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Pre/Post Assessments Analysis in Training Electro-Technical Seafarers Experts

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Abstract: In maritime industry, personnel's training is considered by shipping companies as a top priority matter on the list of factors affecting competitiveness in operating vessels. This paper presents the importance and the effects of training Electro-Technical Experts in the context of latest developments, particularly the advent of the "Electric Ship" and the "Communicative Ship" analyzing the feedback received from several relevant two-days seminars for "Ship Electrical and Electronic Systems for Electro-Technical Officers", in North East European countries. The pre-test and post-test self assessment method that has been used for more efficient interaction between trainers and trainees is analyzed using *t*-statistics. The attendees have had diverse basic backgrounds, yet company experts Fleet Engineers on merchant or war ships. The training's effectiveness and gain is discussed in this paper and further proposals for the Electrical and Electronic training are presented through the valuable feedback for improvement.

Key words: Electro-technical officers, maritime education and training, pre/post testing, self-assessment, standards of training certification and watch keeping, *t*-test, training experts.

1. Models for Traditional Technical Classrooms

Traditional classroom learning is based on behaviourist and cognitive information-processing approaches which are both objective in nature. The objectivist model views knowledge as an absolute reflection of reality, existing independently of the learner. As such, the goal of instruction is to model that external reality for the learner, so that knowledge can be transmitted and internalized. The role of the instructor is to analyze the subject in order to determine what reality should be learned and then break the knowledge down into simplified parts to be built into a complex whole. The goal of the learner is to assimilate the knowledge and correctly mirror the content and structure in his thinking [1]. Learning is manifested as a change in the trainee's behaviour or cognitive structures. Since the underlying assumption of objectivism is that reality is externally mediated, and thus can be assimilated by all learners through essentially the same process, the student of objectivist based instruction is not expected to interpret, question or create knowledge, but to receive it passively from the teacher.

This teacher-centred approach has a long history in instructional design. Models of instructional design that are based on the assumptions of objectivism follow a common approach wherein each step in the pedagogical process is analyzed, decided, designed, delivered and evaluated by the instructor, with minimal input from the learner. Instructors analyze the learning conditions including the content, tasks and learner

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characteristics to determine what specific knowledge should be taught to the learner. The selected content is then decomposed into manageable units or modules for ease and efficiency of learning and component tasks that are the expected outcomes of learning identified, prioritized and sequenced [2]. Based on the content/task analysis, learning objectives are formulated, indicating what specific knowledge the learner will acquire by the end of the instruction period. Evaluation consists of determining whether specific learning objectives have met with emphasis placed on identifying observable changes in the behaviour and cognitive structures of learners [3]. There is necessarily a strong alignment between learning objectives, instructional activities and evaluation. According to [4], there are eight characteristics of the objectivist-rational instructional design model: the process is sequential and linear, planning is top down and systematic, objectives guide development, experts are critical to instructional design, careful sequencing and the teaching of sub-skills are important, the goal is the delivery of pre-selected knowledge, summative evaluation is critical and objective data are critical.

Many traditional technical classroom learning activities can be seen as fixed, abstract and out of context, imbued with the assumption that knowing is separate from doing. This dissociation is artificial and particularly problematic especially in the field of engineering where emphasis must be focused on what learners are able to do rather than what they know. While doing can presuppose knowing, knowing does not necessarily translate to competence in doing. Trainees can assimilate abstract concepts, rules and procedures in the academic context without knowing how to use them in practice. Such knowledge remains embedded in the academic context and is essentially inert. In contrast to abstract classroom activities, on-board training in the situated apprenticeship model supports the development of skills and knowledge in the real-life context in which they are intended to be used [5]. According to [6], situated learning occurs when students elaborate on authentic activities that take place in realistic situations. From the viewpoint of situated learning, learning is a function of the activity, context and culture in which it occurs [7]. The apprentice, in onboard training, uses tools (both literal and figurative) of the profession, building an understanding not only of the tools themselves but of the community and culture in which they are used.

2. Maritime Training for On-Board Competencies

A rising number of maritime companies are organized to operate with a limited number of employees equipped with a large variety of technical skills and qualifications. At the front of those skills are technologies involving networked instrumentation, automated machinery controls, integrated information, communication systems and signal processing, which generate fast responses and are developed rapidly. Well qualified and trained personnel are the wealth of any organisation and therefore would have to be retained for maximum period thereafter to enable to obtain optimum returns. Companies would have to engage in early exploitation of the rapid growth in commercial communications capabilities, including satellites and fiber-optic communications, to acquire the necessary increased bandwidth and diverse routing for future networking needs.

Moreover, for military navies, the functions affected are much more and vary from shipboard damage control and system maintenance to target acquisition and weapon firing, all of which will be performed with fewer personnel in future naval systems. According to LtCdr Golsalves, personnel would have to be considered as integral parts of the overall system from its inception. More emphasis is given recently on simulators to speed up training and improve job performance, thereby shortening the time required for more expensive training with actual systems in their real environment. It is hardly feasible for an individual to keep pace with the proliferation in electronics and

wide spectrum of evolving digital applications. Vertically specialised training is essential to ensure in-depth knowledge of systems for optimum exploitation, up to junior officer level. Moreover, navy should also prepare for graceful degradation of these systems in times of warfare. The information systems would have to be protected against increased software and electromagnetic information attacks and other vulnerabilities.

3. The MANILLA Amendment for Electrotechnical Officers

The stakeholders of education and training in the maritime sector should sustain a high level of understanding of the fundamentals underpinning competence based education in order to support informed policy decisions. The trap for Electro-Technical Experts education and training is a literal reliance on standardization from the strict rules of STCW (Standards of Training, Certification and Watch keeping for Seafarers). And because there is a strong need for internationally defined ability, with consideration of the global labour markets, it is important for countries to stay tuned to the specific context and collaborate to find the appropriate balance. There is also need to take into consideration the latest developments, innovations and dilemmas in the Electro-Technical Officer (ETO) profession. Structured training and learning in the environment of the ship, is a continuation of education and training pathway and enhances learning in the workplace. Thus, a mixture of formal and informal learning and evaluation, a guided learning and self-directed experiential learning are the constant values for the systematic and effective ETO training.

