THE EFFECT OF SHIPBOARD MARINE SIMULATION ON STUDENT SUCCESS IN RADAR COURSES

BROWNE D. STEVEN

California Maritime Academy, USA

ABSTRACT

Historically, a large percentage of maritime cadets, as many as 25% in some years, have failed the Radar/ARPA class (DL-325) at California Maritime Academy (CMA). This high failure rate has resulted in delayed progress towards graduation and the requirement for additional instructor and classroom resources necessary to teach the same students twice. In May and June of 2012, aboard CMA's training ship, *Golden Bear*, first-year cadets participated in 30 hours of intensive radar training utilizing the ship's new Navigation Laboratory (NavLab). The NavLab contains a part-task integrated bridge electronic systems trainer (IBEST). The NavLab provides the capacity to train up to 20 students simultaneously on simulated radar and automatic radar plotting aids (ARPA) units. In the Fall semester of 2012, every student passed the Radar/ARPA course. This positive result could be attributed to the radar training the cadets received utilizing the simulation system onboard the *Golden Bear* and illustrates the benefits of incorporating simulation technology into Maritime Education and Training (MET) programs.

Keywords: *Radar Training, ARPA Training, Shipboard Marine Simulation, Maritime Education and Training.*

1. INTRODUCTION

In order to be licensed as Third Mate upon Oceans in the United States, a prospective mariner must complete a Radar-Observer course and an Automatic Radar-Plotting Aids (ARPA) course that have been approved by the United States Coast Guard [1]. This requirement parallels that of the Standards of Training, Certification and Watch keeping (STCW) Code for Officer in Charge of a Navigation Watch (OICNW) [2]. To meet these requirements, Marine Transportation cadets at the California Maritime Academy (CMA) in Vallejo, California, USA, take a combined Radar/ARPA course (DL 325) during their 3rd Class (sophomore) year [3]. Before the Fall semester of 2012, this course was the first exposure to those topics for most students. Historically, cadets have failed this class at a very high rate. In some years, more than 25% of registered students failed to complete the course requirements. As a result, failing cadets have to repeat the course the following semester or the next year, delaying their progress towards graduation. This high failure rate also results in increased requirements for instructor and facility resources to serve repeating students.

During the summer (May and June) of 2012, 3rd class Marine Transportation cadets participated in five days of radar and ARPA training using simulation equipment aboard CMA's training ship, *Golden Bear*. This was the first time this training was offered at the Academy and the first exposure that this group of cadets had to the subjects. During the following academic term (September to December), approximately half of the cadets (n=44) enrolled in the Radar/ARPA course conducted at the CMA campus in Vallejo, California. This paper will examine the effect of the radar and ARPA training conducted on the *Golden Bear* on student success rate in the subsequent course taught on campus.

2. SHIPBOARD SIMULATION ON TRAINING SHIP *GOLDEN BEAR*

As a course prerequisite to Radar/ARPA (DL 325), Marine Transportation (deck) cadets must complete Sea Training (CRU 100), a 2-month training voyage onboard CMA's training ship, *Golden Bear* (TSGB) [3]. Typically, cadets take CRU 100 during the summer prior to their 3rd class year at the Academy. In recent years, student enrollments at the California Maritime Academy have rapidly increased; this increase strained the resources of the *Golden Bear* and limited training opportunities. In 2005, for example, 38 cadets enrolled in CRU 100. They were placed in training groups of 12 or 13 students that rotated through three duty assignments: bridge watchkeeping, on-deck maintenance and practical seamanship training. Over the course of the 2-month voyage, each cadet stood approximately 19 4-hour watches on the bridge. Since 2005, the number of cadets enrolled in CRU 100 steadily increased, reaching 78 in 2012, an increase of 105.3% in 7 years. (The number of enrolled students is projected to increase to 85 in the summer of 2013.) Due to the increased enrollment, the number of training groups was increased from three to five to include classroom-based training and simulation training, and the average number of bridge watches per cadet dropped from 19 in 2005 to 9 in 2012. (See Figure 1).

