# Statistical Analysis on the Effective Pedagogical Methodology Onboard the Training Ship

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# 실습선의 효과적인 교육방법에 관한 통계적 분석

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## Abstract

This paper studies the effective method in the training delivery onboard the training ship 'Sae Nuri' All deck and engine cadets participated in the questionnaire surveys that aims to measure the shipboard training weakness and strengths. The study gathered the data and statistically analyze the responses which came up with the following observations: Most cadets prefer to board the merchant ship in their first phase of shipboard training; cadets mostly from the engine spent more than six months onboard merchant ships. Of the major topics taught onboard, both deck and engine cadets averagely rated them only as "Fairly Adequate" with Cargo work- handling and care rated as "Inadequate" However, Chi-square test used yields an independence on the relationship from each major navigation topic taught, while the engine responses showed that the major topics are related and dependent on each other. The study also found that cadets prefer the more active training, performing real deck works and experiencing actual engine maintenance than the passive lecture-based delivery. Cadets-respondents, likewise, chose the participation of Deck and Engine officers as their trainers in addition to ships' Professors. Some recommended that Bosun, Quartermasters and Oilers, likewise, be included in the teaching activities to learn the realistic way of doing ship works and gain basic seamanship skills during their training ship education.

Key words : Training ship, STCW '78 Ch.II-III, Shipboard training sequence, Shipboard training method, Onboard trainers

## Ⅰ. Introduction

The training ship 'Sae Nuri' conducted a questionnaire survey of the effectiveness of the current teaching-learning methodology onboard. All the current senior cadets onboard, navigation and engine, participated in the survey.

The study aims to measure the effectiveness and reliability of the current curriculum and training methodology of senior cadets, and find the strengths and weaknesses for improvement and further development. Its further goal is to ensure that the training of cadets meets the requirements of the IMO STCW '78 (as amended) and the standards of contemporary seamanship brought upon by new and developing technology, environmental

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concerns, and the global maritime transportation mind-set and behavior of the present generation of seafarers.

The respondents are senior cadets who had already done their first phase of shipboard training onboard various types of commercial vessels. There are 65 on each navigation and engineering senior cadets participated in the re-test survey which is used in Part II of the study.

## 1.1 Methodology of Research

The questionnaire is arranged in two parts: Part I has two questions about the last semester shipboard training - duration and where did they performed their previous training – onboard merchant ship or from training ships. Part II is composed of four questions about the current training onboard the training ship 'Sae Nuri'. To test the reliability of the questionnaire, the study carried out a "Test and Re-test" method of Part II only where it was given to the students twice because questions in Part II have more relevance with the aim of the study. There was a 3-week interval in the administration of the first test and the re-test. The result of the Tests showed consistency on the rankings to all the questions asked, hence, ranking correlation calculations intended (Spearman rho) is deemed un-necessary.

Although, the participants are asked to be objective, there seem to be a bias towards their last merchant ship experience (see Section 3.1 and the compilation of their remarks in Section 4.1). To prove reliability and objectivity, a follow-up survey should carried out with those cadets who had their training ship experience in the first phase.

## Ⅱ. Part I. First Phase of Shipboard

## Training Onboard Merchant Ship

Part I of the questionnaire is about the students last shipboard experience from the previous semester. They were asked "what type of ship" were their past training: from merchant ship or one of the university training ships, usually from T/S 'Sae Yudal'.
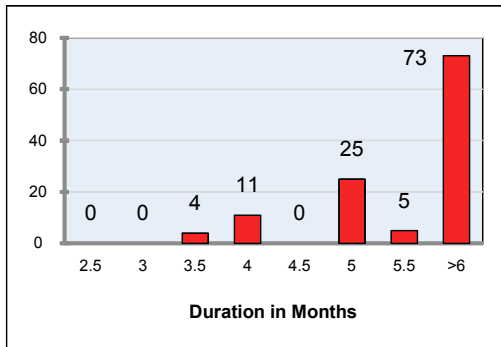
The university has two-phase shipboard training program for cadets. The first phase is done on the second semester of the current school year where about half of the junior cadets shall embark on merchant ships and the other half onboard the training ships. On the first semester of the preceding school year, the cadets senior year, it is reversed. Those from the merchant ships will continue their STCW required one-year shipboard training aboard the training ships and their contemporaries shall board the merchant ships. This survey was carried out at the first semester, hence, the respondents had already experienced the first phase, the merchant sea-life and training.

