

**FaR 2021**

**International Forum “Freedom and responsibility in pivotal times”**

**USING PEDAGOGICAL DIAGNOSTICS IN SPECIAL  
DISCIPLINES AT A MARITIME UNIVERSITY**

Svetlana N. Tomilina (a)\*, Alexander N. Tomilin (b), Anastas L. Boran-Keshishyan (c),  
Svetlana I. Pankina (d), Rinat R. Tuktarov (e), Evgeny M. Dorofeev (f)

\*Corresponding author

(a) Admiral Ushakov Maritime State University, 93, Lenin Ave., Novorossiysk, 353924, Russia,  
mail@nsma.ru

(b) Admiral Ushakov Maritime State University, 93, Lenin Ave., Novorossiysk, 353924, Russia,  
mail@nsma.ru

(c) Admiral Ushakov Maritime State University, 93, Lenin Ave., Novorossiysk, 353924, Russia,  
mail@nsma.ru

(d) Admiral Ushakov Maritime State University, 93, Lenin Ave., Novorossiysk, 353924, Russia,  
mail@nsma.ru

(e) Admiral Ushakov Maritime State University, 93, Lenin Ave., Novorossiysk, 353924, Russia,  
mail@nsma.ru

(f) Admiral Ushakov Maritime State University, 93, Lenin Ave., Novorossiysk, 353924, Russia,  
mail@nsma.ru

**Abstract**

Professional training of cadets of maritime educational organizations, along with the study of basic, special and general humanitarian disciplines, includes the development of the requirements of the International Maritime Organization (IMO), set out in the International Conventions and Codes. The cadets acquire the necessary competencies, knowledge, skills and abilities in the field of preserving human life at sea in the process of mastering conventional disciplines, including such as "Basic Safety Training". To test the effectiveness of the study of special disciplines, it is advisable to use the possibilities of pedagogical diagnostics. The article substantiates and reveals the main provisions of the diagnostic technique that allows assessing the knowledge of the types of shipboard life-saving equipment by cadets. The methodology is intended for use in the process of conventional training, as well as during the final certification of cadets in the discipline "Basic Safety Training". The practice of systematic testing of the level of knowledge among cadets contributes to the formation and development of a sense of high responsibility for the quality of mastering the educational material and the effectiveness of educational activities, the formation of each student as a competent specialist in maritime transport. The results of experimental work (testing of cadets according to the test questionnaire of the diagnostic technique), as well as mathematical processing of the results are presented which prove the reliability and validity of this technique.

2357-1330 © 2022 Published by European Publisher.

*Keywords:* Diagnostics, assessment, test questionnaire, experimental work



This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 Unported License, permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## 1. Introduction

Various methods of pedagogical diagnostics are used in pedagogy. Among them: observation, conversation, interview, survey, pedagogical experiment, questionnaire survey, testing, study of pedagogical documentation. These methods make it possible to conduct current, intermediate control of the development of programs of special educational disciplines, as well as to carry out the final certification of cadets. In the practice of special training of future specialists of maritime transport, the possibilities of pedagogical diagnostics are actively used, which make it possible to control the level of mastery of cadets of educational programs. The testing method has become especially significant for the practice of vocational training.

The performed theoretical analysis of the regulatory and legal framework of maritime activities (International Convention for the Safety of Life at Sea [SOLAS,], 1974; International Convention on the Training, Certification and Watchkeeping of Seafarers, 1978 [STCW], 2018; International Life-Saving Appliance Code [KCC / LSA Code], 1996) indicates that it is aimed at ensuring the safe life of seafarers and preserving human life at sea. For this purpose, the study of conventional disciplines is organized in maritime educational institutions aimed at mastering the requirements of international conventions adopted by the International Maritime Organization (IMO).

The conventional discipline "Basic Safety Training" at the maritime university is studied by the second-year cadets. Along with other competencies, this discipline forms among students the professional competence PK-39 "Able to manage the safety of ship's crew members and passengers, the operational state of life-saving appliances and devices, fire-fighting systems and other security systems". The main indicators of this competence are shown in Table 01.