In order to increase both the quantity and quality of training offered to the increasing number of cadets on the training ship, California Maritime Academy constructed a multi-million dollar Navigation Laboratory (NavLab) onboard the *Golden Bear* [4]. The NavLab on the ship contains a full-mission bridge simulator and a part-task integrated bridge electronic systems trainer (IBEST), (See Figure 2). The full-mission bridge (FMB) simulator, in the forward compartment of the NavLab

consists of an Integrated Navigation System and three display monitors (See Figures 3 and 4).

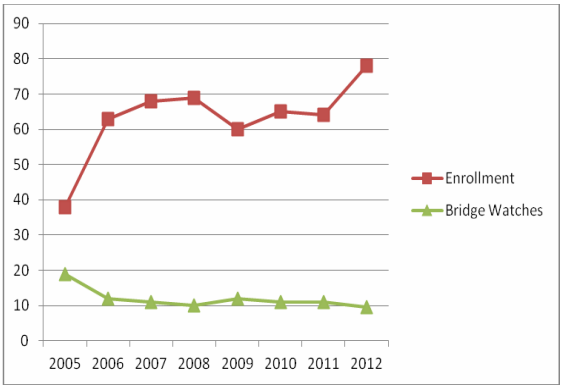

Figure 1 Enrollment and Bridge Watches (2005-2012)

The IBEST, in the after compartment of the NavLab, consists of 10 simulation stations that can be used to train up to 20 students on radar, automatic radar plotting aids (ARPA), electronic display and information systems (ECDIS), ship handling and navigation (See Figures 5 and 6). The primary purpose of the NavLab is to provide 1st class (senior) cadets opportunities to gain additional watch keeping experience in the FMB while on the training voyage. It also is used to introduce 3rd class cadets, enrolled in CRU 100, to the use of radar, ARPA and ECDIS equipment in the IBEST.

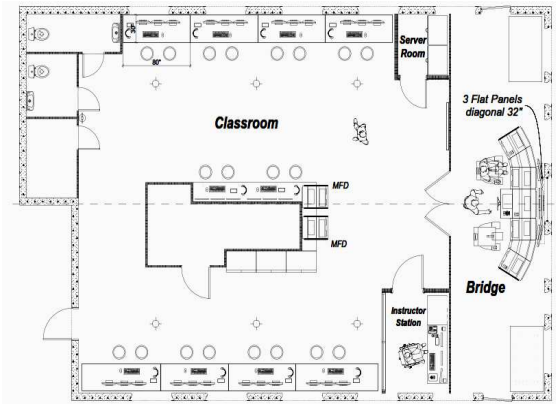

Figure 2 NavLab Layout

Figure 3 Full Mission Bridge (FMB)

Figure 4 Cadets training on the FMB

Figure 5 IBEST Student Station

Figure 6 Cadets using the IBEST

The NavLab was completed in 2011 and fully utilized for training during the *Golden Bear*'s training voyage of May and June, 2012. During the voyage, the 78 cadets enrolled in CRU 100 received five days (approximately 30 hours) of radar and ARPA training in the IBEST. During that period, 2½ training days (approximately 15 hours) were utilized for the teaching and learning of radar plotting techniques for collision avoidance. The remaining 2½ days (again, approximately 15 hours) were used for training in radar navigation and the use of ARPA in collision avoidance.

This was the cadets' first formal exposure to these topics in their curriculum. In the Fall semester of 2012, 44 of the students that had received the shipboard training enrolled in the Radar/ARPA course (DL 325) on the CMA campus.

3. STUDENT FAILURE RATE IN RADAR/ARPA COURSE (DL 325), 2003 to 2011

The Radar/ARPA course (DL 325) at CMA consists of a lecture portion and a lab portion. Each week, for 14 weeks, enrolled cadets attend two 1-hour lectures and two 2-hour labs, a total of 84 instructional hours each semester. Radar and ARPA theory is taught during the lecture periods, while the lab periods are utilized for hands-on training and assessment of radar plotting techniques for collision avoidance, radar navigation skills and the use of ARPA. The lecture is conducted in a lecture hall and each section of the course typically is limited to 24 students due the room capacity. The lab is conducted in the Radar/ECDIS Lab in the Simulation Center on campus which is fitted with 8 radar/ARPA simulation stations and each section is limited to 16 students. Students are scheduled to take the course either in the Fall or Spring semester of their 3rd class years at the Academy, depending on the first letter of their last names.

