to ensure it is positioned correctly at the planned anchorage.
(e) The ROC lets go of the anchor at the planned anchorage, lets out the cables to a predetermined length, stops the main engine and finally dismisses the anchoring station.

(3) Shortly after the training, students self-evaluate based on a rubric.

(4) Each team then discusses anchoring training, that is, its positive aspects and those needing improvement.

(5) Each team member presents their ship handling notes, while the others engage in active listening and thinking. Instructors provide comments based on the evaluation rubric.

Figure 5 shows the planned route and an example of a track in the training area.

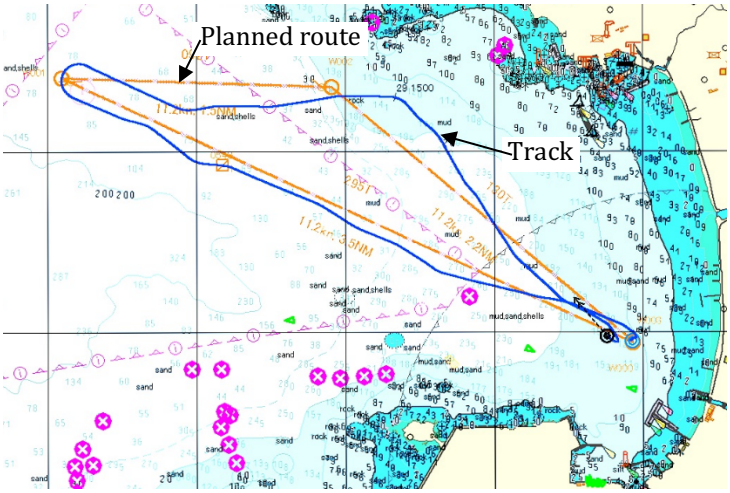

Figure 5. The planned route and an example of a track in the training area.

Instructors' Evaluation

In the anchoring training, two instructors who have worked as captains of large training ships evaluate the anchoring training conducted with and without ARGW. To assess the anchoring training, 14 specific evaluation items were created, and a rubric evaluation, which sets evaluation criteria for each item, was adopted. Evaluation criteria were scored in four stages: 4 points (90 or more out of 100 points), 3 points (80–90), 2 points (60–80) and 1 point (fewer than 60). For the scored evaluation, results were compared between the training with ARGW and the one without ARGW.

Figure 6 shows a comparison of averages, while Figure 7 compares the evaluation results of the give-way/stand-on ship handling. Both correspond to the evaluation results of training conducted after ARGW was implemented in 2020 (ARGW was not in effect from 2017 to 2019). The average evaluation result was 3.4 points (out of 4.0) in 2020, which is an achievement rate of 85%, a difference of 27.5% compared to 2019. For the give-way/stand-on ship handling, a 45.5% difference in achievement rate was observed from 2018. In 2020, while the data count

was as small as two cases, it clearly showed good evaluation results. Specifically, it can be seen that the evaluation items for the give-way/stand-on ship handling have improved significantly.

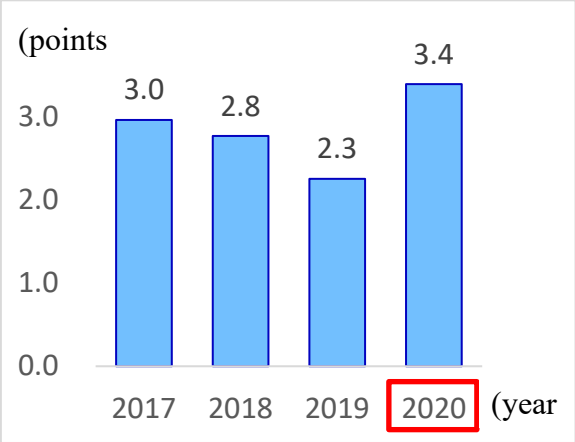

Figure 6. Comparison of evaluation results (average).

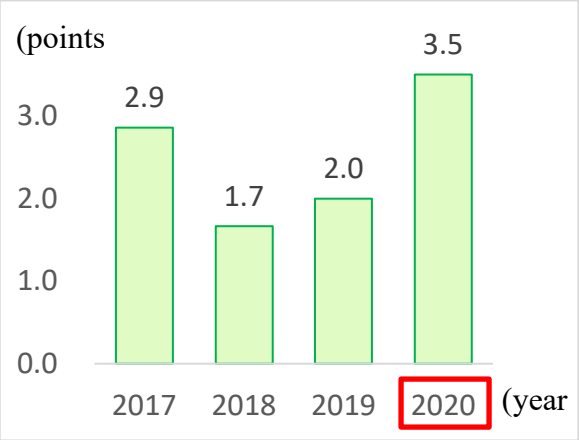

Figure 7. Comparison of evaluation results (give-way/stand-on manoeuvring).

