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FORMATION OF PROFESSIONAL READINESS OF CADETS IN THE STUDY OF CONVENTIONAL DISCIPLINES

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Abstract

The subject of the research is the professional readiness of the cadets of the maritime university in the study of conventional disciplines. The term *professional readiness* of cadets of a maritime university is understood as integral education and the established level of personality development, a temporary situational state, attitude, a mechanism for regulating activity, a special long-term or short-term mental state, the concentration of the future specialist's forces aimed at performing certain actions and the achieved performance. This article contains the main provisions of the methodology for assessing the level of knowledge by cadets of the rules related to survival, including the need to be prepared for any accident at sea. The method is intended for use in the process of conventional training, as well as in the final certification of cadets in the discipline "Basic safety training " in order to carry out intermediate and final certification, as well as to increase the responsibility of future maritime transport specialists for the level of their professional training, competence, readiness to effectively perform professional duties as part of the crews of maritime transport vessels. The results of experimental work are given: testing of cadets according to the developed test questionnaire, as well as mathematical processing of the results obtained, which proves the reliability and validity of the proposed method.

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1. Introduction

Professional training of cadets of the maritime university for the upcoming professional activity on ships of maritime transport, along with basic and special disciplines, also includes the study of conventional disciplines by students, aimed at forming the preparedness of future command personnel of ships for competent actions in any emergency situation, making necessary and justified decisions and their implementation in the interests of preserving human life at sea (Tomilin, 2020).

In the IMO guidance documents, the term marine accident is defined as “an event or sequence of events that results in any of the following occurring in direct connection with the operation of a ship:

- death of a person or serious bodily injury;
- loss of a person from the ship;
- loss, presumed death or abandonment of the vessel;
- damage to the vessel;
- landing a ship on the ground or depriving it of the possibility of movement or participation in a collision;
- damage to maritime infrastructure outside a ship that could seriously endanger the safety of the ship itself, another ship or an individual;
- serious damage to the environment or possible serious damage to the environment caused by damage to the vessel or vessels” (Code of International Standards and Recommended Practice..., 2008).

However, the term marine casualty does not include willful act or omission with the intent to harm the safety of a ship, an individual or the environment.

Accident preparedness provides for high professional training of the crew members, including professional competence, high processing skills and abilities of seafarers, constant readiness for prompt and effective actions in any emergency situation (International Convention on the Training, Certification and Watchkeeping of Seafarers [STCW], 1978; International Life-Saving Appliance Code [LSA Code], 2018).

The constant readiness of the crew to act in emergency situations is ensured by (Dmitriev, 2005):

- 1) the constant presence on board of a specified number of crew, capable of ensuring effective actions in the event of emergency;
- 2) high professional qualifications of the crew, preliminary simulator training, regular drills and practical trainings;
- 3) an effective system and organization of actions, including the "Alarm Schedule", emergency parties, vessel response plans, checklists of recommended actions (CheckLists) for all identified risks, taking into account the specifics and design features of the vessel, features and properties transported goods;
- 4) constant readiness of the means of struggle for vessel survivability;
- 5) constant control and supervision (including with the help of special control and warning systems) of the main safety elements, detection of the source of an emergency at the earliest possible stage, as well as quick, decisive, effective actions of the person who was the first to detect the occurrence of an emergency.

In the process of training cadets at a maritime university, cadets receive the necessary amount of theoretical knowledge, practical skills and abilities that form the necessary level of preparedness for any accident.

2. Problem Statement

The study of the conventional discipline "Initial safety training" provides for the formation of a number of competencies, including the PK-35 competence "Able to ensure actions in case of accidents occurring during sailing", the indicators of which are given in Table 01.

Table 1. Indicators of competence PK-35

Competency code	Competence name	Code and name of the competency achievement indicator
PK-35	Able to provide actions in case of accidents occurring during sailing	PK-35.1. Knows precautions for the protection and safety of passengers in emergency situations PK-35.2. Knows the initial actions after a collision or grounding; can perform initial damage assessment and damage control PK-35.3. Knows how to use the procedures that must be followed when rescuing people at sea, when providing assistance to a ship in distress, in case of an accident in the port PK-35.4. Knows how to determine the types and scale of accidents and how to use emergency plans PK-35.5. Knows the precautions for intentional grounding of a vessel and the actions to be taken if grounding is imminent and those after grounding PK-35.6. Knows the steps to bring a vessel afloat with external help and on their own PK-35.7. Knows the action to be taken if a collision is imminent, when the watertightness of the case is compromised for any reason PK-35.8. Knows how to assess damage control PK-35.9. Knows emergency steering PK-35.10. Knows emergency towing devices and towing procedures

