Adaptive Learning Environment Design in the System of Future Maritime Specialits' Training

Serhii A.Voloshynov[1], Ivan M. Riabukha[2], Olena O. Dobroshtan[3], Halyna V. Popova[4] and Tatyana S. Spychak[5]

[a] [1]Kherson State Maritime Academy, 20 Ushakova Ave., Kherson, 73000, Ukraine
[b] [2]Kherson State Maritime Academy, 20 Ushakova Ave., Kherson, 73000, Ukraine
[c] [3]Kherson State Maritime Academy, 20 Ushakova Ave., Kherson, 73000, Ukraine
[d] [4]Kherson State Maritime Academy, 20 Ushakova Ave., Kherson, 73000, Ukraine
[e] [5]Kherson State Maritime Academy, 20 Ushakova Ave., Kherson, 73000, Ukraine

Abstract

In an environment of education reformation aimed at transition of higher education to competence based and individual approaches, we face the need to construct individual learning path for every future maritime professional. In this respect technology of adaptive learning based on modern ICT becomes of high importance. At the same time COVID-19 pandemic has changed system of education at all its levels, but the issue of quality and efficiency is still to be considered and studied by scientists and practitioners.

Under these conditions the issue of adaptive information environment creation becomes relevant for training modern and competitive specialists. This environment should be based on implementation of adaptive technologies for education and training of maritime students, therefore, article provides investigation of pedagogical problem of future navigators' professional culture building in training system of adaptive information environment of maritime educational establishment. Feasibility of adaptive learning technologies implementation is grounded as a tool for future navigators' professional culture building in the process of their fundamental education and training.

Example of higher mathematics adaptive learning implementation for future navigators at Kherson State Maritime Academy is considered. Higher mathematics adaptive learning was introduced through: adaptive feeding of educational content of the course; problems solving support based on examples and pre-created typical algorythms; adaptive testing; analysis of test tasks answers; system teacher support; constant support conditions for individual tasks completion; adaptive course navigation, etc. As the result of experiment there was found out that higher mathematics adaptive learning for future navigators presupposes: individual learning path designing; possibility to timely provide advising and objective control as well as evaluation; enhancement of learning activity and motivation of through improved degree of autonomy; promotion of students' research skills development; creation of cooperation, partnership and maritime brotherhood atmosphere.

Keywords

Adaptive learning environment, future marine navigators, higher mathematics, system of education and training.

3L-Person 2021: VI International Workshop on Professional Retraining and Life-Long Learning using ICT: Person-oriented Approach, co-located with 17th International Conference on ICT in Education, Research, and Industrial Applications: Integration, Harmonization, and Knowledge Transfer (ICTERI 2021), October 1, 2021, Kherson, Ukraine

EMAIL: s_voloshinov@ukr.net (S.A.Voloshynov); r.i.m_17@ukr.net (I.M.Riabukha); dobroshtan16@gmail.com (O.O.Dobroshtan); spagalina@gmail.com (H.V.Popova); gb-xbckj@ukr.net (T.S.Spychak);
ORCID: 0000-0001-7436-5144 (S.A.Voloshynov); 0000-0002-6217-1177 (I.M.Riabukha); 0000-0003-0313-6336 (O.O.Dobroshtan); 0000-0002-6402-6475 (H.V.Popova); 0000-0002-0054-8768 (T.S.Spychak)

1. Introduction

Modern globalization of society conditioned great interest of scientists and practitioners to the problem of future maritime specialists' training and education both in Ukraine and in the world. Thus one of strategic tasks of modern Ukraine is the necessity to transform the system of future maritime specialists' education and training, in particular its professional constituent connected with Mathematics. It was defined in international and national standards namely in International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), Strategic Plan of Marine Transport Development till 2020, Strategy of Ukrainian Sea Ports Development till 2028, etc.[1]

Under this conditions the issue of maritime education quality improvement at all levels and all forms of implementation becomes particularly relevant. Solvation of this issue is first of all connected with improvement fundamental training quality, namely in Mathematics and Physics, which creates important ground for learning professional cycle courses. Mathematical basis is the platform for development and training of future navigators. Mathematical training, as a constituent of fundamental training, is of special concern of maritime educational establishment stakeholders. Main stakeholder of Kherson State Maritime Academy (KSMA) provides for the students tests in Mathematics and Physics developed by specialists from the industry. This testing is conducted on the platform LMS MOODLE using all its resources. The results of testing are immediately sent to the company by the system, the representatives of stakeholder check the tests and the Academy receives consolidated report on the result. Twice a year Academic Council of KSMA considers the results of this test and introduces changes to the programme of education and training [9-10, 19].