STCW is a systematic international maritime legislation concerning the "professional competency standards" of seafarers. What is more, the technological developments such as network centric communications, new navigational aids, digital electronics, microprocessors circuitry, sensors and network data exchange cards, pose raise demands on electrical, electronic and telecommunications navigational training. The advanced networking of systems, demonstrated in Fig. 1 and the integrated "ship-wide" monitoring and control management, are those technological developments that enhance the demand for professional competency standards set by STCW. The amendment is of great significance for the Maritime Education and Training systems and should be fully understood so as to respond to it effectively. Major impacts brought by the amendment, with purposes to raise recommendations for trainers to implement the amendment effectively are analyzed in this paper.

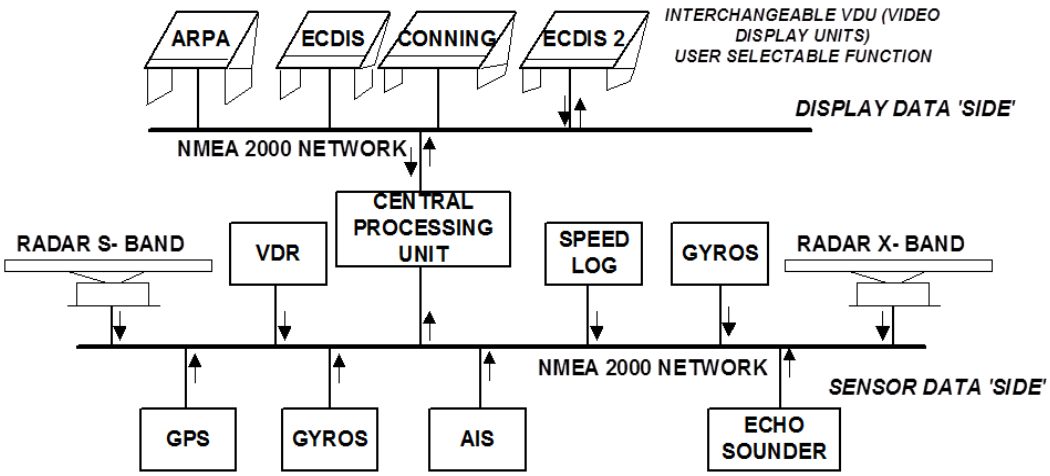


Fig. 1 A navigation workstation example that shows that the Integrated Bridge Systems (IBS) centralize the functions of

monitoring collision and grounding risks and to automate navigation and ship control.

The review of the International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW) adopted by International Maritime Organization (IMO) and the new amendment, which is also named as Manila amendment, has been effective since January 1st 2012, entering new mandatory requirements and provisions for seafarers on July 1st 2013, with a transitional period of 2012-2016. Iis implementation will be totally effective from January 1st 2017 [8]. The abilities specified in the standards of competence are grounded into seven main functions. There is an apparent diffusion of electrical and electronic issues into all functions, but more specifically, the fifth function for electrical, electronic and control engineering is appointed to Chief Engineers at the management level, to Electro Technicians and Engineering Officers at watch, at the operation level and to all engineering ratings at support level. The introduction of new Competence Tables (Manila Amendment Revision) that we have already mentioned consists of ECDIS, Bridge Resource Management (BRM), Engine Room Resource Management (ERM), Leader Ship & Team working Skill, High Voltage and last but not least Electro-Technical Officers & Ratings. An example table of Competency that shows the specification of minimum standard of competence for officers in charge of an engineering watch is demonstrated in Table 1.

4. Course Design, Implementation and Application

The purpose of the "Ship Electrical and Electronic Systems for Electro-Technical Officers" short training course was to act as a supplementary and updating course, covering the new major electrical competences for Electrical and Electronic (EE) engineers. It was designed for two days of duration, ten hours each, included two parts, one Electrical and one Electronics and Telecommunications, with sixteen modules, self-assessment and evaluation both for attendees and instructors. It was delivered by two instructors and the number of participants varied from ten to twenty two, as indicated in Table 2.

The aim of this training course was to provide the knowledge and skill necessary to use and maintain the electrical, electronic navigational and communications equipment commonly found on merchant or war ships.

Table 1 Minimum requirements for certification of Electro-technical Officers (http://www.navit.fo).

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence Examination and assessment of evidence obtained from one or more of the following:	Criteria for evaluating competence
Use hand tools, electrical and electronic measuring and test equipment for fault finding, maintenance and repair operations	Safety requirements for working on shipboard electrical systems Construction and operational characteristics of shipboard AC and DC electrical systems and equipment Construction and operation of electrical test and measuring equipment	Approved workshop skills training Approved practical experience and tests	Implementation of safety procedures, Selection and use of test equipment and interpretation of results, Selection of procedures for the conduct of repair and maintenance in accordance with manuals, Commissioning and performance testing of equipment and systems brought back into service after repair
Operate electrical and electronic control equipment	Theoretical knowledge, Marine electrotechnology, electronics and electrical equipment, Fundamentals of automation, instrumentation and control systems	Approved in-service experience Approved training ship experience, Approved simulator training, where appropriate, Approved laboratory	Operation of equipment and system is in accordance with operating manuals, Performance levels are in accordance with technical specifications

equipment training

Table 2 Seminars examined for *t*-statistics.

No. of seminar	No. of questions	No of attendees
1st Seminar (May 2013)	25	10
2nd Seminar (December 2013)	25	22
3rd Seminar (February 2014)	25	11

Attendees improved their skills to in fault-finding down to component and module level, depending on the constraints imposed by the design of the equipment and the resources normally available on board ship. The training aimed also at enabling the maintainer to appreciate the range of operational uses of electronic navigational data, the limitations of this data and the probable magnitude of error. Information derived from the use of such information is assessed and used as a primary basis for the evaluation of faults occurring in these systems. Training on fault finding techniques included the application of systems level knowledge, the use of test equipment including any built-in test equipment, an understanding of the advantages and disadvantages of modular replacement techniques, and the location of faults to component level. At least twenty percent of course time should have consisted of practical exercises on approved equipment but lack of an appropriate laboratory on the foreign country made this impossible to be implemented.