An analysis of Table 01 shows that a graduate of a maritime university who has undergone special training in the discipline "Basic safety training" must be thoroughly prepared to act in any emergency situations on board, know what to do and be able to perform a full list of actions in this case. The competence itself and its indicators emphasize the elements of the personal responsibility of each maritime transport specialist for the level of his professionalism, skill, attitude to educational activities and readiness for future work as part of ship crews.

3. Research Questions

The study and analysis of scientific literature related to the design of new methods and test development (Gershunsky, 1987; Gulidov, 2005; Kondratiev et al., 2019; Mishina, 2021; Moroz, 2010;

Popov, 2013) shows that such activities require serious thoughtfulness, logic and reliance on the experience already gained in such activities. Based on this statement, the main issues of the research are: development of the main provisions of the methodology for assessing the level of knowledge by cadets of the rules relating to survival, including the need to be prepared for any accident at sea, responsibility for preserving their lives and the lives of subordinates; verification of the developed methodology in the interests of establishing its performance; formulation of basic recommendations for improving the quality and effectiveness of studying the conventional discipline "Basic safety training". The proposed methodology will make it possible to carry out intermediate and final control of the level of formed knowledge and competencies among students. At the same time, it allows increasing the personal responsibility of cadets for the quality and effectiveness of professional training, and can also serve as a basis for the development of mini-tests and their use in educational activities.

4. Purpose of the Study

The key objective of the study is to develop a new methodology "Assessment of knowledge of the rules relating to survival, including the need to be prepared for any accident" and verification of its feasibility, reliability and effectiveness of application in the practice of conventional training in maritime educational organizations. The results of testing or final certification of cadets make it possible to determine the degree of cadets' readiness for professional activity on board ships of sea transport.

In the process of studying the conventional discipline "Basic safety training" in order to form the professional competence of PK-35, cadets sequentially study the following topics: "General information about the ship. Requirements of guidelines"; "Types of emergency situations and their consequences"; "Shipboard emergency plans and emergency situations", etc.

After completing a full study of the subject of the working curriculum, individual testing is carried out with the cadets throughout the course and differential credit with a personal assessment.

This form of final control is in some sense not perfect enough and acts as a lottery. Questions to check the level of knowledge related to the field of competence: Survival at sea in the event of abandonment of the vessel (Section A-VI/1, Table A-VI/1-1 of the STCW Code) (Kondratiev et al., 2019), providing for the assessment of knowledge of rules related to survival, including the need to be prepared for any accident may not receive due consideration.

The study of special literature on the topic under consideration confirms the lack of tests to check the level of knowledge of the cadets of the rules regarding survival, including the need to be prepared for any accident.

Consequently, the development of a new methodology containing a test questionnaire to establish the true level of preparedness of cadets in the field of survival at sea, including the need to be prepared for any accident, from a scientific and practical point of view is an urgent, important and necessary task.

5. Research Methods

To carry out this study, a set of methods was used, including theoretical analysis of scientific and educational literature; scientific publications in the field of testology; testing method; method of analysis;

methods of mathematical verification of the reliability and validity of the developed test. In this study, the test questionnaire acts as a measuring method for effectively achieving the set goals – determining the true level of preparedness of cadets in the field of survival at sea, including the need to be prepared for any accident.

6. Findings

Based on the above, the authors of the article have developed a new methodology "Assessment of knowledge of the rules related to survival, including the need to be prepared for any accident". In the process of creative activity, the authors used the experience and recommendations of S.I. Kondratyev and co-authors related to the development of test items (3, 4). Questions of the test questionnaire are given in Table 02.

