# FORWARD INTEGRATION: A STUDY IN ALTERNATIVE MARITIME EDUCATION TECHNIQUES

***Peter J. Hayes,***
Capt., JD, MA, BS
Associate Professor, Department of Marine Transportation
California Maritime Academy
E-mail: phayes@csum.edu

***Abstract.*** *Many institutions have abandoned broad-spectrum integration of essential nautical training knowledge and skill sets in favor of modular education. Those topical areas in follow-on courses where instructors note deficiencies are remediated squandering valuable instruction time. A study conducted aboard the Training Ship Golden Bear (during its 2008 annual training cruise) followed by post-requisite courses provided data which strongly suggests that early introduction of a wide-range of nautical skill-sets introduced informally (as to grading), and reinforced, in follow-on courses effects better long-term student retentiveness of curricular fundamentals.*

Approximately eighty students were inculcated in a broad variety of basic navigation and radar plotting skill sets external to traditional grading schemes. Opportunity to utilize these skills during the training cruise motivated student participation. Student progress was monitored through the first exams (approximately one quarter of the semester) in the post-requisite terrestrial navigation and RADAR/ARPA courses. Results were correlated against results of the control group (the previous year's students).

Survey data results strongly support the conclusion that student interest is elevated and maintained by learning professional skills in an alternative environment; additionally, objective data indicates that students retain these skills at, or above, the competency level and are able to apply them without remediation.

## 1. INTRODUCTION

Aristotle said, "That which we must learn to do, we learn by doing." Planned repetitive instruction in experiential-learning environments is a demonstrated and accepted tenant of learning. But maritime educators are caught in the crux between remediating students in fundamental skill sets and pressing forward to introduce the advanced knowledge materials in their courses due to a lack of broad-based re-enforcement of foundational skills. Room in our already over-full training curriculums must also be made for the newer technologies without sacrificing core competencies. Increasing public and industry scrutiny of incidents in the profession necessitate personnel assessment at higher competency levels. Additionally, maritime educators aspire to produce the best-trained entry-level mariners from their universities.

Over the past fifteen years, many maritime universities have segmented maritime skill sets in order to more easily account for those which fall under the mandate of the International Maritime Organization's (IMO) convention on the Standards of Training, Certification, and Watchkeeping of 1995 (STCW 95). The Convention's guidelines set the minimum standards for the assessment of demonstrated and knowledge-base competencies for the documenting and licensing of deck and engine mariners whose duties include Bridge and Engine Room watchstanding, respectively. The trend towards this segmentation has been further exaggerated by the periodical imposition of post-STCW 95 technical certifications levied upon the already overburdened maritime curriculums.

The STCW 95 assessment standards mandate a solitary assessment event of demonstrated competencies (in some instances, after an approved training period). The convention also requires that training facilities identify in which course and what manner the assessment will occur. The door, then, has been wide open to formally teach all skill sets solely in these "identified" courses thus reducing more broad-based re-enforcement and creating openings in the curriculum for new required materials or for a cumulative

reduction of unit load. The result has been a reduction of deep-seated foundational nautical skill sets in maritime students. Many instructors are forced to expend a significant portion of the post-requisite courses remediating students in these skills. The impact is not measured as only a delay in coursework but as actual negatively aggregated learning: portions of the course work (typically, advanced materials from the terminus of the class) are never introduced.

The detrimental results have a ripple effect as much of the follow-on curriculum has to compensate for the student lack of curricular fundamentals. The students themselves are not incognizant of the situation. If the instructor remediates, the students quickly realize the aggregate loss of topical material; vice-versa, if the instructor presses on, forcing new materials upon the unprepared student, learning is frustrated and can create widespread apathy and disillusionment with the course of study.

The purpose of this study was to examine the effects on student retention of several nautical skill-sets assessed informally (as to grading), and reinforced, in follow-on courses; in particular, whether this particular methodology of experiential learning with non-formal assessment parameters has any significant impact on student learning from objective and subjective perspectives.

## BACKGROUND

Non-formal learning in education has been an underlying foundation system for centuries. In maritime education at the implementation of STCW, this process changed when efforts shifted to accounting for each and every competency into identified single courses; the universities adopted the rubric scheme of tracking competencies and, in the redesigning of curriculum, many eradicated broader spectrum and less-structured training. The rubric-driven system determined that a single assignment of skill-set learning and assessment met the established international criteria and required no other introduction or re-enforcement. Many educators question the validity of such a system and believe the quality of such teaching pedagogy is suspect.