The course provided candidates with the required basic knowledge in electrical systems. The syllabus included operation performance fundamentals, safety precautions, maintenance and troubleshooting malfunctions about Electric Power Generation Systems, Electric Power Distribution and Protection Systems, Electric Power Consumption, Ship Electric Propulsion, Power Converters, High Voltage technology, Power Management and Cargo Handling Systems. Moreover, the course provided candidates with the required basic knowledge in electronics and radio engineering to enable them to maintain ships radio communications equipment. The syllabus included Signals, Spectrum, Antennas Systems, Distortion, RFI, EMC, Navigation Systems, Integrated Bridge Systems, Radar and Automatic Radar Plotting Aid, Electronic Chart Display and Information System, Control for Navigation Systems, NMEA 2000, Communication Systems and Equipment, Operation Performance Fundamentals, Safety Precautions, Maintenance and Troubleshooting Malfunctions.

Summarizing, subjects included in the “Electrical and Electronic Competences” course are: monitor the operation, safe use, maintaining and repair of electrical electronic and control systems of propulsion and auxiliary machinery, operate generators, distribution systems, computers and networks on ships, use hand tools, electrical and electronic measurement equipment for fault finding, maintenance and repair operations are of major importance in syllabus. Last but not least, subjects include maintaining and repair of bridge navigation equipment, ship communication systems, electrical, electronic, control systems of deck machinery, of cargo-handling equipment and of safety systems for hotel equipment.

5. Assessment Utility and the PRE/POST Testing

In such a large, dense and multi-section course, assessment brings to the surface gaps, deficiencies and inconsistency of the training content and trainees knowledge, searching for the level of coverage and mastery of learning objectives. Pre-Post assessments give more quantitative data than a capstone assessment.

In every educational process, assessment tasks get the attention of attendees, but once students submit their work they typically become disengaged with the assessment process. Hence, opportunities for learning

are lost as they become passive recipients of assessment outcomes. Future-learning oriented assessment engages students in the assessment process to improve both short- and long-term outcomes by requiring students to make sophisticated judgments about their own learning, and that of their peers [3, 4]. In this paper, we describe and critique initiatives that experiment with future-learning oriented assessment within a faculty of training. These initiatives involve self-assessment and pre-test and post-test assessments, to help EE Engineers to confirm their knowledge or even certify them. Based on our experiences, we conclude with suggestions of how others might also use self- and peer-assessment to work towards better short- and long-term learning outcomes in higher education.

According to [9], three strategies which instructors can be used to improve the quality of both self- and peer-assessment include modelling, scaffolding, and fading. Assessment and learning have to be one activity, assessment is considered as the integral part of the learning process. When trainers share with their attendees the process of assessment, the professional judgment of both is enhanced. Assessment becomes not something done to attendees. It becomes an activity done with attendees. Lecturers know that they have to provide attendees an opportunity to consider the importance of reflexivity and self-monitored learning. As the proposed solution developed, the self-assessment factors were guided by the principle: The self-assessment marks had to be authentic and weighted fairly.

The use of different materials such as interactive white boards and laptops referring to a text book is of great importance for the leaning process. According to Paivio's dual-coding theory there are two distinct cognitive systems for the representation and processing of information, the verbal and non-verbal system, which maintains associative structures [10]. Presenting concepts with the use of different methods generates the two sub-systems and multiple interconnections between them facilitating learning and cognition.

6. Questionaire Development and First Results

In applied research pre-tests and post-tests are utilized as a method of monitoring the learning outcomes of an educational intervention. Written factual questionnaires are the tool for the collection of information. The answers of the participants are analyzed and categorized leading to the formation of conclusions [11]. The importance of scientific research derives from the fact that it constitutes a source of information for institutions, educators, students, policy makers for the creation, adjustment, amelioration and updating of courses and syllabus.

Several seminars were held with their respective questionnaires. The questions (Table 2) were the same for the three of the seminars that will be analyzed. Two of them with their results are shown in Figs. 2 and 3. For the other seminars, there were different questionnaires, but all questions were based on the same philosophy. The total number of questions was twenty five. These questions were partitioned into three groups (see example in Table 7) as described in paragraphs 3 and 4:

(a) The initial ten questions were related to training on electric issues,

(b) Ten questions related to electronics and telecommunications issues and,

(c) Five questions related to general issues on navigation.

All were closed-ended questions that limited respondents with four answer choices. All were in the form of multiple choices, the majority of the questions had had only one answer correct. There were also very few questions that were in scale format, where respondent decided to rate the situation and to decide the more suitable one although more than one was correct. There were no open-ended questions.

One of the purposes of the examination was to allow At the beginning of the course (day one), they were asked to indicate their answers in column A (pre-testing). At the end of the course (day two), the paper returned to

the trainee and the trainee was asked to answer the questions again, using column B (post-testing). Where more than one correct answer was possible, the best answer should be selected. A sample from each group of questions is listed in Table 3 and in Fig. 4.

7. Statistical Important Differences for Processed Responses

Quantitative research methods were originally applied in natural sciences to analyze natural phenomena. These methods were also developed in educational research to study learning procedures. For the purpose of quantitative analysis certain variables were determined during the planning phase of our research. Data collection concerning the variables mentioned above was conducted through a questionnaire. The collected data were used to describe variables in terms of distribution (frequency, central tendency).

In the present research descriptive statistics were applied including averages, frequencies, variances and standard deviations. Variables were displayed graphically by tables and bar charts. Descriptive statistics were employed to describe relationships between the performance before and after the training course.