<Table 1> shows that majority, 85%, had merchant ship experience while only 13% came from training ship and 3% (3 cadets) never embarked at all.

<Table 1> Type of ship of previous semester

|  | Deck | Engine | Total | % |
|---|---|---|---|---|
| Merchant ship | 49 | 53 | 102 | 87% |
| MMU Training ship | 7 | 8 | 15 | 13% |
| Total | 56 | 61 | 117 |  |

Question no. 2 asks about the duration of cadets stay on merchant or training ships during the previous semester. This question was asked to gauge cadets period of stay onboard where they can objectively answer the succeeding questions.

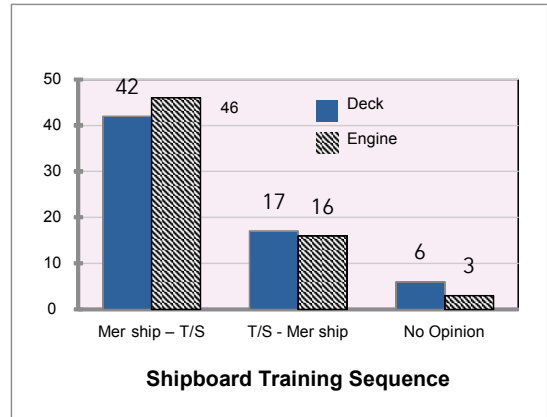[Fig. 1] Duration of previous semester shipboard training

[Fig. 1] graphs the duration of past experiences. Both deck and engine cadets almost equal in the more than 6-months sea-time (73/76 respectively), followed by 5-month sea-time. The study deemed this as sufficiently reliable for the cadets to make an objective assessment of the survey questions.

# Ⅲ. Part II. Second Phase of Shipboard Training Onboard T/S "Sae Nuri"

The succeeding four questions begin the assessment of the quality and effectiveness of training onboard the T/S 'Sae Nuri' These questions are included in the 'Re-Test' where it has a high reliability relationship and where more cadets (130) are surveyed because of the late-joiners' inclusion in the re-test survey.

## 3.1 Effective Shipboard Training Sequence

The third question deals with "Effective shipboard training sequence" The cadets are asked which sequence, based on their over-all shipboard experiences: merchant and training ships, is more effective.



[Fig. 2] Effective shipboard training sequence according to senior cadets onboard T/S 'Sae Nuri'

Most of the cadets, 68%, preferred the "first merchant ship then training ship" sequence. This is shared almost equally by navigation and engine cadets. The "training ship first" flow has only 25%, again, almost equal on both departments. "No Opinion" has 9 responses. (See above [Fig. 2])

3.2 Effectiveness of Subject-Matter Taught

This section deals with the effectiveness of the training curriculum and activities onboard the training ship. The question asked was: "In your opinion, rate the teaching methodology onboard the training ship of each subject-matter, on its effectiveness to prepare you as future merchant ship officer" Each department has different groups of subject matter based on the standards of STCW.

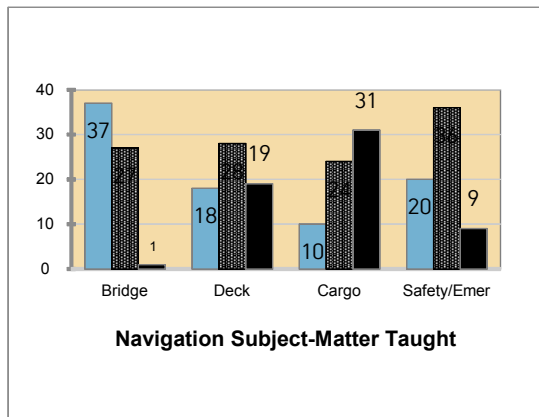3.2.1 Navigation (Deck) Department

STCW '78, as amended lists the competency requirements for the candidates to acquire the sufficient skills. Chapter II, Section A-II/1 "Mandatory minimum requirements for certification of officers in charge of a navigational watch on ships of 500 G/T or more" Tabulated list is shown in Table A-II/1 with the different 'Functions' at

operational level.