Table 2. Contents of the test questionnaire "Assessment of knowledge of the rules related to survival, including the need to be prepared for any accident"

Item No.	Multiple choice test questions	Answer
1	<i>General ship organization means ...</i> a) the readiness of the ship's crew to abandon the ship; b) survival of the crew on the survival craft after leaving the sinking ship; c) the unification of the personnel of the ship (crew) into an organization that provides round-the-clock management of people and service at the crossings and while the ship is at rest.	
2	<i>What forms of activity does the general ship organization have?</i> a) everyday; b) emergency; c) special.	
3	<i>The crew is the personnel of the vessel ...</i> a) ensuring only the operation of the ship; b) providing only the survivability of the vessel; c) ensuring the control, movement, survivability and safety of the operation of the ship.	
4	<i>Who is the crew of the vessel?</i> a) ship master, other officers and the ship's crew; b) ship master, scientific and technical staff; other officers and crew; c) ship master, other officers and the ship's crew; people picked up from the water.	
5	<i>What is meant by the daily activities of the ship's crew?</i> a) emergency response; b) maintaining order and maintaining hygiene conditions in the premises of the ship; c) compliance with the ship's rules during work.	
6	<i>Ship alarms are used to ...</i> a) waking up the crew in the morning, b) announcement of a lunch break; c) alerting the ship's crew and passengers of the danger.	
7	<i>On board the vessel, the following can raise the alarm:</i> a) any crew member; b) any person on board; c) officer of watch only.	
8	<i>Raising the alarm on the ship can be done:</i> a) by pressing the corresponding alarm button; b) by activation of the alarm; c) by means of communication.	
9	<i>The general ship alarm consists of ...</i>	

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- a) seven short beeps followed by one long beep;
a) five short beeps followed by one long sound signal;
b) seven continuous signals.
- 10 *What are the types of alarms?*
a) general alarm;
b) boat alarm;
c) emergency alarm.
- 11 *When and who will announce the MOB alert?*
a) the officer of watch shall announce this alarm when a person falls overboard or when a person(s) is found overboard;
b) this alarm is announced by the engineering officer of watch when a person falls overboard or a person(s) is found overboard;
c) this alarm is announced by the sailor of watch when a person falls overboard or when a person(s) is found overboard.
- 12 *On-board communication means include ...*
a) telephone communication; communication using portable radiotelephones (VHF radio stations);
b) machine telegraph; communication using a megaphone;
c) backup communication systems (emergency PBX).
- 13 *What are the "Places of gathering of people" on the ship intended for?*
a) These are places where people gather for safety briefings;
b) These are the places on deck where the crew and passengers are assembled on the basis of alarms to check for their presence;
c) These are the gathering places for people taking over the watch.
- 14 *Why are alarms on board a ship?*
a) meeting the requirements of the auditors
b) fulfillment of IMO requirements
c) maintaining the practical skills (competence) of the crew.
- 15 *Where are the duties of alert for each member of the ship's crew indicated?*
a) on posters at the place where the crew is assembled;
b) in dining rooms, mess rooms or resting places;
c) in the "Alarm Schedule" and personal cabin card.
- 16 *How should the ship's escape routes be marked?*
a) red arrows;
b) green arrow on a white background;
c) white arrow on a green background.
- 17 *The constant readiness of the crew to act in emergency and emergency situations is ensured by:*
a) a fixed number of crew on board at all times, capable of effectively responding to emergencies; high professional qualifications of the crew, preliminary simulator training, regular drills, drills, trainings;
b) an effective system and organization of actions, including the "Alarm Schedule", emergency parties, ship operational plans of actions (VesselResponsePlans), checklists of recommended actions (CheckLists) for all identified risks, taking into account the specifics and design features of the vessel, the characteristics and properties of the transported cargo; constant readiness of the means of struggle for vessel survivability;
c) constant control and supervision (including with the help of special control and warning systems) of the main safety elements, detection of the source of an emergency at the earliest possible stage, as well as quick, decisive, effective actions of the person who was the first to detect the occurrence of an emergency
...
- 18 *The general management of actions in emergency situations, the struggle for the vessel survivability is carried out by the captain. The chief mate will be in direct control. In the absence of the captain and chief mate on board, the struggle for the vessel survivability is headed by:*
a) senior mechanic;
b) senior on board;
c) officer of navigational watch.
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- 19 In accordance with IMO requirements, the organization of crew actions in any emergency should be aimed at preserving:
- a) ship;
 - b) cargo;
 - c) human life.
- 20 In an emergency or hazardous situation, it is important to properly assess the priorities before taking any decisions and actions. Priorities should be positioned as follows:
- a) the safety of life, then everything else.
 - b) safety of life; ship safety; safety of cargo and the environment;
 - c) environmental safety.