Statistical analysis was conducted using *t*-tests. *t*-statistics was used to measure the differences between the means of two groups. A paired sample *t*-test is used when there are two related observations (i.e. pre-test and post-test per subject) and we want to examine if the means on these two normally distributed variables differ from one another. The level of statistical significance is determined to 0.05, $p < 0.05$ according to the standards in social sciences [12]. The symbol "*p*" represents the probability of a significant difference between two groups. The probability of an event happening varies from 0 to 1. If *p* is close to 0, then the event is less likely to occur. In our case if we compare means of the scores before and after the training course and there is a probability of less than 0.05 (i.e. 4%) that the difference in means will occur by chance, this means that the influence of the training course is significant. Referring to our research hypothesises the null hypothesis (H0) is that there is no difference between the performance of trainees before and after the seminar and prescribes the hypothesis that the quantitative research is aiming at disproving. The alternative hypothesis (H1) is that there is an influence of the seminar on the performance of the trainees before and after the course. An hypothesis test or a significance test determines the rejection or acceptance of the null hypothesis according to the results of a random sample of the population under consideration [13, 14].

A paired sample *t*-test to examine if the means of the two relative and normally distributed variables (the pre-test and post-test per question) differs from one another. *t*-statistics method is analyzed bellow.

Table 3 An example of the questionnaire examined.

A(pre)	B(post)	Q1. What is an electric generator :
		(a) A device generating navigation lights
		(b) A device generating mechanical power
		(c) A device generating electric power
		(d) None of the above
		Q11. What does mean -3 dBm:
		(a) That the output power of a system is half of the input power
		(b) That the output voltage of a system is half of the voltage in the input
		(c) That the power on a measuring point is 500 mW
		(d) That the power on a measuring point is 500 μW
		Q21. The radar carriage requirements for over 10.000 GT cargo vessels are:
		(a) At least 2 radars in X band

(b) At least 2 radars in S band
(c) At least 2 radars in S or X band
(d) Nothing of the above

7.1 Data Collection

Data were collected through participants' completed questionnaires.

7.2 Data Analysis

Participants' responses were graded 0 or 1 based on whether they met the evaluation criteria for each of the 25 assessment tasks. The total score for each of the 25 pre- and post-assessments for every participant was calculated and paired samples *t*-test were conducted. Prior to that, we applied Shapiro-Wilk test of normality. The results of the test indicated that the samples presented normal distribution ($p < 0.05$). This procedure enabled the comparison of the mean scores for the participating groups across the 25 tasks.

7.3 Results

Initial quantitative results for each seminar have been already illustrated in Paragraph 6. Analysis of the overall results is discussed here and a more qualitative discussion is presented in Paragraph 8.

7.4 Comparison of the Performance of the Participants before and after the Seminars

Participants demonstrated improvement after the two day seminar in the majority of the tasks (as shown in Figs. 2 and 3).

After the seminar the participants were found to have greater mean scores across the 25 questions (Table 4). The paired samples *t*-test was found to be significant ($t = -11.647$, $p < 0.01$). Tests of normality for total pre- and post-tests scores are provided in Table 5 and Table 6 presents the results of the paired-samples *t*-tests indicating the specific questions with statistical important differences.

Some remarks made after processing answer statistics are listed below:

(1) While in the first day almost all the attendees did not answer correctly in many questions (669 out of 1,075 questions were answered correct, 62% in percentage), the next day this figure was significantly increased (the number of correct answer had increased by 207, 19% in percentage) reaching a score of at least 20 correct answers per question out of forty three.

(2) The improvement for each attendee varied from 4% up to 63%. The minimum improvement is noticed mainly to those that had scored very well in the first day (nineteen correct answers out of twenty five).
The maximum improvement is noticed mainly to those that had scored badly in the first day (eleven correct answers out of twenty five).

(3) Out of twenty five questions of the questionnaire: The minimum number of correct answers on the first day was one, while on the second day (post-assessment) eighteen, out of forty three answers as shown in Fig. 3. On the other hand, the maximum number of correct answers on the first and second day was forty three.

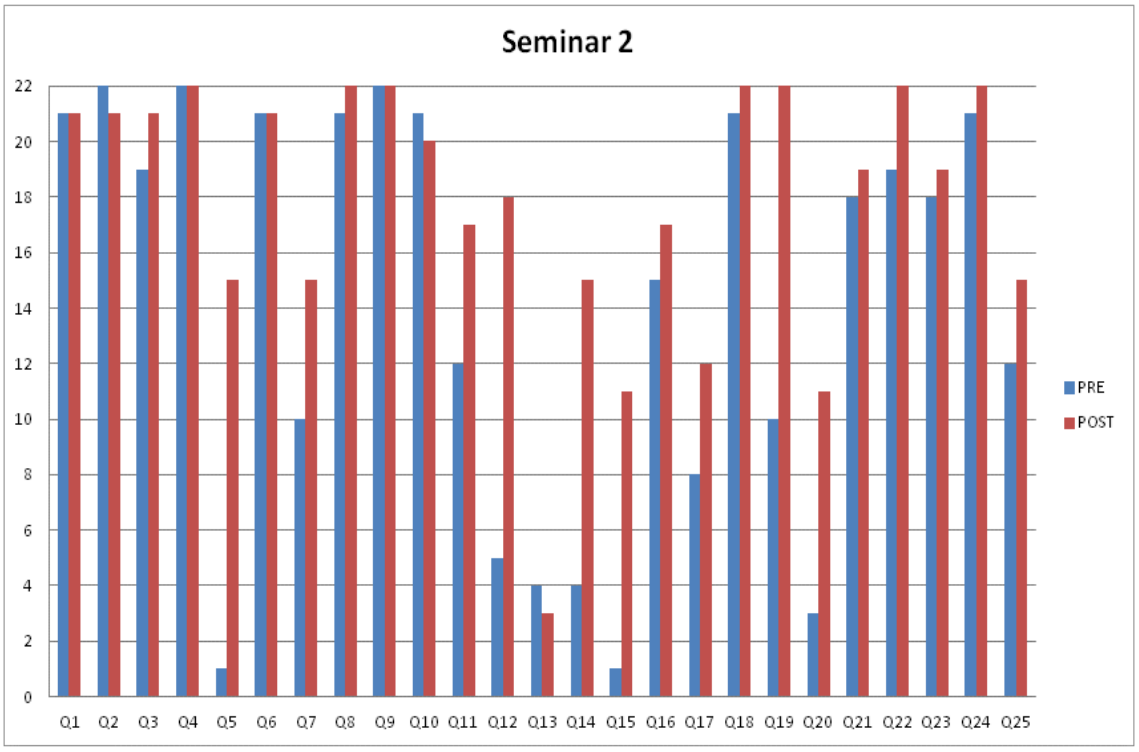
8. Questions Requiring Illustration and Treatment

t-statistics is presented for three of the seminars, where the questionnaires were the same. It was a great pleasure to find out that the questions requiring analysis and treatment (problematic answers) were identical for all seminars. The most significant differences can be found in the questions presented in Table 6, according to *t*-test statistics, where statistical important differences *p* values were less than 0.05.