Re-introducing non-formal experiential training back into the curriculum entails creativity and flexibility. An opportunity is presented to build bridges between different methods of teaching and learning in traditional maritime university systems. This opportunity does not involve a return to past systems but partnerships between and among alternative education techniques within a formalized framework to create new curriculum. Crucial to this change is the reorientation of formal vocational education to student-outcome-based objectives. Bjømåvold [1]. The validity and reliability of non-formal experiential training no longer competes with the grade-based formal education or the competency rubric.

The non-formal experiential approach to learning is advantageous to students as an alternative, or additional, method to traditional implicit education. In the absence of pressure to demonstrate learning under the graduated formal process, students tend to perform at higher levels, instituting self-induced performance stresses. Some of these stresses are competitive by nature; others are induced by real engagement – the desire to learn. Inspired to work at their own pace, the non-formal experiential learner typically advances at an advanced pace through topic materials.

Additionally, non-formal training systems mesh into situations where traditional formal education systems are challenged by excess student numbers; in particular, where this training is involved at the pre-requisite to competency assessment level. The flexibility of non-formal training models encourages recurrent learning. Guggenheim [2]. As a result, students engaged in experiential learning outside the formal grade demands retain these skill sets with a net effect of reducing both remediation burdens and failure rates.

The non-formal methodology incorporates experiential competencies within validation principles. No progressive curriculum system exists without the express obligation of measuring learning outcomes. edefop [3]. However, in a well designed non-formal learning program, a number of competencies may be

assessed discretely; whereby students are engaged at the point where they have no awareness of assessment performance.

## METHODOLOGY

The study was conducted aboard the university's training ship, the United States Training Ship Golden Bear (TSGB), during the two-month training period in the late spring of 2008. Deck students are required to spend two training periods aboard the TSGB; the first cruise, after their first year of academics, is CRU 100, the second cruise, after their third year of academics, is CRU 300. Deck students are also required to successfully complete a third at-sea training period as a cadet aboard a commercial vessel; students complete this training after their second year of academics. The study focused on students on their first training cruise (CRU 100). As the study was conducted as an experiment in learning, all third-class cadets were required to participate. The study followed the progress of those students who then completed the post-requisite courses in terrestrial navigation (NAU 102 Navigation I) and RADAR (DL 325 RADAR/ARPA) as far as the first graded assessment instruments.

CRU 100 includes four training sections: Bridge WatchStanding, Vessel Maintenance, Practical Training, and Professional Training. Each section is conducted over two five-day training rotations. The experiment was conducted during the Professional Training sections. Basic introductory navigational skills were introduced over six days for a total of twenty-two hours; introductory radar plotting skills were introduced during the morning afternoon periods (three hours each) for two days. CRU 100 is unique from the post-requisites identified previously as it is graded as a Credit/No-Credit course rather than a graded (A, B, C, etc.) course. The multiple sections allow for reduced class sizes (approximately sixteen students per section) – essential for necessary one-on-one skill set introduction in this area. Student participation and successful completion of assigned problem-based learning utilizing the introductory skills were the only formal criteria for the experiment.

The navigation experiment and the radar experiment were conducted independently; due to scheduling requirements, portions of the two experiments were conducted on the same day. The navigation experiment consisted of traditional 45 to 60 minute lectures followed by 60 minute problem-based exercises in chart familiarization, introduction to plotting, near-coastal sailing, fundamentals of celestial navigation, and compass error and gyro error determination. The RADAR experiment included basic radar plotting techniques utilizing paper plots and vector analysis techniques following traditional collision-avoidance rules as well as the Seagull™ computer-based-training "RADAR Observation and Plotting". The Seagull™ training required completion prior to the commencement of the Radar coursework.

The navigation problems utilized the United States Coast Guard approved training charts for license which cover Block Island Sound, Long Island Sound, and Chesapeake Bay Entrance. The chart problems were sequential, requiring correct plotting techniques in order to progress to the question. The gyro error problems made use of the publication method for azimuths using the *Nautical Almanac* and *Pub. 229 Sight Reduction Tables for Marine Navigation* and students were required to obtain real-time sights of the Sun using a bearing circle and one of the TSGB's Bridge-wing repeaters.