Based on these requirements, the navigation cadets were asked to rate the subjects-matter taught onboard according to the following weights: "Very Adequate", "Fairly Adequate", and "Inadequate" shown in <Table 2>. [Fig. 3] graphs the degree dispersion of effectiveness of the subject-matter taught in navigation.

<Table 2> Subjects taught to deck cadets with weighted ranks

| Navigation / Deck Subjects-Matter Taught | Very Adequate | Fairly Adequate | Inadequate |
|---|---|---|---|
| Bridge- Nav & Comm | 37 | 27 | 1 |
| Deck Opn & Works | 18 | 28 | 19 |
| Cargo – Lecture based | 10 | 24 | 31 |
| Safety & Emer Preparedness | 20 | 36 | 9 |
| Totals | 85 | 115 | 60 |



[Fig. 3] Effectiveness of Subject-Matter taught for navigation cadets

For this survey question, the study wants to establish whether there are significant relationships in the quality of training specifically among these four major subjects taught onboard. To answer this hypothesis, the responses gathered from this question are statistically analyzed using the Chi-square ($\chi^2$) test1 for significance of the major subjects taught onboard.

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

*Null Hypothesis.* There is no significant difference between subjects taught in Navigation cadets onboard the T/S 'Sae Nuri' The 4 major navigation subjects are independent from each other.

*Test Method.* Chi-square ($\chi^2$)

*Significance Level.* Let $\propto$ = 1%

*Sample distribution.* N = 260 with df = 6 [(C-1)(R-1)]

*Region of Rejection.* The null hypothesis is rejected if Chi-square ($\chi^2$) value is same or greater than the tabulated value at df 6 and 1% level of significance.

Where,

        O = observed frequency

        E = expected frequency

        N = number of samples

        C = columns

        R = rows

        df = degree of freedom

The topics were assigned the following: (A) Bridge Works (Navigation and Communication), (B) Deck Operations and Works (Deck maintenance, anchoring and mooring operations, seamanship and deck maintenance), (C) Cargo Work – Lecture based only (Cargo handling and care, and stability calculations), (D) Safety and Emergency Preparedness (Safe working practices and emergency drills). These subjects are patterned from the

requirements for competency of the STCW Ch. II and the Functions at Table A-II/1 of the same Code. The calculations phases are presented by <Table 3>, <Table 4> and <Table 5> below.

<Table 3> Navigation assigned topics and weighted ranks

| Weights | A | B | C | D | Total |
|---|---|---|---|---|---|
| Very Adequate | 37 | 18 | 10 | 20 | 85 |
| Fairly Adequate | 27 | 28 | 24 | 36 | 115 |
| Inadequate | 1 | 19 | 31 | 9 | 60 |
| Total | 65 | 65 | 65 | 65 | 260 |

<Table 4> Expected frequency calculations

| Very Adequate | Fairly Adequate | In-Adequate |
|---|---|---|
| 37 = 21.25 | 27 = 28.75 | 1 = 15.00 |
| 18 = 21.25 | 28 = 28.75 | 19 = 15.00 |
| 10 = 21.25 | 24 = 28.75 | 31 = 15.00 |
| 20 = 21.25 | 36 = 28.75 | 9 = 15.00 |

<Table 5> Calculation of Chi-square ($x^2$) value (Deck Data)