During the course, the attendees were very careful and helped to a interactive course to a significant extent. Most of the attendees seemed to be rather well qualified as they had answered correctly a significant number of questions even on day 1 (pre-testing). With the exception of a limited number of questions there

was a significant improvement (increase of correct answers). There were only a couple of answers requiring some calculations that confused a limited number of trainees that we will discuss them. Summarizing the problems noted (leading in most cases in wrong answers), the results are classified into three categories:

(a)



(b)

Fig. 2 Correct answers per question; (a) Results of the first seminar (total number of questions: 25, total number of attendees: 10), (b) Results of the second seminar (total number of questions: 25, total number of attendees: 22).

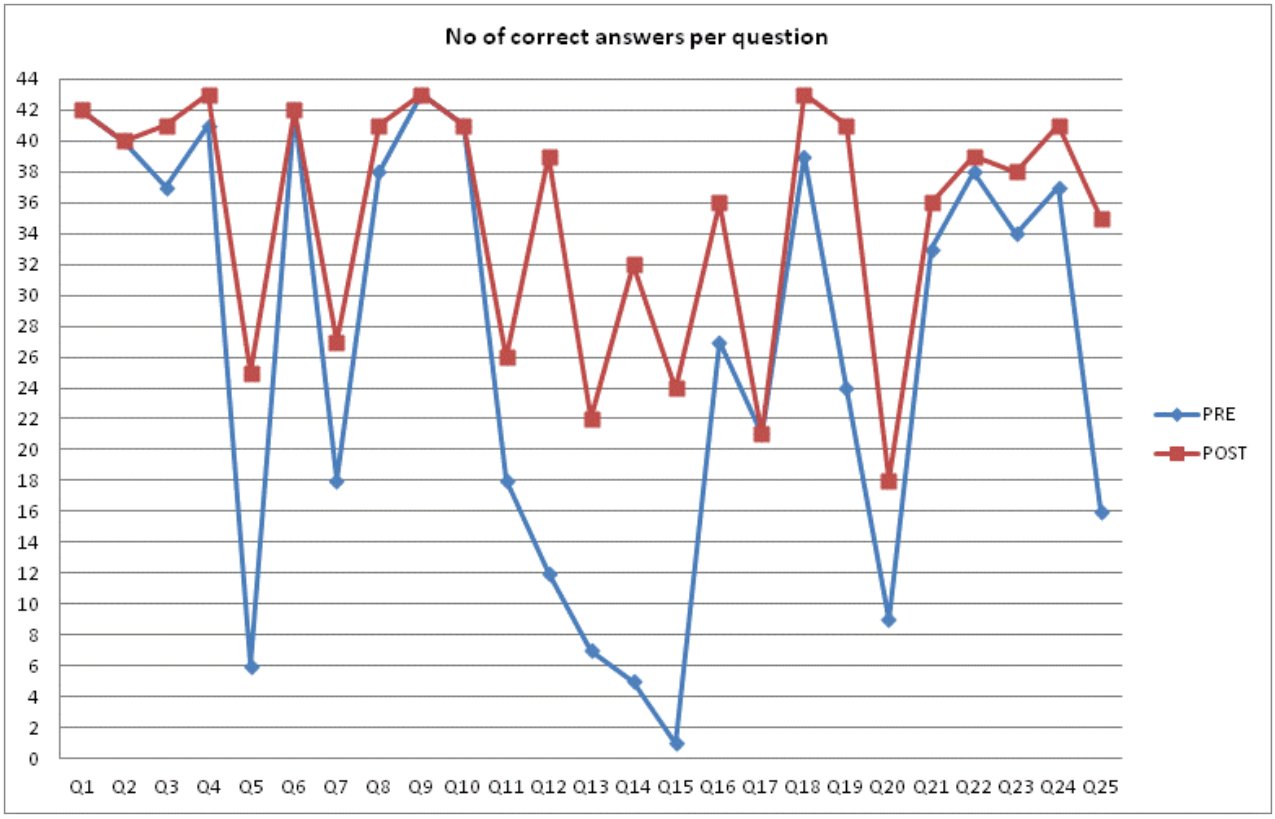


Fig. 3 Total scores in pre and post assessments (total number of questions: 25, total number of attendees: 43).

Table 4 Means and standard deviation on the twenty five assessment tasks between pre- and post-tests.

Assessment	Mean	SD
Pre-test	15.49	2.539
Post-test	20.37	2.401

Table 5 Tests of normality for total pre- and post-tests scores, according to Lilliefors Significance Correction (Kolmogorov-Smirnov non parametric test and Shapiro-Wilk test).

Test of normality	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Total Pre-test score	0.145	43	0.024	0.944	43	0.035
Total Post-test score	0.138	43	0.039	0.934	43	0.016

Table 6 Paired samples *t*-tests on the assessment tasks with statistical important differences.

No. of question	Paired samples *t*-test *t* value	Statistical important differences *p* value
Q5	-5.766	0.000
Q8	-8.854	0.000
Q12	-8.854	0.000
Q14	-8.419	0.000
Q15	-6.950	0.000

(1) The English terminology was not very clear to the attendees.

(2) The attendees made mistakes, in questions where some calculations were required.

(3) In some questions the terminology was confused due to the low basic background of some learners (diverse basic backgrounds).

