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ABSTRACT: At Kalmar Maritime Academy (KMA) the first-year students at the Master Mariner program complete a course in the use of ARPA\(^1\). The course includes eight simulator exercises, where seven of them are completed in pairs and the last exercise is an individual assessment. Previously, instructors have encouraged students to choose a new partner for each of the first seven exercises; however, the reason for this strategy has not been well documented.

The aim of this study was to examine the effect of fixed versus rotating bridge teams on the individual learning outcome. During an eight-week course in spring 2012, two groups of students were asked to work either with the same or a new partner for each exercise during a course. The result showed no difference between the two groups with regard to the individual assessment, and the students who failed did so because of inadequate interpretation of the ARPA information, and not because of insufficient radar knowledge.

1 INTRODUCTION

Navigation simulators have become a natural part of the Master Mariner education, and students spend a lot of time in the simulator. However, most of the time the simulator is used for training purposes, not for assessment. In this setting, one instructor might have 10-12 students at the same time, only allowing a few minutes with each student individually; in unfortunate situations a student might not even get any quality time with the instructor for a complete exercise.

There are different ways of arranging the students into bridge teams. One way is to form rotating bridge teams that change from exercise to exercise, thus students never work together with the same peer twice. This method has two advantages. Firstly, although all students have the same prerequisites, they all have varying knowledge and experience from their on-board practice, therefore each new study partner is a potential new source of knowledge. Secondly, upon signing on a vessel as a crew member one can almost never choose whom to work with. Therefore the ability to co-operate in different combinations has to be acquired at an early stage, preferably already at the maritime academy. On the other hand, one could also argue that working with the same peer every exercise would form a solid and well-functioning bridge team that would facilitate learning even better.

The aim of this study is to investigate if there is any tendency of correlation between the way the bridge team is set up in the simulator, i.e. as a rotating or fixed team, and the outcome of student learning. This will be observed during a course in the use of ARPA. The subject to be studied comprises of a first-year class at the Master Mariner program at KMA. The group will be split into halves; in one half the students will be asked to choose a new partner for each exercise, and in the other half the students will be asked to work in fixed teams. The course ends with an individual practical assessment where the student’s ability to use the radar and ARPA is assessed by the course instructor.

2 BACKGROUND

At Kalmar Maritime Academy the first-year students at the Master Mariners program attend two radar courses: one general radar course and one course in the use of ARPA. The courses correspond to 3 and 2 ECTS\(^2\)-credits respectively, 1.5 ECTS-credits corresponding to one week (40 hours) of full-time studies. The two courses are given consecutively in time and are closely related to each other with regard to content, the first course being a stepping stone for the latter one. Both courses consist of theoretical studies (lectures) and practical studies (simulator exercises). However, the students are not required to have passed the first course in order to attend the second one, since this would in reality require all students to pass the radar course on the first attempt, otherwise excluding several students. During the ARPA course each student is required to complete a total of eight 90-minute simulator exercises: seven exercises where students work in pairs learning the ARPA functionality and interpretation of the ARPA, and finally one individual examination. In essence, the students practice in pairs but are examined

\(^1\) Automatic Radar and Plotting Aid

\(^2\) European Credit Transfer System
individually. The examination is divided into two parts. First the student is asked to start the radar and adjust the settings according to the instructor’s orders. This involves e.g. adjusting gain, anti-clutter sea and rain, setting range and pulse length, setting CPA and TCPA limits and defining guard zones, all to show that the student is familiar with and can operate basic radar functions. Secondly, the student has to command a vessel in a traffic situation and manoeuvre safely according to the COLREGs by using the radar and ARPA. During this second half of the examination the student will be asked by the instructor to perform certain actions, such as manual and automatic plotting and trial manoeuvre, as well as to explain the different usages of true and relative vectors. After the examination is completed the student is awarded a grade, either pass or fail.

Since the curriculum does not call for teamwork, there has not been any strict recommendation about how students should be paired together. A general consensus among the colleagues has been to have the students change pairs for every new exercise, with the intent that each new partner can contribute with new views and solutions to problems. However, as an academy has to strive towards relying on research rather than old habits, this set up could be questioned until it can be scientifically proven to be the most efficient one.