**Table 1.** Competence PK-39 and its main indicators

PK-39	Able to manage the safety of ship's crew members and passengers, the operational state of life-saving appliances and devices, fire-fighting systems and other security systems	PK-39.1. Knows the types of ship life-saving appliances; PK-39.2. Knows the rules concerning life-saving appliances (International Convention for the Safety of Life at Sea); PK-39.3. Knows how to organize firefighting and ship abandonment drills; PK-39.4. Knows the actions to be taken to protect and safeguard all persons on board in the event of an accident; PK-39.5. Masters actions to localize the consequences of damage and rescue a ship after a fire, explosion, collision or grounding;
-------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Evidently, one of the indicators of professional competence is the knowledge of the types of ship rescue equipment by the cadets.

When studying the conventional discipline "Basic safety training" with cadets, lectures are conducted: "Ship life-saving appliances", "Collective life-saving appliances" and laboratory work "Abandonment of a ship using liferafts" and "Abandoning a ship using a lifeboat".

Consequently, cadets' knowledge of the types of shipboard life-saving appliances and the procedure for their use is the most important component of their conventional training, an indispensable condition for competence to obtain a certificate of the established form under the Basic Safety Training program, the basis for admitting cadets to the first sailing practice on ships of sea transport.

## **2. Problem Statement**

The amended international convention STCW-78 indicates the need for thorough training of all members of the ship's crew to act in emergency situations. The STCW Code requires future crew members to develop the necessary knowledge and skills on a group of issues: Sphere of competence: Survival at sea in case of abandonment of the ship (Section A-VI/1, Table A-VI/1-1 of the STCW Code), including the knowledge of seafarers and cadets of maritime educational organizations of ship rescue equipment types, the ability to use them in any situation to save and preserve human life at sea. In modern conditions, the crews of ships are a mixed composition, from representatives of different countries, which complicates the process of communication and management of the ship's personnel in an emergency (Kondratiev & Smirnov, 2015; Makashina et al., 2016). Consequently, the issue of the preparedness of seafarers, their effective activity in a difficult and emergency situation requires constant attention, care for increasing the level of professionalism, the formation of readiness and responsibility to skillfully act on alarm signals.

In pedagogy, sufficient experience has been accumulated in applying the testing method to control the quality of mastering educational material, conducting current, intermediate and final testing (Churina & Zimina, 2015; Efremova, 2011; Gorbunova, 2020). When developing the test questionnaire, the experience of designing test tasks was creatively used for the state final certification of graduates of maritime educational organizations (Kondratiev et al., 2019a; Kondratiev et al., 2019b).

## **3. Research Questions**

Every maritime transport specialist must be prepared to respond quickly and accurately in any emergency. At the same time, they must thoroughly know all types of individual and collective life-saving appliances, and also be able to use them in the interests of personal safety and saving his life. The main objectives of the research are: 1) substantiation of the need for cadets of the maritime university to know the types of ship rescue equipment; 2) development of a constructive methodology for checking the level of knowledge by cadets of types of ship rescue equipment; 3) testing of cadets who have completed the study of the educational discipline "Basic safety training" according to the developed test questionnaire; 4) checking the efficiency of the developed technique.

## **4. Purpose of the Study**

The purpose of this study is to reveal the practice of using pedagogical diagnostics in the study of special disciplines at a maritime university. For this, the authors have developed a diagnostic technique containing a special test questionnaire designed to determine the reliable level of knowledge of the types of ship rescue equipment by the cadets of the maritime university. The presence of a complex of diagnostic tools for each teacher of a higher professional school makes it possible to systematize the process of monitoring the level of mastering of the studied material by students, improve the educational process, and predict the results of professional training.

## 5. Research Methods

The realization of the goal of this study required the following methods to be applied: theoretical analysis of documents related to the legal framework of conventional training; designing a new technique; observation; conversations with participants in experimental work; interview; ascertaining experiment; testing; mathematical and statistical processing of the results obtained. The use of this set of methods made it possible to cover the entire problem as a whole, to logically and consistently carry out constructive and creative activity, experimental work, processing and interpretation of the results obtained.

## 6. Findings

The diagnostic test questionnaire contains 20 test questions covering the subject of the conventional discipline "Basic safety training", contained in Section 2 – "Ways of personal survival." The homogeneous test is a system of questions of a certain content created with the aim of an objective, high-quality and effective method of assessment structure and changes in the level of preparedness and knowledge in the studied section of the discipline.

The test results are assessed on a dichotomous scale: 1 point if the answer to the question posed is correct, or 0 points if the answer is incorrect.

Thus, the maximum possible score for all correct answers to the test questions of the questionnaire is equal to the number of test questions, that is, 20 points.