Regarding the Electric course issues (group a questions)

it was firstly revealed that there is a confusion among the terms "converter" "rectifier" and "inverter" and despite that this was discussed and clarified during the course, the attendees had not assimilated that (Q7). Secondly, there was a question about the most frequent failures in certain pieces of equipment (Q5). The opinion of most attendees (based on their experience of a specific ship type) was different from that of the official (but global for all ship types) statistical data.

Regarding the Electronics and Telecommunications course issues (group b questions) there were a couple of questions referred to the definitions of power and voltage gain in dB and the definition of power alone in dBm (Questions Q12 and Q14). While all students knew at the end of the course that 3 dB means to duplicate "something" and -3 dBs means to make it half, either confused the "something" either failed to make calculations regarding logarithmic function. Most students at the beginning of the course had not clarified yet that dB is a relative unit for power or voltage or current ratios, while the dBm is a measure of power compared to 1 mW. It is worth mentioning that some students believed that dB is only a measure of sound. What is more it was not clear that power ratio equals to the square of voltage ratio. So, some of the students confused the voltage and the power gain and some confused dB with dBm. In the same manner, in another question (Q15) where some calculations were required in order to find the reflected power with the VSWR given, although all the attendees had a clear opinion of what voltage standing waves ratio means, and how harmful is for a transmitter to have a high VSWR, they had troubles in solving an equation having a fraction and square roots, for the reflected power. Last, but not least, although all attendees used to use Spectrum Analyser, they still had not realized at the beginning of the course that is not generating but measuring signals. During the course, its function was clarified, it was clear that signals are presented in the frequency domain. But in a relative question (Q20), although instructors clarified Fourier Transform, learners answered wrong—even on day two, they did not pay attention to the last sentence regarding "time domain" and "frequency domain" as shown in Fig. 4.

All questions regarding radar carriage requirements, Automated Identification System, Global Maritime Distress and Safety System, Inmarsat Systems, Ship Performance Monitoring System, magnetron, Voyage Data Recorder and others relevant to navigation systems, navigations means, communication systems and equipments (group c questions) were very easy for all those who were professionals and were answered correctly by the majority of attendees. Questions regarding operational use, troubleshooting and maintenance were also very easy.

Many of the attendees seemed to be rather well qualified, especially for the electrical course (group a questions) and for the last part (group c questions) as they had answered correctly a significant number of questions even on day one. On the contrary, for the electronics-telecommunication part of the course, this percentage is dropped dramatically as shown in Table 7. Still, at the end of the course, there was a significant improvement (increase of correct answers). There were only a couple of answers requiring some calculations that confused a limited number of trainees, especially

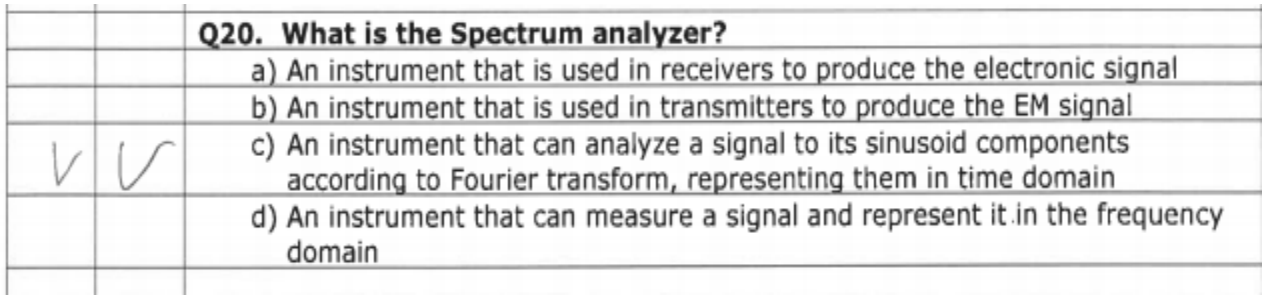


Fig. 4 An example of a misunderstood question that gave no better results.

for the telecommunications' course (group b questions). Questions that required some kind of calculations and ability to handle mathematical operations like square root or logarithmic functions, confused trainees (questions Q12 to Q15). While in the day one almost all the attendees did not answer correctly in many questions, the next day this figure was significantly reduced (the number of correct answers has increased with a maximum value to be twenty seven more correct answers out of forty three attendees) as shown in Figs. 5 and 6.

9. Data Analysis

The course itself and the instructors were evaluated too by the attendees. The main conclusions of delivering those assessments are listed below:

Attendees were particularly interested in basic theory, measuring devices and navigational systems. They asked for more coverage of control subjects, with emphasis to actuators and sensors, for Programmable Logic Circuits (PLC) theory, use and maintenance, for more converters' subjects, Buck-Boost Switched Mode Power Supplies, more references to propulsion systems and high voltage systems.

The two-day duration was not adequate. A third day may be added with emphasis on practical training (lab equipped). Lack of time and lack of minimum requirements laboratory equipment on the foreign country made this impossible to be implemented. But, simulation tools for electrical, electronic and telecommunication systems, or a Web based Training modules could be a very attractive option. On the other hand, the method of pre/post assessment gave the opportunity to meet specific learning objectives. Assessment based on repeated tests had been statistically analyzed with *t*-test on paired samples method and the results are presented in this paper.

As an alternative method in such a dense course, it

Table 7 Correct answers per groups of knowledge.