CONSIDERATION

The proposed ARGW will be considered below based on the purpose of the proposal, the evaluation of the training ship instructors and the experimental results of anchoring training.

Educational Effects of Group Work

(1) It is a learning method that encourages students to think actively

By applying ARGW, students will learn actively. Students set their own restrictions based on the given training materials and think about how to avoid collisions for the new situation; hence, learning will be based on active thinking.

(2) This technique sets up many situations and provides a virtual experience of ship handling for collision avoidance

First, many situations are created by listening to the opinions of others in group work and by communicating and sharing ideas. By thinking about ship handling for collision avoidance in each situation and exchanging opinions, students can virtually experience more ship handling for collision avoidance scenarios. We believe that thinking and imagining many situations will improve students' knowledge and skills. As the training ship instructors commented, imagining many situations and how they might respond to these is expected to have an educational effect close to that of actual experience.

(3) This method promotes improvement through discussions

Through group discussions, ship handling methods for collision avoidance can be corrected and improved. In addition, we believe that a better ship handling method for collision avoidance may be devised in combination with other ship handling techniques. Furthermore, in group work, ship handling methods for collision avoidance will be more concrete by explaining and discussing the considered methods. In addition, students can fully understand and establish ship handling methods for collision avoidance.

Educational Effect of Materials Based on Actual Cases

It is thought that students find it easy to learn with a sense of reality by using materials based on actual cases. In addition, when students impose restrictions based on actual cases, they would find it difficult to impose unrealistic restrictions and would propose a situation in which more realistic restrictions are applied.

On the other hand, at the knowledge and skills acquisition stage of students who perform ARGW, we believe that it is essential that they experience actual voyages on training ships. If students do not experience actual voyages, they would not be able to fully understand the sea conditions, the conditions of other vessels and their own, and they would find it challenging to imagine ship handling techniques to avoid collisions. We also believe that students need to learn maritime traffic regulations.

Educational Effect of Students' Active Imposition of Arbitrary Restrictions

ARGW does not solely consider ship handling methods for a given task (situation), but students also actively impose arbitrary restrictions. Since the students themselves will think actively and create new training materials, we believe they will work hard to consider ship handling methods for collision avoidance; as a result, we presume that these training materials will not be for unrealistic situations. Meanwhile, since the original material is based on the ship handling for collision avoidance data actually carried out on the JMETS training ship, it is itself a valid training material. In addition, the situation changes as students impose arbitrary restrictions on this training material. Discussions on training materials that have changed such situations and how ship handling methods change as a result is a good opportunity to think about many ship handling techniques.

Evaluation of the Educational Effect of ARGW

ARGW has a certain educational effect based on evaluation from the training ship instructors and the results of anchoring training. Regarding the former, most of the instructors stated that the training was 'effective' in terms of the following:

(1) Considering a collision avoidance method by adding restrictions that each person has considered.
(2) Conducting dialogues and discussions through group work.
(3) Presenting the results of group work.

Although ARGW cannot be actually experienced, many have argued that it would be beneficial to assume many situations (cases) and consider ship handling methods for each. In other words, having many options in actual situations by considering many scenarios and their corresponding ship handling methods would be effective. We believe that both quantitative expansion and qualitative deepening can be achieved by not only listening to the story but also expressing opinions and making corrections and improvements.

In addition, we believe that these educational effects will be improved by emphasising students' active learning. In group work, students think for themselves and impose restrictions on an actual situation where a ship avoided a collision. Students then consider the ship handling method for collision avoidance for that situation. We also think that exchanging opinions with group members and asserting or modifying their own opinions are beneficial for acquiring knowledge and skills.

Meanwhile, while the number of group members for the group work was set to four to six, we considered that three people would be appropriate after considering the training ship instructors' opinions. In the case of four to six students per group, some students may not have the opportunity to express their opinions; on the other hand, if there are only two members, opinions would tend to be biased, and it would be challenging to produce new and diverse ideas. Furthermore, to improve the effectiveness of ARGW, instructors or teaching assistants need to provide appropriate support. We think that inexperienced students find it difficult to impose many restrictions. Also, they may not derive the ship handling method for collision avoidance that suits the situation. Therefore, we believe that instructors or teaching assistants need to correct or facilitate the flow of discussions in group work.

CONCLUSION

We proposed a training method that is considered effective and does not need large-scale equipment such as actual ships and simulators. ARGW maximises the effects of group work and obtained good evaluations from training ship instructors and anchoring training experiments. The training was effective because the students themselves set the scenarios by adding restrictions on their own initiative, and they devised ship handling methods for collision avoidance for many situations. In addition, group work discussions were found to help deepen and establish students' knowledge and skills.

Instructors must provide support to group work such as appropriate facilitation, and if this is done properly, we believe that training would be more effective. In the future, we would like to investigate more effective group work implementation methods and instructor involvement.

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