The questions of the test questionnaire are shown in Table 02.

**Table 2.** Contents of the test questionnaire "Assessment of knowledge of types of shipboard life-saving appliances"

Item No.	Multiple-choice test questions	Answer
1	<i>Life-saving appliances are ...</i> A) means for protection from external harmful factors; B) a set of devices, mechanisms and structures intended for training and rescue of the crew and passengers in the event of the loss of the ship; C) means to combat the damage of the vessel in case of water ingress.	
2	<i>The requirements defining the types of shipboard life-saving appliances are specified in the following documents:</i> A) Merchant Shipping Code of the Russian Federation; B) Manual on damage control of a vessel; C) SOLAS 74, LSA Code, Rules for the equipment of sea-going vessels of the Russian Maritime Register of Shipping.	
3	<i>Ship life-saving appliances can be classified as ...</i> A) means for combating water; B) protective equipment during work on the ship; C) individual, collective and auxiliary life-saving appliances.	
4	<i>Personal life-saving appliances are designed ...</i> A) to protect a person from external harmful factors; B) to keep a person on the water and protect against heat loss in the water; C) to protect against dust and gases.	
5	<i>Collective life-saving appliances are means ...</i> A) which can be used by a group of people during evacuation from a sinking ship and survival on the water; B) which are designed to fight water in case of damage to the case; C) to fight a fire on board.	

- 6 *Personal life-saving appliances include:*  
A) helmet, goggles, respirator, earmuffs, cotton clothing;  
B) wearable fire extinguishers, fire-fighting mat;  
C) lifebuoy, life jacket, immersion suit, protective suit, thermal protective equipment.
- 7 *What is the personal life-saving device not intended for?*  
A) for marking on the water;  
B) for protection from cold and keeping on water;  
C) for protection from marine predators.
- 8 *The lifebuoy is made of ...*  
A) a floating material, a single piece of foam;  
B) cork shavings or chips;  
C) must be inflatable.
- 9 *How many lifebuoys are equipped with self-igniting lights?*  
A) three lifebuoys;  
B) 10 % of the total on board;  
C) 50 % of the total on board.
- 10 *How many self-igniting lifebuoys are equipped with a smoke bomb?*  
A) at least three circles;  
B) at least two circles;  
C) four or more circles.
- 11 *Life jackets can be constructively ...*  
A) inflatable or with "rigid" elements;  
B) inflatable only, divided into two chambers;  
C) rigid only.
- 12 *Each lifejacket must be equipped with ...*  
A) a rescue line;  
B) a smoke bomb with orange smoke;  
C) a whistle attached to it with a cord and a white signal light.
- 13 *The wetsuit is a protective suit ...*  
A) designed also for diving to a depth of 10 meters;  
B) reducing the loss of heat by the human body in cold water;  
C) for work on the ship at low temperatures.
- 14 *A protective suit is a suit designed for use ...*  
A) by crew members assigned to rescue boats;  
B) by crew members assigned to marine evacuation systems;  
C) in firefighting on board.
- 15 *A heat protective means is ...*  
A) a wetsuit designed to protect you from the cold in the water;  
B) a protective suit designed for work on the deck;  
C) a bag or suit made of waterproof material with low thermal conductivity.
- 16 *Caught in the water by accident or when leaving the ship, ...*  
A) to keep warm, constantly work with your hands and feet in the water;  
B) determine the location of the vessel, lifeboats and rafts, other victims or objects afloat;  
C) try to climb onto a liferaft or a floating object.
- 17 *Collective life-saving appliances include:*  
A) lifeboats and rescue boats;  
B) liferafts;  
C) wooden rafts.
- 18 *Lifeboat is:*  
A) a boat capable of ensuring the preservation of the lives of people in distress from the moment they leave the vessel;  
B) a boat designed to rescue seafarers after the death of the ship;  
C) a boat equipped with everything necessary for the survival of sailors at sea.
- 19 *Rescue boat is ...*  
A) any boat designated as such on the ship;  
B) a boat designed to rescue people in distress and to collect lifeboats and rafts on the water;  
C) a boat used to rescue crew members who have fallen overboard and to carry out other special missions.

- 20 *Life raft is a raft ...*  
 A) designed on a ship to rescue crew members and passengers who did not have enough space in the lifeboat;  
 B) used to save a small group of people;  
 C) capable of ensuring the preservation of the lives of people in distress from the moment they leave the ship.