Government of Ukraine defined the year of 2020 as the year of Mathematics; besides the 40th session of General Conference of UNESCO on September 3, 2019 declared the 14th of March to be the International Mathematics Day. Session's resolution emphasizes that enhancement of global mathematic training has the key role for solving such modern actual issues as artificial intelligence (autonomous sea vessels), climate change (rise of World Ocean level), Energetics, improvement of humanity welfare; it also reveals applied nature of Mathematics and its importance for progress in all fields of Engineering, marine in particular. Thus improvement of methodics of future maritime specialist's education and training in mathematical, science and professional disciplines with wide implementation of digital technologies becomes an urgent issue.

The second half of 20^{th} century became the period of transition of society to the state of information one. Introduction of modern information and communication technologies became the priority development direction for professional education of Ukraine. National Strategy of Education Development in Ukraine for 2012-2021 emphasizes that the main tasks for modernization of education include: digitalization of education; development of effective system of teaching in education; creation conditions for development of modern teaching tools industry. At the same time, the influence of innovation technologies development becomes greater both in maritime industry and maritime education.

In the conditions of constant development of digital technologies in technical equipment of sea vessels the conditions of work are being changed, and these changes cause shifts in the models and conditions in education and training. The above mentioned makes creation of adaptive information environment relevant; this environment should be based on introduction of adaptive technologies for education and training of future maritime specialists.

2. The theoretical basis of research

Adaptive learning s included to list of main trends of modern innovative education along with mobile and blended ones, micro-learning, gamification, VR, AR, critical thinking and others [2-11, 19-20]. The notion of adaptivity and adaptive learning system (ALS) is not new in science; a lot of researchers from different countries investigated classified and introduced it into their educational works. In 2015 Peter Froschl in the work "Adaptive e-Learning with Eye-Tracking" considers adaptivity as "possibility to change necessary to solve different situations" and defines five basic

adaptive systems: macro-adaptive systems (they have a set of disadvantages, absence of consideration individual features among them); micro-adaptive systems; micro-adaptive systems of abilities' correlation and possibilities of their correction; intellectual learning systems (ILS) (supplemented with hypermedia potential); adaptive hypermedia systems (principal element of it is a student; it is impossible to design ALS without thorough information about the level of students' education and knowledge, as well as about the aim and requirements of future profession) [13].

From the point of view social and philosophical basis Maron, A. considers adaptation as two-track process of educational environment adjustment to the personality of a student. "Adaptation is adjustment, its function is to provide appropriate generally accepted behaviour and activity of a person corresponding to his internal structure (interests, value orientations, peculiarities of temperament)" [14]. The researcher points out main directions of adaptive learning: psychological and motivational adaptation, which presupposes transformation of person's actions due to his mental activity, understanding of importance of strategy and methods choice for achievement of predictive learning outcomes; organizational and objective focused adaptation aimed at maximal approximation of participants' objectives and system of educational process arrangement based on their individual peculiarities; content adaptation involving selection of targeted study material, variability of study plans and educational programmes; technological adaptation interpreted as possibility to adjust study programme to the peculiarities of specific educational process aiming at its streamlining.

The above mentioned leads to the conclusion that ALS structure incorporates one subject of adaptation with all its requirements and needs and a number of objects of adaptation containing different factors of adaptation.

The researchers Moscal, P., Carter, D. and Johnson, P. (2017) used a very definitive, to our mind, comparison of ALS and GPS. During learning educational discipline by a student there should be taken into account principles of personalization of education; they provide possibility to alter educational technologies (route in GPS) leading to the aim of the course. It is feasible due to the possibility to evaluate and assess the knowledge constantly and, depending on the result, to implement definite corrective actions in order to achieve progress in the results [15, 19-20].

As we can see there are a lot of researches proving advantages and opportunities of ALS introduction, but presently there is no well-defined concept of adaptive learning in electronic environment; therefore, design of ALS is an actual task. We shall define ALS here as educational resource developed in the context of competence-based approach, represented in digital form and containing technologies capable to adapt a subject of learning taking into account and on the basis of his personal features and characteristics. [16-17, 19].

.