Participant perception surveys were administered at the end of the second training rotation for each group; students indicated the extent, on a five-point Likert scale, to which they agreed or disagreed with each survey statement. Individual subject matter for each experiment was surveyed through identified statements; several of the survey statements were pointed towards the combined components of the experiments. Additionally, the CRU 300 students were administered similar surveys to determine their perceptions of the underclass training. The topics covered in the navigation experiment were identified in the first exam of the post-requisite course, NAU 102. Only participant grades were recovered as several NAU 102 students were either repeating the course or were not otherwise subjected to the experiment.

The control group for the navigation course was the previous year's students (2007). The results of sixty-five participants were tracked through this process. The experiment's RADAR materials aligned with the first DL 325 plotting assessment. Only twenty-three of the participants' data was available from the post-requisite RADAR course (two sections). The control group for this portion of the experiment was drawn from two sections from the previous year (2007) who were also members of the first control group.

The survey data, navigation exam results, and RADAR assessments were amassed and entered into Microsoft Office Excel 2003. The data was then imported into Statistic Package for Social Sciences (SPSS) version 16.0 software for analysis. The Independent Samples t-test was conducted on the navigation and RADAR data to whether determine statistical significance of the experiment existed (see Table 1). The survey data were analyzed for inaccuracies and inconsistencies and were found to be statistically acceptable.

## FINDINGS

Participants in the experiment earned 5.652 grade-points more than the control group on the NAU 102 exam. The standard deviation for the DL 325 portion of the experiment indicated those results statistically unreliable; however, the mean of the participant group was 1.878 grade points higher than the control group. Participant and 1/C surveys indicated that students valued the non-formal experiential training for immediate use (aboard the TSGB) and for post-requisite coursework.

The data indicates that student retention of the skill-sets was higher using the non-formal learning approach. Causative factors may include non-tracking of participants and control group students who were repeating the NAU 102 and DL 325 courses; if any of either faction existed, they would have already had more exposure to the skill-sets measured than first-time students; additionally, the data was collected over a relatively short period of time and the sample for DL 325 included only one-third of the expected available data.