The calculation of the indicators of the questionnaire test is carried out in accordance with the key given in Table 3. For each complete match with the key, one point is awarded. The higher the total score, the higher the level of knowledge of the cadets of the maritime university in the types of ship life-saving equipment.

**Table 3.** Answers to test No. 2 "Assessment of knowledge of types of ship rescue appliances"

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

To test the efficiency of the developed methodology, a stating experiment was carried out with the participation of 122 graduating cadets and 118 second-year cadets who studied the discipline "Basic safety training" during the third semester. A total of 240 cadets took part in the study.

As a result of statistical processing of the test results, a binary 30×20 matrix of test results (for each group of cadets) was formed, the rows corresponding to the students, and the columns corresponding to the test tasks. The matrix summarized the profiles of the cadets' answers and the profiles of the test tasks.

Mathematical and statistical processing of the results obtained included a number of steps (N = 30):

- calculation of individual score  $X_i$  of the  $i$ -th tested student ( $i=1, 2, \dots, N$ );
- number of correct answers  $R_j$ , to the  $j$ -th questionnaire question ( $j=1, 2, \dots, 20$ );
- ordering of a binary matrix (ranking by rows and columns from higher to lower value)
- number of incorrect answers  $W_j$  to the  $j$ -th questionnaire question ( $W_j=N-R_j$ );
- fraction of correct answers  $p_j(p_j = \frac{R_j}{N})$ ;
- fraction of incorrect answers доля неверных ответов  $q_j (q_j=1-p_j)$ ;
- determination of the variance of test scores  $p_j \cdot q_j$  in the  $j$ -th questionnaire question;
- standard deviation  $\sqrt{p_j \cdot q_j}$  of the students' results in the  $j$ -th question;
- determination of the mode, median and arithmetic mean ( $\bar{X} = \frac{1}{N} \sum_{i=1}^N X_i = 11.6$ );
- calculation of dispersion  $S_x^2 = \frac{1}{N-1} \sum_{i=1}^N (X_i - \bar{X})^2 = 10.3$ ;
- determination of standard deviation value  $S_x = \sqrt{S_x^2} = 3.2$ ;
- normal distribution was estimated as  $\bar{X} - 3S_x \leq X \leq \bar{X} + 3S_x$ .

Approximately 69 % of the curve area is within the standard deviation ( $\bar{X} + S_x$ ) and 99.6 % of the curve area is within ( $\bar{X} + 3S_x$ ).

Determining the quality of a questionnaire test traditionally comes down to determining measures of reliability and questions of the validity of the results obtained.

The reliability of the normative-oriented questionnaire test was assessed using various methods, which, according to the method of implementation, were conditionally divided into two groups:

1) retest method for assessing reliability (test-retestreliability), based on calculating the correlation coefficient of the individual scores of each student, obtained as a result of repeated testing (after 2–3 weeks);

2) split-half method based on calculating the reliability factor when splitting the test results into two parts for even and odd tasks.

To determine the reliability factor during repeated testing, we used the following equation:  $r_{rel} = \frac{N \sum_{i=1}^N X_i Y_i - (\sum_{i=1}^N X_i)(\sum_{i=1}^N Y_i)}{\sqrt{N \sum_{i=1}^N (X_i)^2 - (\sum_{i=1}^N X_i)^2} \sqrt{N \sum_{i=1}^N (Y_i)^2 - (\sum_{i=1}^N Y_i)^2}}$ , where  $r_{rel}$  is the coefficient for the retest method,  $X_i$  is the individual score of the  $i$ -th test student in the first testing;  $Y_i$  is the individual score of the  $i$ -th test student in the second testing.

Since during testing, in order to increase the degree of honesty, sincerity, conscientiousness and responsibility of respondents when writing answers to the questions asked, all survey participants were informed in advance about the anonymity of the survey, the works were assigned a serial number for repeated testing. On average, the reliability coefficient for the groups by the retest method varied from 0.78 to 0.84.

To use the test splitting method for a single test, it is necessary to take into account the homogeneity of the test (parallelism of the two halves of the test for even and odd numbers of questions). In this case, the reliability coefficient was also calculated using the formula for the Pearson correlation coefficient:

$r_{rel.split} = \frac{N \sum_{i=1}^N X_i Y_i - (\sum_{i=1}^N X_i)(\sum_{i=1}^N Y_i)}{\sqrt{N \sum_{i=1}^N (X_i)^2 - (\sum_{i=1}^N X_i)^2} \sqrt{N \sum_{i=1}^N (Y_i)^2 - (\sum_{i=1}^N Y_i)^2}}$ , where  $X_i$  is the individual score of the  $i$ -th test student for even questions;  $Y_i$  is the individual score of the  $i$ -th test student for odd questions.