	Correct answers	
Group of questions	Pre	Post
Electrical	348 (81%)	385 (90%)
Electronics and Telecommunication	140 (32%)	294 (69%)
Navigation	181 (84%)	197 (92%)

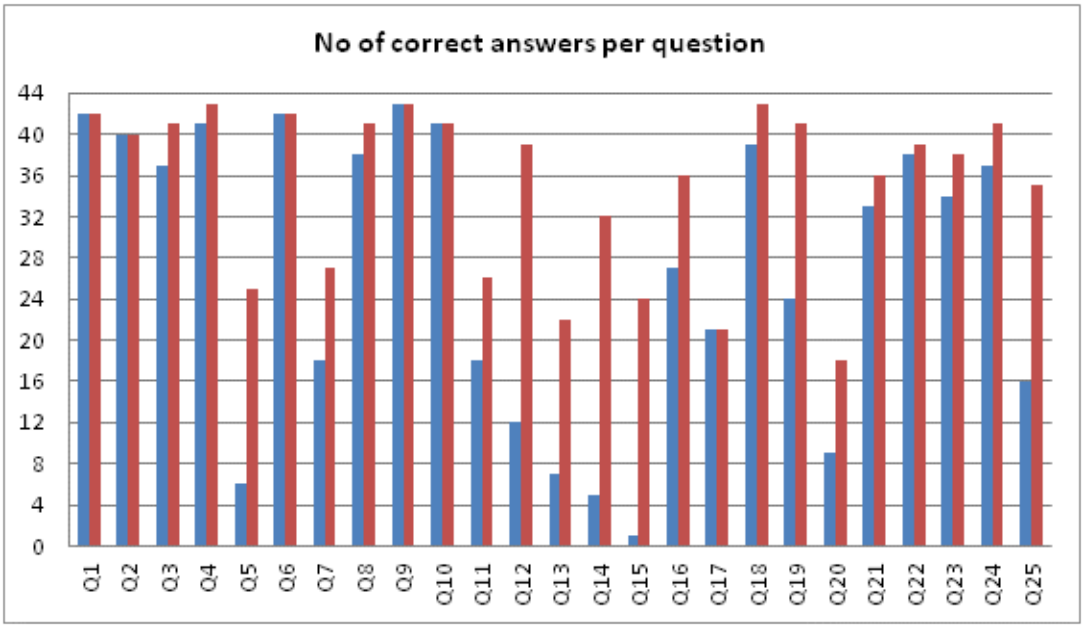


Fig. 5 Results of the seminar: number of correct answers per questions.

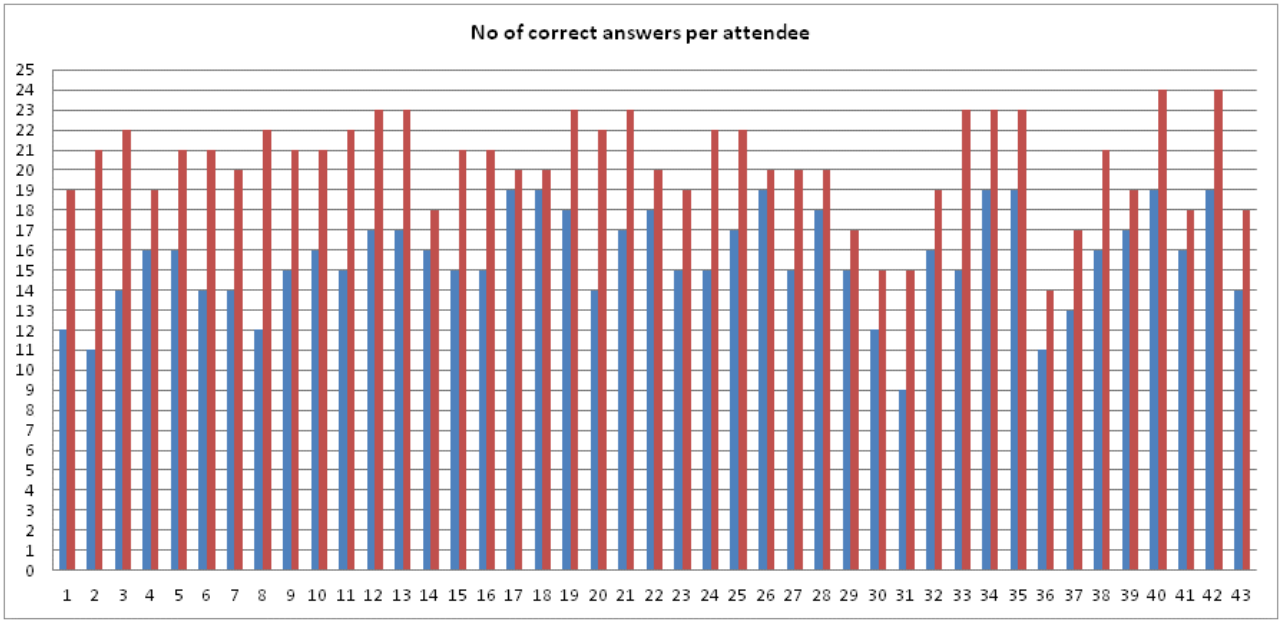


Fig. 6 Results of the seminar: number of correct answers per attendee.

could be used in the method of self- and peer-assessment after the completion of each module containing a limited number of questions that would generate a discussion between trainees and instructors. After the completion of the entire course consisting of sixteen modules and thus sixteen self-assessments, a set of more peer-assessment questions (with the addition of two high degree of difficulty questions) are suggested to be applied as a mean of evaluation for the participants and the general outcomes of the course. Last but not least, attendees had diverse basic backgrounds that imposed difficulties in training. There was apparently the need for development of similar courses more suitably tailored to ranks, specialties, backgrounds and types of ships.

Although it is not directly related to this course, technical documentation aboard (as its presence or rather the absence, as well as its organization) strongly affects the operation of the ETOs as attendees pointed out. The IMO has introduced minimum requirements for the navigation library, its availability and updating. This library is to include a fixed minimum set of documents available on the bridge. Navigation officer coming to any vessel has almost the same set of documents within the same organization. It often happens that there are excessive documentations from the shipyard—needed rather for construction than operation. The amount of technical documentation on shipboard in the late 20 years had fold increase, and its minimal standardization (via requirements of Class Bureau for manufacturers of marine equipment and shipyards) could drastically reduce unproductive time of searching, reading and understanding of the technical documentation. In contrast, there are no standardization requirements, within the framework of IMO, for the technical documentation of the ship equipment(s), and therefore each manufacturer, shipyard applies its own standard for documentation (documentation nomenclature, formalization and figuration, methods of organization). So, if an ETO changes from one to another type of vessel, and sometimes when he goes to a ship of the same series which had been built few years earlier, he has once again to penetrate and bottom into the logic of technical documentation structure (often quite intricate). At times, some descriptions and specifications of equipment are not included to the main list, and the ETO has to look them for a long time and even does not find them out—they are simply absent on shipboard. This affects the safety of navigation.