The calculation of the indicators of the questionnaire test is carried out in accordance with the key given in Table 03. For each answer that completely coincides with the key to each respondent, one point is awarded. The higher the total score, the higher the level of knowledge of the cadets of the maritime university, knowledge of the rules related to survival, including the need to be prepared for any accident.

Answers to the test questionnaire "Assessment of knowledge of the rules related to survival, including the need to be prepared for any accident"

ANSWERS to test questions									
1	2	3	4	5	6	7	8	9	10
c	a, b	c	A	b, c	c	a, b	a,b,c	a	a, b
11	12	13	14	15	16	17	18	19	20
a	a,b,c	b	C	c	c	a, b, c	c	c	b

The developed methodology based on statistical processing of the results is built on three stages:

- *the first stage* includes the formation of groups of participants and the establishment of the homogeneity of the samples according to the initial input diagnostic tests;
- *the second stage* in the process of studying the discipline "Basic safety training" involves the inclusion of questions to check the level of knowledge related to the sphere of competence "survival at sea in case of abandonment of the vessel" using questionnaire tests and their statistical processing, analysis and correction;
- *the third stage* is statistical processing of the results of applying the methodology at the final testing to determine the level of preparedness of cadets in the field of survival at sea.

Five groups of graduating cadets (122) ($n_1 = 22$; $n_2 = 28$; $n_3 = 25$; $n_4 = 26$; $n_5 = 21$) were involved in approbation of the questionnaire test. The results of the test work were assessed on a dichotomous scale: 1 point if the answer to the question posed is correct, or 0 if the answer is incorrect. Thus, the sum of possible values of dichotomous variables as a result of testing was measured on a 20-point scale, which was divided into three non-overlapping intervals, and determining low (from 1 to 7 points), medium (from 8 to 14 points) and high (from 15 to 20 points) the levels of formation of the studied levels of training of cadets.

The results obtained are ranked according to the number of points scored and are determined by the levels of knowledge assimilation, according to the characteristics described in Table 04.

The calculation of indicators and their statistical analysis made it possible to highlight a high level of knowledge for clear actions in emergency situations in the field of studying the proposed methodology: from 70 to 100 % of the maximum number of points received for the diagnostic test questionnaire, and a

low level – insufficient for mastering the new method—with the number of points less than 35 % of the maximum.

Table 3. Determination of the levels of knowledge assimilation by possible types of emergency situations

Quantitative characteristics of levels	Qualitative characteristics of levels
<i>Low level – from 1 to 7 points</i>	Characterizes the fragmented knowledge of the cadets of the Maritime University on the main types of emergencies, poor knowledge of actions in case of collision of ships or landing of a ship aground; does not determine all types and scales of accidents.
<i>Average level – from 8 to 14 points</i>	Characterizes the mediocre level of knowledge of cadets on precautions and safety of passengers in emergency situations, the initial assessment of damage and the scale of the accident and the actions associated with it; in general satisfactorily meeting the requirements of conventional and professional training in the field of security.
<i>High level – from 15 to 20 points</i>	Characterizes the respondents as serious and responsible individuals with solid and complete knowledge of the main types of emergency situations; procedures to be followed in rescuing people, in assisting a ship in distress; knows the precautions for grounding a vessel; knows emergency steering and towing devices.

The obtained test results show a low level of cadets' knowledge on such issues as the definition of the term *accident* – 70 %; *incident* – 47 %; main causes of ship fires – 50 %; features of fires that determine the emergency of the situation – 73 %; actions upon detection of a fire – 73 %; the main reasons for the ingress of water into the ship's hull – 53 %; indirect signs of water entering the compartment – 60 %; the main actions of each crew member when signs of water ingress are detected – 50 %, etc.

The homogeneity of the final test results of cadets was checked using the Pearson χ^2 agreement criterion according to the following formula: $\chi_{obs.}^2 = N \cdot \sum_{i=1}^k \sum_{j=1}^r \frac{(\eta_{ij} - v_j \frac{n_i}{N})^2}{v_j n_i} = N \left(\sum_{i=1}^k \sum_{j=1}^r \frac{\eta_{ij}^2}{v_j n_i} - 1 \right) = 6.37$, где N is the total number of respondents (N = 122); r is the number of formation level (r = 3); k is the number of selections, groups (k = 5); η_{ij} is the number of students of the i-th selection, who reached the j-th formation level ($n_i = \sum_{j=1}^r \eta_{ij}$); $v_j = \sum_{i=1}^k \eta_{ij}$ is the total number of elements of all five selections which reached the j-th level.