3 PREVIOUS STUDIES

There is a vast amount of research on topics related to student teamwork and group composition. Traditionally, academic education has included numerous large format lectures and very limited interaction between teacher and students, as well as among the students themselves. However, it has been proven that small-group learning results in higher grades, a deeper level of understanding of the subject matter and improved communication and teamwork skills. Also, the latter way of learning gives the student a better understanding of his or her future role within the chosen profession [1].

A team can be defined as “two or more individuals with specified roles interacting adaptively, interdependently, and dynamically toward a common and valued goal” [2]. In the case with this simulator course, the students naturally have a common goal; they strive to acquire knowledge and to receive a passing grade. However, they are not necessarily interdependent of each other. There is no course component that stipulates any co-operation between students, which is also the result when a group of students does not make up even pairs, and one student undertakes an exercise alone.

So if the students do not perform any teamwork by definition, what do they really do? One plausible answer would be that they collaborate in order to enhance learning. Nevertheless, when individuals work together in a group all team members tend to reduce their work effort to some extent. When a person works alone, that person depends solely on his or her own performance, but in a group there are always other persons there to “pick up the slack”. This phenomenon is called social loafing, and in educational settings it refers to an individual who slacks more than others, and therefore becomes a burden [3]. In addition to the group result, a social loafer will not learn as much on an individual level, hence, it is in everybody’s interest to avoid this.

There are a number of things that can be done to minimize this phenomenon. Firstly, it is reported that group size correlates with social loafing; smaller groups, or even pairs, reduce the presence of slackers [3]. Secondly, self-selected teams have been observed to have a lower frequency of slackers [4]. However, to let the students select their own team mates can have a number of consequences. Students tend to choose to collaborate with similar minded peers. Thus, stronger students seek each other, leaving the weaker students to team up on their own which makes the groups homogenous [1]. This is called academic alignment [3] and there are different views about whether this favours student learning or not.

One way to look at academic alignment is that both strong and weak students benefit from mixed groups. Oakley’s view is that “in well-functioning diverse groups, the weak students get the benefit of seeing how good students approach assignments and they may also get some individual tutoring, while the strong students who do the tutoring may benefit even more” [1]. Today learning through teaching is a well-known concept which is widely used. Similar findings were made by Brush who examined for how long elementary school students stayed focused on a specific task when working in pairs, either in high ability homogeneous pairs, low ability homogeneous pairs or mixed ability pairs [5]. Even though these students were considerably younger than university students, the result is interesting; the low ability students stayed focused longer when paired with a high ability peer, than with a student of similar ability. A contrasting view was found by Pieterse and Thompson who experienced that the weaker

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2 Closest Point of Approach
3 Time to Closest Point of Approach
4 Convention on the International Regulations for Preventing Collisions at Sea
students rarely sought help from stronger peers, who in turn did the work themselves rather than tutoring the weaker students [3]. In such a situation a homogeneous alignment might better benefited those students.

In this context, a cohort is made up of a group of students enrolled in a study program together, e.g. the students at a Master Mariner program. Cohort groups are built on collegial support which enhances the teaching and learning process. A study by Greenlee and Karanxha examined how group dynamics differed between cohort and non-cohort students. The result showed a significant difference on three characteristics: trust, cohesiveness and satisfaction. Of these factors, it is interesting to see that cohort students had a significantly higher level of trust than non-cohort student [6]. This could be relevant to this study as well; it is possible that students working in fixed pairs experience the same effect as cohort students, and if they trust each other, they might be more likely to work well together even if they are a mixed ability pair (compare to Brush 1997).

A final issue concerns team set-up. Generally there are three ways of arranging students in teams: self-selection, random assignment and lecturer assignment. To conform to academic alignment, Oakley strongly recommends teams to be chosen by the instructor [1]. From a student perspective, Drake, Goldsmith and Strachan found student feedback on group formation to be more positive from lecture assigned groups than from self-selected. Furthermore, they also found self-selected teams to lack in variation and styles [7]. The latter was confirmed by Oakley who observed that when left to form own groups, the more experienced or confident students formed teams, as did the less experienced [1].