Last, but not least, concerning motivation for attending such courses, it is generally known motivation always improves the quality of education. Our modern time requires highly efficient skills for the information obtaining, its splitting and selecting the core and main elements, its timely and proper assimilation. In our case, the motivation will be high if the audience knows that this knowledge will—without fail—help in their further work.

The main goal of this course is not so much to give a certain amount of knowledge, as to generalize and systematize existing attendees' knowledge, and even more important is to outlook perspective of the vessel "hardware" (navigation, computers and nets, communication, power equipment, propulsion, etc.). And it is also important to show self-study methodology and techniques (permanent training) as the ETOs constantly encounter (even run against) new equipment and its study is part of function duties.

10. Discussion

The "Professional competency standard" for ETO poses new challenges in teaching and training of seafarers. The amount of information, which seafarers have to perceive and process has increased significantly over the past decade, and still, is increasing. Fundamental changes in the equipment and rig used aboard, a huge large number of regulatory documents (IMO, Class Bureau's, Port authority, Company (owner) instructions, etc.)—all this requires new methods and techniques of training and active methods/techniques of perception and assimilation of knowledge.

"The training became one of these progressive methods, I believe. The course had been prepared perfectly both organizationally and methodologically (in terms of the teaching material). The need of such trainings is beyond any doubt." trainee says. But there are some suggestions that would contribute to improving effectiveness of such short-term courses. First, if two working days could be sufficient for full presentation of all information provided in the course curriculum, these two days are insufficient for assimilation and skilling. Therefore, we suggest, lectures content could be amended and adjusted on the basis of the pre-test results. For example, after the pre-test and its fast processing, the topics which have received 70% and over could be either completely omitted, or only 1-2 specific questions that had the most errors have to be highlighted—thus, time needed for more thorough explanation would be freed up. Secondly, attention has to be drawn to the issue of teaching material selection covered by the course. The rules are the industry standards set and enforced by the bureau of shipping for construction, maintenance, and operation of seagoing vessels and stationary offshore facilities, i.e. they include all information relating to these. Given the time limit for the training, it is necessary to pay more attention to the topics directly related to the exploitation (maintenance and operation) of the vessel electrical equipment, and to minimize sharply the construction and building information (which usually contain a lot of formulas and calculations and their interpretations are difficult to perceive without understanding and awareness of the physical meaning of a phenomenon, especially in such a short time). Since all participants receive a package of all course documents, they may in future self-refer to this material to clarify emerging issues. Excluding purely theoretical issues and the corresponding information which is not practically applied by ETOs in their work—and as is mentioned above, it is very difficult to be realized by listening in such a short time—would provide more time for more detailed study of other subjects. It would be interesting to see whether the covered educational items are of those that a professional do find and live with or are theoretical items and the criticality of such missing knowledge. This gap is some subjects that have been discussed in details in this paper and the possibility of an interactive e-learning or web-based modules appear very charming, where direct interaction regarding the assessment, will cover the gaps.

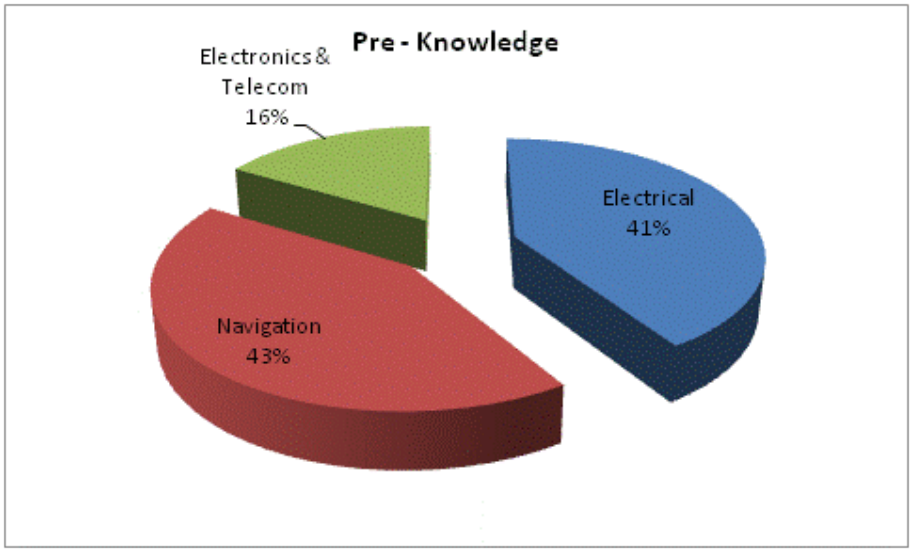


Fig. 7 Statistics show that emphasis must be given on training in electronic and telecommunication issues.

A well-structured crew personnel strategy has impacts on every view of the ship's operation. This paper proves that emphasis should be given by maritime companies in Maritime Education and Training, as already has been noted [15 - 24]. The profession of an electrician is a traditional occupation and almost all Electro-Technical Officers have exceptional knowledge. Nowadays, they have to deal with the "communicative ship" too, undertaking the responsibilities of the Electronic and Telecommunications Engineer, as imposed by recent developments in electronics and telecommunication systems on a ship. Statistics showed (Fig. 7 that more training is needed particularly in Electronics and Telecommunications issues as described in this paper. The method of training and assessment affect the effectiveness of implementation of the STCW convention, the quality of seafarers, the global distributions of seafarer services and general level of safety.

The purpose of the "Ship Electrical and Electronic Systems for Electro-Technical Officers" short training course was to act as a supplementary and updating course, covering the new major electrical competences for Electro-Engineers. The aim of this training course was to provide the knowledge and skill necessary to use and maintain the electrical, electronic navigational and communications equipment commonly found on merchant or war ships.

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