The Radar/ARPA course is graded on a Credit/No Credit basis. In order to receive credit, a cadet must achieve passing scores on: a radar plotting test in week 5 (90% or better to pass), a radar skills assessment in week 7 (100% to pass), a written exam on radar theory in week 9 (70% or better), a written exam on ARPA theory in week 14 (70% or better), and an ARPA skills assessment in week 14 (100%). If a student fails to achieve a passing score on any of the assessments, a grade of No Credit is issued and the student is dropped from the course at the time of the failure.

3. Historical Success Rate

From the Fall of 2003 to the Fall of 2011, cadets failed DL 325 at a high rate. (Although the course is offered in both the Fall and Spring semesters, only the data from the Fall semester is examined in this paper. This is deemed to be appropriate because course data for the Spring of 2013 is not yet available.) The failure rate has varied from a low of 6.1% to a high of 25.5%. During the time period, the overall failure rate was 16.4%. (See Table 1)

Table 1. DL 325 failure rate by year

Semester	Year	Enrolled	Credit	No Credit	% No Credit
Fall	2003	46	38	8	17.4%
Fall	2004	44	33	11	25.0%
Fall	2005	32	28	4	12.5%
Fall	2006	43	37	6	14.0%
Fall	2007	36	30	6	16.7%
Fall	2008	51	38	13	25.5%
Fall	2009	49	46	3	6.1%
Fall	2010	53	43	10	18.9%
Fall	2011	54	48	6	11.1%
Total:		408	341	67	16.4%

Seven instructors taught DL 325 sections in the years 2003 to 2011. Instructors were assigned to teach DL 325 based on the needs of the Academy and the availability of the instructor. Some instructors taught DL 325 as many as 5 semesters in the time period (e.g. Instructor #1), while other instructors taught the course once (e.g. Instructor #6.) Table 2 shows the student failure rate by instructor (with names removed.) Over the course of the decade, two instructors, #1 and #3, failed 20% or more of the students enrolled in their classes. The causes of the variance of the failure rate by instructor were not explored.

Table 2. DL 325 failure rate by instructor

Instructor	Enrolled	Credit	No Credit	% NC
#1	113	89	24	21.2%
#2	94	83	11	11.7%
#3	90	72	18	20.0%
#4	41	36	5	12.2%
#5	39	33	6	15.4%
#6	17	16	1	5.9%
#7	14	12	2	14.3%
Total:	408	341	67	16.4%

3.2 Repercussion of High Failure Rate

Radar/ARPA (DL 325) is a prerequisite course for 10 other courses in the Marine Transportation curriculum [3]. Accordingly, students that fail DL 325 are stalled in their progress towards graduation and must retake DL 325. Retaking the course in a subsequent semester increases the academic burden on the student due to the additional course load that semester.

The high failure rate has an impact on the Academy as well. Each semester a significant portion of the students enrolled in DL 325 are attempting the course for the 2nd or 3rd time. Because of the small number of students allowed per lecture (24) and lab (16), the Academy often must add additional sections of the course to serve the repeating students. The addition of course sections requires classroom space and instructors. In the past 10 years, 7 additional course sections have been added to the schedule to serve repeating students, necessitating the hiring of the equivalent of one full-time instructor.

4. STUDENT SUCCESS RATE, FALL 2012

4.1 Results

As discussed earlier, 78 3rd class cadets participating on the training voyage of the *Golden Bear* in the summer of 2012 received radar and ARPA training in the new NavLab facility. This was the first year cadets received such training on the ship. In September of 2012, 44 of those cadets enrolled in Radar/ARPA (DL 325). Instructor #1 was assigned to teach 27 of the cadets, while Instructor #3 taught the remaining 17 students. As indicated by Table 2, these are the instructors with the highest failure rate in the past 10 years. At the conclusion of the course taught in the Fall of 2012, every student passed the course. This was the

only time in the 10 years examined by this study that the failure rate was 0%.

Upon the completion of DL 325, Instructors #1 and #3 were interviewed by the author. They reported that the course was conducted using the same academic standards as in previous years. In their opinions, every cadet passed the course because they were better prepared due to the training received aboard the *Golden Bear*.