| | O | E | O-E | $(O-E)^2$ | $(O-E)^2/E$ |
|---|---|---|---|---|---|
| | 37 | 21.25 | 15.75 | 248.063 | 11.67 |
| | 18 | 21.25 | -3.25 | 10.563 | 0.50 |
| | 10 | 21.25 | -11.25 | 126.563 | 5.96 |
| | 20 | 21.25 | -1.25 | 1.563 | 0.07 |
| | 27 | 28.75 | -1.75 | 3.063 | 0.11 |
| | 28 | 28.75 | -0.75 | 0.563 | 0.02 |
| | 24 | 28.75 | -4.75 | 22.563 | 0.78 |
| | 36 | 28.75 | 7.25 | 52.563 | 1.83 |
| | 1 | 15.00 | -14.00 | 196.000 | 13.07 |
| | 19 | 15.00 | 4.00 | 16.000 | 1.07 |
| | 31 | 15.00 | 16.00 | 256.000 | 17.07 |
| | 9 | 15.00 | -6.00 | 36.000 | 2.40 |
| Total | 260 | 260 | 0 | | **54.54** |
| The tabulated value of Chi-Square ($\chi^2$) at df 6, $\propto$ 1% : | | | | | **16.81** |

The result shown in <Table 5> can be interpreted as that the computed chi-square ($\chi^2$) value of 54.54 is greater than the tabulated value

of 16.81 with the degree of freedom of 6 (df) at 1% level of probability. Therefore, it is significant. This means that the Null hypothesis is rejected and there are significant differences in the four major Navigation subjects taught onboard T/S 'Sae Nuri'The four major subjects taught are independent from each other.

3.2.2 Engine Department−Marine Engineer Cadets

STCW also has competency requirements for marine engineering cadets. Chapter III, Section A-III/1 and Table A-III/1 that tabulates the different 'Functions' required of an engineering candidate.



[Fig. 4] Engine subject-matter taught effectiveness

Similar to the navigation cadets survey result, the responses from the engine cadets are analyzed using the Chi-square ($\chi^2$) test for significance. It also follows the same process, differing only on the major subjects asked at the survey. The null hypothesis, test method, level of significance and region of rejection have the same parameters except on the "*Sample distribution*" where N = 257 with the same df of 6 [(C-1)(R-1)].

Weighted ranks similar to deck department are also assigned to each four major subjects taught to engine cadets. <Table 6> is shown below.

<Table 6> Engine department ranked weights of assigned topics

| Engine Department Subject-Matter Taught | Very Adequate | Fairly Adequate | In-Adequate |
|---|---|---|---|
| Engine Work (Watchkeeping) | 20 | 41 | 4 |
| Engine Operations: (Main/Aux, etc.) | 26 | 34 | 4 |
| Eng Maintenance (Main/Aux, etc.) | 27 | 35 | 2 |
| Safety & Emergency Preparedness | 28 | 35 | 1 |
| Total | 101 | 145 | 11 |

Codes were likewise assigned to the topics used in <Table 7>: (A) Engine works (watch-keeping at sea and in port) with 65 responses, (B) Engine Operations: (Main/Aux engines, Boilers, Ref Plant, Elect, etc.) 64 responses, (C) Engine Maintenance (Main/Aux engines, Pumps, Boilers, etc.) 64 responses, and (D) Safety & Emergency Preparedness, 64 responses.

<Table 7> Engine assigned topics and weighted ranks

| Weights | A | B | C | D | Total |
|---|---|---|---|---|---|
| Very Adequate | 20 | 26 | 27 | 28 | 101 |
| Fairly Adequate | 41 | 34 | 35 | 35 | 145 |
| Inadequate | 4 | 4 | 2 | 1 | 11 |
| Total | 65 | 64 | 64 | 64 | 257 |

<Table 8> Expected frequency calculations (Engine Data)

| Very Adequate | Fairly Adequate | In-Adequate |
|---|---|---|
| 20 = 25.54475 | 41 = 36.67315 | 4 = 2.7821 |
| 26 = 25.1518 | 34 = 36.1089 | 4 = 2.7393 |
| 27 = 25.1518 | 35 = 36.1089 | 2 = 2.7393 |
| 28 = 25.1518 | 35 = 36.1089 | 1 = 2.7393 |