The asymptotic distribution of statistics is χ^2 , the distribution with the number of degrees of freedom $(k - 1)(r - 1) = 8$. The tabular value of the criterion at a significance level of $\alpha = 0.05$ and eight degrees of freedom is equal to $\chi_{crit.}^2 = 15.51$. According to the decision rule for $\chi_{obs.}^2 < \chi_{crit.}^2$ ($6.37 > 15.51$) for the criterion χ^2 , the result obtained does not give sufficient grounds to reject the null hypothesis, that is, the results obtained for five groups of cadets with testing are homogeneous and they can be combined and analyzed in a general sample, which allows determining the training level of all graduate cadets in the field of survival at sea.

The analysis of the levels of formation of the competence of students in this area of consideration (survival at sea in case of abandonment of the vessel) makes it possible to adjust the programs and methods used in case of insufficiently satisfactory results, thereby increasing the quality of professional training of cadets.

However, in order for the test questionnaire to adequately assess the level of preparedness of cadets in the area under consideration, it must have a number of characteristics. In our study, the following basic requirements are highlighted, with the help of which the objective nature of test procedures is ensured: reliability, validity and discriminatory power.

To determine the reliability of the questionnaire test, a criterion related to the concept of self-consistent test questions was used, which allows immediately obtaining a characteristic of the reliability of the complete test. This criterion is based on the test splitting method and is calculated using the Ruhlson formula: $r_{rel.} = 1 - \frac{S_d^2}{S_x^2}$. To do this, it is necessary to calculate the variance of the differences S_d^2 between the indicators of each cadet for the two parts of the test and the variance of the indicators for the full test S_x^2 . It should be noted that this formula is related to the determination of the error variance.

Consideration of the suitability of the developed methodology for measuring the level of assessment of knowledge of the rules related to survival, including the need to be prepared for any accident, its effectiveness and practical value, and includes the requirement for the validity of the test. An important aspect of constructive validity is the internal consistency of test questions, reflecting the extent to which the answers to the developed questions are subordinated to the main direction of the test, that is, they are focused on assessing cadets' knowledge of the rules regarding survival at sea and readiness for it. The assessment and analysis of the internal consistency of the questionnaire test was carried out by correlating the received answers to each question and the overall test result.

One of the most important means of increasing the reliability and validity of the method is its strict regulation and the same type of diagnostic procedures: the same time for the subjects, the environment and conditions of activity, the same type of instructions and questions, the same time constraints for all, methods and features of contact with the subjects, the procedure for presenting questions. With such standardization of the research procedure, it is possible to significantly reduce the influence of extraneous random factors on the test results and thus increase its reliability and validity.

To assess the discriminativeness of the questionnaire test, Ferguson's coefficient δ (delta) was calculated: $\delta = \frac{N^2 - \sum_{i=1}^n f_i^2}{N^2 - [N^2/(n+1)]} = \frac{(n+1)(N^2 - \sum_{i=1}^n f_i^2)}{n \cdot N^2}$, where f_i is the frequency of occurrence of each test result (therefore, $\sum_{i=1}^n f_i = N$); N is the total number of test students; n is the number of tasks. This coefficient demonstrates the relationship between the indicator of discriminatory power obtained for a certain test, and the maximum value of discriminatory power that a complete test can provide.

7. Conclusion

Statistical processing of the obtained test results (122 fifth-year cadets of the Faculty of Computer Science and Education) to assess knowledge of the rules related to survival, including the need to be prepared for any accident, and the analysis, using various methods of the presented questionnaire test, allows concluding about the effectiveness of the application methodology testing in the study of the discipline "Basic safety training".

The conceptual foundations of the testing methodology proposed in the article make it possible to assess the level of formation of the PK-35 competence (the ability to ensure actions in case of accidents occurring during sailing), contribute to the formation of theoretical foundations on issues related to survival,

including the need to be prepared for any accident, and also contribute to the formation of and the formation of the personal responsibility of each student for mastering the future profession and readiness for effective activities for the ships of sea transport.

This diagnostic method using testing is the most reliable and objective and can be used in the conventional training of cadets of maritime educational institutions during the intermediate and final certification.

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