4 METHOD

This study was conducted in Kalmar, Sweden, and took place during spring 2012. As the aim was to observe if any differences could be observed from different ways of arranging student groups, the first step was to find a suitable simulator course and student group to observe. The ARPA-course was chosen on the grounds that it is a beginner course that involves basic yet fundamental skills for a deck officer, skills that most students on this program are not formerly familiar with. This way, the learning outcome for the individual student will not be affected by previous knowledge, but rather by the didactic measures undertaken during the course. The course is also appropriate because the exercises themselves do not require any teamwork, such as BTM6; hence any co-operation between the students is done voluntarily to facilitate learning. Nevertheless, the ARPA-course is not the first simulator course that the students encounter and therefore they are already familiar with the bridge equipment, eliminating simple hands-on mistakes. With the course chosen, the group was easy to identify: the first-year students at the four-year Master Mariner program. The reason for this is that it is the largest single group enrolled in this course, and it is already divided into two groups, the latter being very favorable since two methods were to be tested.

The groups were further sub-divided alphabetically into groups of 7-10 students, to meet the maximum capacity of the simulator. At the beginning of the course, one group (n=30) was asked to team up with the same peer for each exercise (the fixed group), and the other group (n=22) to try to team up with a new partner each time (the rotating group). The difference in group size derives from the fact that a few students had for some reason already attended this course. Among the whole group of 52 students, they were encouraged to stick to the pairs described above, but they were not forced to do so. Previous simulator courses at KMA have shown that if students are allowed to switch time slots with each other they are less prone to miss an exercise. Consequently, a student in the fixed group could do an exercise with the rotating group and the other way around. This meant that a student in the fixed group could do for example all but one exercise with the same partner, and a student in the rotating group could for the same reason in fact do two exercises with the same peer. This meant that some students who from the beginning were supposed to be in the fixed group were moved to the other group due to the high number of simulator partners.

Since it is a requirement that the student must have completed the first seven exercises before doing the final assessment (the eighth exercise) two students were omitted for this reason. This study focused on five of the seven exercises where the students worked in pairs, and the result at the final individual assessment. To be able to analyze the results afterwards, for each exercise the names of the student pairs were recorded.

Each student completed the five exercises with a different number of student partners; some completed all exercises with the one and same partner, and others with numerous partners. Based on this, each student was classified according to the highest number of exercises he or she completed with any partner. This meant that a student who completed four exercises with one partner and one exercise with another partner was classified as a “4” (the highest number of exercises with the same partner being four), and a student who completed each exercise with a new partner was classified as a “1” (the highest number of exercises with the same partner being one).

6 Bridge Team Management
To determine which students belonged to the fixed or rotating group, a divide was established. Students classified as 3 or higher were defined as belonging to the fixed group, and students classified as 2 or lower to the rotating group; in other words, the students in the rotating group had not worked with any same partner more than twice.

5 RESULT

Table 1 shows the two groups with the number of students and the result of the individual assessment in numbers as well as percentage.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>n=pass</th>
<th>%=pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed group</td>
<td>22</td>
<td>19</td>
<td>86</td>
</tr>
<tr>
<td>Rotating group</td>
<td>28</td>
<td>24</td>
<td>86</td>
</tr>
</tbody>
</table>

The previous table indicates that there is no apparent difference between the two groups. A more detailed overview of the individual result in relation to the number of exercises completed with the same partner is illustrated in figure 1. The result indicates a slight variation with a possible correlation between number of exercises with the same partner, and result. This tendency means that the more consistency you get by completing more exercises with the same partner, the more likely you are to pass the individual examination. However, the number of participants is very small, and therefore the result is not statistically reliable.

![Figure 1](image)

*Figure 1 Pass rate in relation to number of exercises completed with the same partner*

It has been stated earlier that the ARPA-course is preceded by a general radar course. A possible cause for not passing a practical ARPA examination could be that the student lacks general knowledge about the radar or its operation. However, the students’ grades in that preceding course were checked and no such relationship could be found. Six of the students in this study had yet not completed either the theoretical or the practical part of the radar course, but these six students were all found to pass the ARPA examination.

Table 2 shows the in-depth result of the practical examination for the seven students who did not pass it. The table is an excerpt and does not show all parts of the examination. However, to pass the examination all parts had to be
completed satisfactorily. As stated in the background, the practical examination consists of two main parts: adjusting the radar settings and using the ARPA in an anti-collision situation. A closer look at the result reviles that the students were all weak at the latter part; using and interpreting the ARPA functionality. This is in line with the above mentioned fact that all of these seven students had passed the previous radar course. They knew the basic radar functions, but were not secure enough to rely on the ARPA in a lifelike situation.

| Table 2  In-depth result for the students who did not pass the examination |
|*********************************|
| Part of examination          | n=pass | n=fail |
| Setting up the radar         | 7      | 0      |
| Adjusting vector length      | 7      | 0      |
| Adjusting CPA/TCPA limits    | 7      | 0      |
| Adjusting guard zone         | 7      | 0      |
| Interpreting afterglow       | 2      | 5      |
| Interpreting target data from vectors | 2 | 5 |
| Performing trial manoeuvre   | 4      | 3      |
| Interpreting traffic situation correctly | 0 | 7 |

6 DISCUSSION

This study has been limited in its extent, as it has only looked at a small group of students at one single occasion. Therefore, the reliability is limited and the result should only be used as an indication of how future studies could be performed.