4.2 Student Survey

At the end of the course, students were asked to complete a brief survey regarding the training conducted aboard the ship and the Radar/ARPA course conducted on campus. The survey consisted of six questions:

1. The Radar/ARPA training I received on cruise (CRU 100) was beneficial.
2. The Radar/ARPA training on cruise helped my performance in the Radar/ARPA class on campus.
3. I recommend that the Radar/ARPA training on cruise continue to be offered on CRU 100.
4. I recommend that the Radar/ARPA training on cruise remain the current length (5 days).
5. I recommend that the Radar/ARPA training on cruise be shortened (less than 5 days).
6. I recommend that the Radar/ARPA training on cruise be lengthened (more than 5 days).

The survey utilized a Likert-type scale in which 5 meant "strongly agree", 4 meant "agree", 3 meant "neutral", 2 meant "disagree" and 1 meant "strongly disagree". Forty (40) surveys were completed and returned.

On question 1, the mean was 4.78 and the median was 5. Thirty-nine cadets either strongly agreed (n=33) or agreed (n=6) while only one disagreed with the statement. Similar results were returned for question 3, which returned a mean of 4.93 and a median of 5, with every student either strongly agreeing (n=37) or agreeing (n=3). These results clearly indicate that the students highly valued the training they received and suggest that it be continued to be offered in the future.

Question 2 returned similar results: an average of 4.6 and a mean of 5, with 26 participants indicating that they strongly agree, 12 agreeing and 2 neutral. From these results, it is apparent that the cadets view the training conducted on the *Golden Bear* as contributing to their success in the course.

Survey questions 4, 5 and 6 returned mixed results. 27 out of 40 respondents (67.5%) agreed or strongly agreed that the training should continue to be 5 days in length but 21 participants (52.5%) also agreed that the training should be lengthened. These are contradictory results, but it is plain that most students agree that the training should be 5 days or longer in length. This is supported by the responses to question 5, in which 35 students (87.5%) disagreed or strongly disagreed that the training should be shortened.

4.3 Limitations

The student success rate in the Radar/ARPA course in the Fall of 2012 was unprecedented. For the first time in the 10 years examined in this study, every student passed the course. The students in the course attribute their success to the training received aboard the *Golden Bear*. The course instructors agree. Due to the unavailability of other data, however, it would be inappropriate for the author of this study to claim that the training was the causative factor in the students' success. Other data, if available, might reveal other causes. For example, although the grade point average (GPA) and math proficiency scores were obtained for the current students, that data was not accessible for those that took the course in previous years. Perhaps that data would reveal that the cohort of cadets in the Fall of 2012 are smarter or academically better prepared than their predecessors. If so, that would certainly have contributed to their success in the course.

5. CONCLUSIONS

The Navigation Labratory onboard the *Golden Bear* was created to solve a specific problem: the reduction in the quality and quantity of OICNW training offered to California Maritime Academy cadets due to rapidly expanding enrollments. It contributed to that goal by allowing CMA faculty to provide an additional training rotation in a world-class ship-based simulation center. This has reduced the number of cadets on the navigation bridge at any one time, ensuring that each cadet on the bridge is not merely an observer but a true watch stander. In addition, it has also provided cadets the opportunity to stand several quality watches in a simulated bridge environment.

The faculty and cadets at CMA also view the NavLab as having contributed to student success in academic courses through early exposure to radar and ARPA concepts. This sucess has the potential to improve graduation rates and time to program completion, and to save the Academy money by removing the necessity of teaching the same students twice.

Although the construction and equiping of the NavLab was very expensive, California Maritime Academy considers it money well spent. In the summer of 2013, the *Golden Bear* will sail again and the cadets onboard will again receive radar and ARPA training, but this year the training will be lengthed to 10 days.

6. REFERENCES

[1] United States Code of Federal Regulations, 46 CFR Part 11, www.ecfr.gov.

[2] International Maritime Organization, *Standards of Training, Certification and Watchkeeping, Table A/II-1*, 2011.

[3] California Maritime Academy, *Undergraduate Catalog 2012-2013*, Vallejo, CA, USA.

[4] LEYDA, P., BROWNE, S., COLEMAN, D., *Combining Advanced Marine Simulation with Real Mode Capacity to Enhance OICNW Shipboard Training*, Proceedings of MARSIM 2012, International Marine Simulator Forum, 2012.