3. Experimental study

During the survey of first-year students of KSMA Navigation Faculty there were singled out a set of shortcomings in the arrangement of education and training process of the Academy. Following issues, according to the results of the survey, prevent the students from successful adaptation: overload with classroom lessons (35%), lack of basic knowledge (23%), challenges in adaptation due to students' life and drills (18%), low level of motivation to study (12%), insufficient awareness of students about the changes in KSMA programmes and about results of their studies (38%). Besides there was conducted a survey among the students/cadets connected with the nature of relationships in the frameworks "cadet-cadet" and "cadet-teacher". The results of this survey is depicted in figure 1.

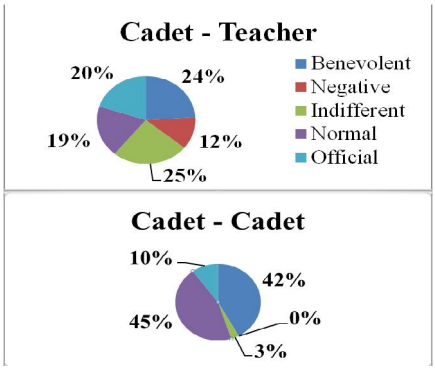


Fig. 1. Nature of relationships in the frameworks "cadet-cadet" and "cadet-teacher".

Figure 1 reveals that the majority of cadets/students (42%) regard their relationships with their mates to be benevolent; at the same time only 24% of them consider their relationships with teachers as benevolent, 12% see them as negative and 25% of cadets/students believe that teachers are indifferent to them. We suppose that the abovementioned issues will be coped when the personality of a cadet/student is in centre of the educational process arrangement. Meeting these challenges is seen as designing of adaptive learning environment, including higher mathematics learning system.

Information adaptive educational environment is understood here as an aggregate of conditions ensuring information interaction between the participants of the process and interactive learning tools aimed at well-timed an effective adaptive corrective actions based on personality oriented approach as well as implementation of modern pedagogical and information communication technologies at different stages of education and training process.

Principle of adaptivity in education and methodical aspects of adaptive learning in modern information system ia aimed at designing individual education programmes, at psychological corrections of student's actions stereotype, his thinking mode and implementation mechanisms. The concept of adaptive learning in modern information system is built on the basis of following principles: personalization (content of an educational discipline is divided into levels of complexity, which allows a cadet/student to choose his own learning path and to design individual environment of study materials; it envisages individualization of interaction between a teacher and a cadet/student); variability of learning content of a course (learning content of a course has different forms of delivery); cyclicity of learning (automatic return to learning material in order to refresh or improve knowledge and understanding); participation (students learn problem solving according to the proposed by a teacher algorithm of actions and individual creation of algorithms for new problems solving depending on the chosen complexity level); autonomy (students learn searching necessary materials individually, allocate principal information, think autonomously, design their own algorithms for problems solving as well as for learning new materials); systematicity and consistency (learning content of a course should be proposed for students/cadets in the form of logic sequence of developing knowledge, understandings and skills in a course module and logic interconnection between modules) [19-20].

In the conditions of adaptive information system, a teacher becomes a promoter, mentor and tutor providing advising, guidance and inspiration for achievement of the learning outcomes defined for the profession of marine navigator. Adaptive learning system utilizing modern information technologies activates the process of education and training through: providing possibility for cadets/students to design individual learning path (pace and rhythm of learning activity, schedule of work with training materials, choice of complexity level, etc.); introduction of differentiated approach to education and training (education and training is student-centered, it takes into account individual peculiarities and motive); optimization of control over the level of student's competences built (system of knowledge and skills monitoring introduces corrections to learning path according to individual features of a cadet/student); enhancement of evaluation and assessment process credibility (information system leaves human factor aside the process of evaluation and assessment); promotion of cadets'/students' autonomy, engagement and sociability during interaction with a teacher and mates in the information system); creation of partnership and cooperation environment between a teacher and cadets/students.

The aim of adaptive learning technology is development of autonomy, self-control, skills of research work in the conditions of maximum adaptation of education and training process to individual peculiarities of a cadet/student. In these conditions a teacher should provide monitoring and control of individual work of every cadet/student; ensure individual teaching actions for those stuck with their studies and for those having leading results in comparison to their mates); encourage cadets/students to learning; provide up-to-date information about novelties of the course. Under the conditions mentioned above, modern information system, operating the principles of adaptive learning, in our case it is the full course of Higher Mathematics (meaning classwork, individual distant work) should ensure learning process.

Analysis of information learning systems and algorithms of adaptive learning design available is given and summarized in the form of table (Table 1) [19].

Table 1.
Adaptive learning systems introduced in different countries of the world.