<Table 9> Calculation of Chi-square ($x^2$) value (Engine Data)

| | O | E | O-E | $(O-E)^2$ | $(O-E)^2/E$ |
|---|---|---|---|---|---|
| | 20 | 25.5447 | -5.545 | 30.744 | 1.20 |
| | 26 | 25.1518 | 0.848 | 0.720 | 0.03 |
| | 27 | 25.1518 | 1.848 | 3.416 | 0.14 |
| | 28 | 25.1518 | 2.848 | 8.113 | 0.32 |
| | 41 | 36.6732 | 4.327 | 18.722 | 0.51 |
| | 34 | 36.1089 | -2.109 | 4.448 | 0.12 |
| | 35 | 36.1089 | -1.109 | 1.230 | 0.03 |
| | 35 | 36.1089 | -1.109 | 1.230 | 0.03 |
| | 4 | 2.7821 | 1.218 | 1.483 | 0.53 |
| | 4 | 2.7393 | 1.261 | 1.589 | 0.58 |
| | 2 | 2.7393 | -0.739 | 0.547 | 0.20 |
| | 1 | 2.7393 | -1.739 | 3.025 | 1.10 |
| **Total** | 257 | 257.000 | 0.000 | | **4.81** |
| The tabulated value of Chi-Square ($x^2$) at df 6, ∝1% : | | | | | **16.81** |

The effectiveness of the four major topics taught to engine cadets shown in the calculations of <Table 7>, <Table 8> and <Table 9> resulted with 4.81 chi-square ($\chi^2$) value. This value is much less than the tabulated value of 16.81 with the degree of freedom of 6 (df) at 1% level of probability. This means that the Null hypothesis patterned with the navigation thesis is accepted. There is no significant difference in the four major engineering subjects taught onboard T/S 'Sae Nuri' The four major subjects taught are dependent on each other. This can be proved by the [Fig. 4] graph showing the subjects-matter taught for engine cadets have no significant differences except the Safety and Emergency Preparedness where most cadets ranked it "Inadequate"

## 3.3 Effective Training Method

This question asks the cadets which, in their opinion and past shipboard experiences, is the most effective training method to prepare them as future

maritime professionals. The three choices offered are "Practical (Actual)", "Lecture-based" instructions and "Others" for those with different method in mind. Among the choices, the "Practical" method was overwhelmingly preferred by both deck and engine cadets as shown in <Table 10>.

To test the relationship of this item, the study used the Pearson Product-Moment Correlation Coefficient (rxy)3 to determine the degree of association between the deck and engine responses as shown by <Table 10> and subsequent calculation.

<Table 10> Calculation of relationship between Deck and Engine responses by Pearson Product-Moment Correlation Coefficient

|  | Freq | Deck X | Engine Y | X² | Y² | XY |
|---|---|---|---|---|---|---|
| Practical (Actual) | 1 | 49 | 45 | 2401 | 2025 | 2205 |
| Lecture - Based | 2 | 8 | 15 | 64 | 225 | 120 |
| Others | 3 | 2 | 3 | 4 | 9 | 6 |
| Total | 3 | **59** | **63** | 2469 | 2259 | 2331 |

$$r_{xy} = \frac{\sum XY - (\sum X)(\sum Y)}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}}$$

$$r_{xy} = \frac{3(2331) - (59)(63)}{\sqrt{[3(2469) - (59)^2][3(2259) - (63)^2]}}$$

$$r_{xy} = \frac{6993 - 3717}{\sqrt{[7404 - 3482][6777 - 3969]}}$$

$$r_{xy} = \frac{3276}{\sqrt{[3926][2808]}} = \frac{3276}{3320.3}$$

$$r_{xy} = 0.99$$

The 0.99 Pearson product-moment correlation coefficient (rxy) indicates of a very high relationship between the deck and engine responses.
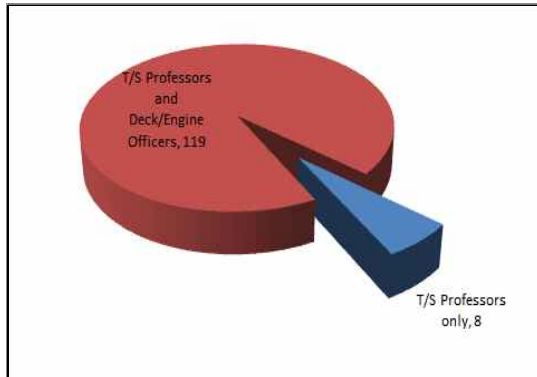
The respondents clearly demonstrate that practical approach to their training onboard is the best method in this phase of their education. It means that a high percentage of cadets from both departments prefer a more active approach in their training than the passive learning way through lecture-based delivery.