Since the use of the splitting method gives underestimated reliability estimates when estimating the halved tests, it is necessary to correlate the reliability estimate along the original test length using the Spearman-Brown formula:  $r_{rel} = \frac{2r_{rel.split}}{1+r_{rel.split}}$ . This coefficient for the groups ranged from 0.73 to 0.82. The validity of the questionnaire test was assessed by correlating the characteristics of the measurement results with such criteria as expert assessment when analyzing the content of the questionnaire test questions and its adequacy to the goals set (meaningful validity) and the results of other tests (constructive validity). The obtained rather high correlation between the surveyed results of the respondents and external criteria confirms the high validity of the questionnaire test.

## 7. Conclusion

Pedagogical diagnostics plays a special role in professional training. It allows objectively evaluating and comparing current and final results. The content of pedagogical diagnostics in the study of special disciplines provides for: checking the compliance of theoretical knowledge and practical skills with the requirements of maritime professional activity, knowledge of ship rescue equipment and the peculiarities of their use; possession of the necessary skills to use individual and collective life-saving appliances; satisfaction of cadets with educational activities, professional training in a maritime university.

The practice of using pedagogical diagnostics in the study of special disciplines at a maritime university shows that the testing method is the most widespread. Thus, when studying the discipline "Basic

safety training", a whole bunch of tests has been created, which allows checking each indicator of a specific professional competence.

This article provides a full cycle of development and testing of the methodology for testing the knowledge of the types of ship rescue equipment by the cadets of the maritime university. The developed test questionnaire can be called objective and high-quality, as it is scientifically substantiated, experimentally verified using several criteria and can give the required results in assessing the knowledge of cadets on the types of ship rescue equipment.

The responses received from the respondents allow stating that the cadets of the maritime university are generally trained in the methods of personal survival at sea, they are firmly aware of the types of ship rescue equipment, their purpose and use in an emergency.

This technique can be effectively used in conventional training with students of maritime educational organizations, establishing the quality and effectiveness of the development of the curriculum. The use of the developed methodology contributes to the formation of personal responsibility for each student of the university for the quality and effectiveness of their conventional training, readiness to act skillfully and energetically in any emergency situation.

The practical significance of the development of this technique is indisputable, obvious and confirmed by the results of the study.

## References

- Churina, K. V., & Zimina, E. K. (2015). Testing as a form of control of learning outcomes. *Young scientist*, 9(89), 1214–1217.
- Efremova, T. P. (2011). Test methods as the optimal control option. *Bulletin of the Irkutsk State Technical University*, 8(55).
- Gorbunova, N. V. (2020). Testing as a method of pedagogical control and an empirical method for the implementation of psychological and pedagogical research. *Problems of modern pedagogical education*, 67-2.
- International Convention for the Safety of Life at Sea (SOLAS-74/78). (1974). ZAO TsNIIMF.
- International Convention on the Training, Certification and Watchkeeping of Seafarers, 1978 (STCW 78, as amended). (2018). TsNIIMF.
- International Life-Saving Appliance Code (KCC / LSA Code). (1996). [https://normative\\_reference\\_dictionary.academic.ru/](https://normative_reference_dictionary.academic.ru/)
- Kondratiev, A. I., & Smirnov, I. O. (2015). On intercultural communication in a mixed team. *Journal of Marine Research*, 12(1).
- Kondratiev, S. I., Boran-Keshishyan, A. L., & Tomilin, A. N. (2019a). Conceptual foundations for the development of a bank of test tasks for the state final certification of graduates of maritime educational organizations. *Marine Intelligent Systems*, 1-2(43).
- Kondratiev, S. I., Boran-Keshishyan, A. L., Tomilin, A. N., & Hekert, E. V. (2019b). Development of a bank of test tasks for the state final certification of graduates of maritime educational organizations. *Marine Intelligent Systems*, 1–2(43).
- Makashina, I., Faivisovich, A., & Trushenko, I. (2016). *Standardization of maritime education as a goal, result and means of improving its quality*. International Association of Maritime Universities – 17th Annual General Assembly.