Nevertheless, the results still lead to some interesting insights, e.g. how easy it is to maintain an old practice without reflecting about why it is done. At KMA it has for a long time been the general agreement among instructors that students should change simulator partner for each new exercise, to improve learning. Yet, the reason for this has been very blurry, and this study indicates that the learning outcome is not dependent on whether the pairs are changed or not. The simulator at KMA is equipped with two radars on each bridge, which are made by different manufacturers, and the students are required to master both of these after the radar and ARPA courses. There has been a worry that students might favor one of these radars over the other, and if students do every exercise with the same peer, they might easily stick to the radar they favor and be reluctant to practice on both. Hence, this complacency could lead to a weaker learning outcome. However, this study indicates that this would not likely be the case. As mentioned in the result section above, the students who failed the individual assessment did so for misinterpreting the presented ARPA information, and not on practical hands-on functionality. So it appears as they were well acquainted with both radars.

It could be argued that two similar courses like the radar and ARPA courses should be separated by some time, which would allow the student to reflect about the acquired knowledge before embarking on the second course. Such a setting has been used at KMA before, and even though there was no analyzed learning outcome at that time similar to this study, the facts remain; the students who failed the ARPA course this time did so merely on ARPA interpretation and not on radar functionality. Therefore, there is no evidence that a separating time period after the first radar course would have changed the outcome.

After establishing that rotating or fixed bridge teams make no apparent difference, the next concern is whether the pairs are to be formed by the students themselves, or by the instructor. As explained in a previous chapter, many studies show that instructor-formed teams generally perform better with regard to teamwork, but self-selected teams have fewer slackers as a result of academic alignment. It is likely that the way teams are formed is more important the longer an assignment is going to last. When a group of students are to work together on a project for a full semester, teamwork is an essential part, but for brief in-class assignments less structure and formality is needed for the exercise to be effective [1]. Therefore, one could argue that for the situation with a 90-minute simulator exercise it would be beneficial to let the students decide their own pairs. This way those students wanting a safe environment built on trust could choose the same partner for several exercises, and those wanting a diverse learning environment could strive at choosing a new partner at regular intervals. That way, each student’s individual learning style could be met.
7 CONCLUSION

Teamwork is an important part of the requirements for a skillful deck officer. However, during the ARPA course the students are still learning practical skills at a relatively basic level, and therefore that course is not the ideal time to practice teamwork; the focus is, and has to be, on learning the fundamentals of ARPA. If this is done through teamwork in pairs, that is fine, but teamwork should not be the goal itself. There are several later courses in the Master Mariner program where teamwork plays a more essential part.

This study has shown that in this specific situation, the way the pairs are constituted does not have any obvious influence on the individual learning outcome for the students. On the other hand, the reader has to keep in mind that the extent of the study has been limited. For further research, it would be suggested to repeat this study at a larger scale, and especially over a larger period of time to see whether the result would remain the same. Another interesting approach to this could be to have students complete a questionnaire about their learning preferences as well as their previous knowledge about radar and ARPA, and from that information have the instructor form either academically aligned or heterogeneous mixed ability pairs.

8 REFERENCES


9 AUTHOR’S BIOGRAPHY

Magnus Boström is a Master Mariner with experience from both the merchant fleet and the role of deck officer, as well as from being a master and instructor in the Amphibious Corps of the Royal Swedish Navy. Since 2009 he is a lecturer at Kalmar Maritime Academy at the Linnaeus University, Sweden. Apart from teaching at the Master Mariner’s Program, he also plans and holds courses in icebreaking and ice management. Currently, Boström is also executing a study mapping the language situation regarding communication between icebreakers and merchant vessels in the Baltic Sea, as well as representing KMA in an EU-project aiming at increasing the accessibility of ice charts and ice information in the European Arctic.

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