## 3.4 Effective "Skills" Trainers Onboard

The last question in the survey deals with "who are the effective trainers" onboard. As shown in <Table 11> and the graph of [Fig. 5], the cadets almost unanimously (94%) chose the training ships' professors and each respective departments' officers as their best trainers onboard rather than the training be delivered solely by ship's professors. The remarks shown in Section 4.4, likewise, indicate that the inclusion of Deck and Engine Officers is more advantageous in their training onboard.

<Table 11> Effective trainers onboard survey result showing the percentage of preference

|  | Deck | Engine | Total | % |
|---|---|---|---|---|
| T/S Professors only | 3 | 5 | 8 | **6 %** |
| T/S Professors and Deck/Engine Officers | 61 | 58 | 119 | **94 %** |
| Number of Cadets | 64 | 63 | **127** | |

[Fig. 5] Graph of the preferred effective trainers onboard

## Ⅳ. Respondents Remarks to the Questions

The study deems it important to include in this paper the objective remarks of the cadets to each questions posed to Part Ⅱ questions. The opinions commented by the respondents presented herein are summarized and edited for clarity and space considerations.

<Table 12> Summary of objective responses

Section 3.1: About best shipboard training sequence

1. Merchant ship: missed training and skill from the merchant ship can be reviewed and re-learn at the training ship.
   One commented that cadets need "1-year merchant ship" training "to increase ability" while another suggested a "minimum of 8-months" merchant ship phase.
   An engine cadet commented "Because it is more work than T/S and learn Machinery Specially*(sic)*" obviously favoring the merchant ship training first.
2. Training ship first: the training ship shall be their indoctrination phase before embarking on the actual merchant ship life.

Section 3.2: About the adequacy of subject-matter taught

1. Most comments are centered on "Deck works and Operations", and "Cargo"
2. Cadets wants to do and learn actual, practical training on deck and cargo handling.
3. Some commented that after their training ship phase, and with the present set-up of training onboard, they will gain more Bridge knowledge than Deck seamanship skill.
4. Most comments centered on the need in performing "realistic" deck tasks and cargo work skills.
5. Verbatim remarks like "Nothing to do for all cadets because everything has worked well since I was onboard", "Lectures and PPT lessons are fair, actual operation and works are hard to follow because there are too many students", "In my opinion in merchant ship, I learn more than training ship" need to be brought forward for perusal and consideration.

Section 3.3: Best Training Method: Practical or Lecture

1. Most comments state that there should be a shared percentage between lecture base with more emphasis on practical and active learning.

Section 3.4: Best Trainers Onboard

1. Most of the student-respondents agreed on both ships'Professors and Deck/Engine Officers are the best trainers on board.
2. Some even recommended the Bosun and Quartermasters (QM) for deck trainers, and Oilers as the engine trainers who can also teach them more effectively the actual tasks onboard.
3. They can also show them the realistic way of performing basic deck and engine seamanship skills and maintenance.

# Ⅴ. Conclusion and Recommendation

From the preceding analysis, the following are observed and recommended: (Herein this section, 'responsible person' is defined as a Professor and/or Ship officer)

1. A follow-up survey should be carried out with cadets who had undergone both training aboard merchant and training ships to have an unbiased and more objective assessment.

2. To include the Deck and Engine Officers in the actual and practical aspects of training of onboard cadets as applicable with relevant rules of STCW, Ch.II, Sec A-II/1, para 6.2

3. On special and temporary basis, the assistance of Deck and Engine Able-bodied Ratings (ABs) under the charge and supervision of responsible person (Officer or Professor) in the training program of cadets in their respective competencies.

4. To include the cadets in the actual basic maintenance of machineries and deck works under supervision of responsible person.

It is observed that active training is the weakest part of training and there is also room for improvement in the delivery of instructions. A review and improvement of onboard curriculum should be revisited to meet the standards of competency required to maritime students with emphasis on practical aspects of training.

# References

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