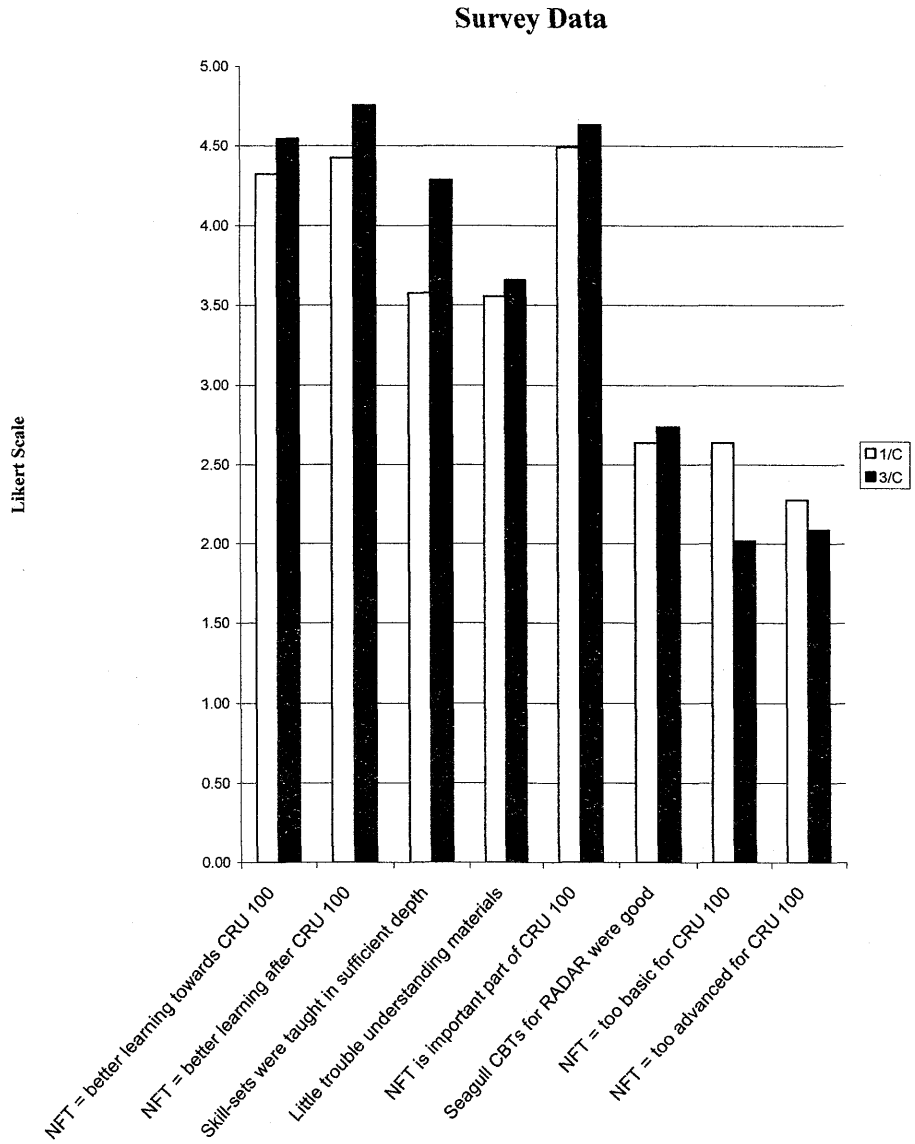
Table 1

**Statistical variances for post-requisite courses**

| | Cruise Year | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Nav I 1st Exam (12,5 % of final grade) | 2007 | 84 | 71.417 | 16.6771 | 1.8196 |
| | 2008 | 65 | 77.069 | 11.8058 | 1.4643 |
| Radar 1st Plotting Exam (90 % to pass) | 2007 | 25 | 81.600 | 19.9332 | 3.9866 |
| | 2008 | 23 | 83.478 | 18.9757 | 3.9567 |

All of the participants felt that the scope and depth of the training was optimal while the CRU 100 students advocated a more rigorous approach (see Table 2, "Skill-sets were taught in sufficient depth"). Interesting to note was the almost unanimously negative response to the computer-based-training component. Subjective comments solicited from both survey groups specified that the Seagull™ training was too advanced and better suited as a post-requisite-course re-enforcement learning device. The participant enthusiasm for learning the skill-sets was high and the post-requisite courses instructor noted the academic advantage participants enjoyed in the first weeks of the courses.

Table 2




## CONCLUSIONS

The study substantiates the concept of re-introducing non-formal training by integration with established formal training systems in maritime education. The argument is not an attempt to return to past structures. Instead, the maritime education community should bring forward those relevant and proven past training techniques and integrate them in existing curriculum. The data indicates that students engaged in this learning mode perform at increased levels in follow-on courses. While the data for the RADAR plotting skill-sets in the follow-on course was statistically sparse, the trend there, as well as the substantive data results in the navigational skill-sets experiment, largely underscore the benefits of non-formal training. Further, the participant and 1/C survey data indicates that the students recognize the value of the opportunities presented by this training.

Two of the highest perceived benefits of the survey data draw attention to the bearing of the non-formal experiential program: the immediate application of skill-sets. The survey statements invited the participants and 1/C to indicate the level of relevance of the training aboard the ship. The responses indicate the usefulness of the learning throughout the contemporaneous training period. The obvious

integration focuses on Bridge Watchstanding; while the participants' responsibilities were directed towards basic duties, they now understood the 1/C concurrent activities' effects on the ship within the micro-environment of the voyage plan. The return-on-investment of attitude and aptitude using this methodology of training rises dramatically when incorporated into the formal education system.

Future studies in this area may tend to create a more comprehensive measurement scheme. While the RADAR plotting instruments effectively measured the skill-sets in that portion of the experiment, the navigation instrument included materials beyond the scope of the experiment. The expectation is that a more concise metric would reflect an even greater statistical result in favor of non-formal training. Finally, no instrument was utilized in the post-requisite courses that measured participant engagement. The experiment itself was not designed to extensively measure engagement but the resultant qualitative survey data strongly supports the need for further research in this area.

## ACKNOWLEDGEMENTS

The author would like to thank Captain Samuel R. Pecota for his assistance in conducting the experiment and editing the process, Captain Mark Hensley for providing post-requisite course data and performance observations, and Ms. Mindy Drake for her research assistance.

## References

[1] Bjømåvold, Jens, "Identification, assessment and recognition of non-formal learning: European tendencies," *AGORA V: Identification, Evaluation, and Recognition of Non-Formal Learning* Proceedings, March 15 – 16, 1999, p. 13.

[2] Guggenheim, Eric Fries, "Mobility and Social Cohesion," *AGORA V: Identification, Evaluation, and Recognition of Non-Formal Learning* Proceedings, March 15 – 16, 1999, p. 53.

[3] Cedefop, "Identification, validation and accreditation of prior and informal learning: United Kingdom report", Scottish Qualifications Authority – SQA. Office for Official Publications of the European Communities, 1997, p. 11.