Learning System	Learning Algorithm in Interactive Adapted Learning System
AHA! (Adaptive Hypermedia Architecture)	System for creation of adaptive web-applications (aha.win.tue.nl). Adaptation is achieved through step-by-step analysis of baseline and interim information about user; based on this information user's model and the system itself are adjusted.
Brightspace	Virtual learning environment including a great number of training materials, resources and learning platforms; using all these it is possible to design individual learning paths for students. In the education and training process a student is actively involved in communication with teachers. This communication provides possibility for correction actions in terms of individual learning path.
Geekie	System provides access for students to following learning materials developed by the teacher: videolectures, digital materials for practical lessons, topical tests, individual practical classes etc. Students operating with these materials are made ready to the final assessment works. The programme monitors the whole process of education and training, summarizes and systemizes personal information of every student and provides it for the teacher. Every study course starts with a test with the results providing information about the level of necessary competences development of students. Based on the results of diagnostic test there can be chosen content of the course aiming at the learning outcomes. All learning materials are of multi-level character, therefore every student can individually design own learning path for the course (level of complexity, types of activities, pace, timing etc.).
Knewton (MyLab & Mastering series)	Platform for designing programmes with adaptive function. MyLab & Mastering series project is the system providing answers for following questions: what student knows; why he made mistake in the task completion; what learning material is more important; what student's prognostic performance can be reached at every stage of education and training.
DreamBox Learning Math	Adaptive online-maths programme based on Intelligent Adaptive Learning technology monitors the results of learning activity of a student, analyses methods and algorithms used during tasks completion. Based on the information collected the system introduces changes into the content of the course (level of tasks complexity, number of prompts, information to be learned, pace of learning etc.).
InterBook	A tool intended for electronic textbooks and manuals designing. The server of InterBook creates individual learning path for every user registered; it ensures adaptive guidance, adaptive navigation support and adaptive help tips and prompts for students.

Smart Sparrow	Open learning platform allowing creation of interactive adaptive courses. Learning is based on "small data" approach using algorithms, which allow to analyse previous answers of a student in order to choose next question or task. There is a possibility to arrange teacher's feedback to students for learning process support in the form of prompts (links and references to the source, video or audio materials, charts, pictures, figures, basic diagrams etc.) right in the moment when a student meets difficulties in doing task or answering question.
Aero	The system defines objectives of the course, topics, tasks for individual work and topical tests. The system stores information about results of tasks completion, number of attempts, number of consulting with theoretical part of course. Thanks to adaptivity (personalization), tasks are different for every student. The system autonomously decides time and content of material to be revised. Thus, a teacher can create fully individualized course and anticipate the final quality of knowledge.
Stepik	A construction kit of free open online courses and lessons providing possibility to create interactive courses with feedback loop.
Plario	Platform created aiming at decreasing teacher's workload during the process of freshmen adaptation. On the basis of results of initial diagnostic testing in mathematics the system detects existing problems and designs scheme of the detected problems improvement through framework of microlearning. Algorithm of adaptive learning in the system leads a student from the simple to the complex. Learning material is provided in small portions, tasks are specifically aimed at training separate mathematical skills. Every problem in the system has example of solving and a student can address to it at any time. In addition, the system contains elements of gamification aimed at students' interest raising to the process of education and training.
MOODLE (Modular Object-Oriented Dynamic Learning Environment)	LMS Moodle allows generation of own system with necessary functional possibilities, namely: management of learning activity of students, controlling tasks completion, designing individual sets of educational and training tasks, adjusting the structure of a course to the personality of every separate student.

Analyzing all the adaptive learning systems mentioned above we can make a conclusion that Big Data (big volume of structured and non-structured information operating for data collection, storage and processing) and Data Mining (work with several structured data; search for interconnections in-between big volume of data, anticipation, classification and visualization) – these are basic technologies of any modern intellectual interactive adaptive system [11-15, 19-20].

On the basis of analysis of existing adaptive learning systems we had an opportunity to find out definite drawbacks (absence of information about psychological readiness of students to study, it could have greatly facilitated the process of adaptation and improve the quality of education in general; there is unified model for adaptive learning designing) and advantages (possibility to collect, store, synthesis and systematization of large volume of personal information about a student aiming at further adaptation of learning process; saving teacher's time for checking tasks completed, analysis of problem issues and arrangement of individual learning path for every student.

In order to implement adaptive learning in the course of Higher Mathematics teachers of Department of Natural Sciences designed and created information adaptive environment on the basis of System of E-Learning Management of KSMA (https://mdl.ksma.ks.ua/login/index.php) for students of Navigation Faculty. The course of Higher Mathematics for students of Marine Engineering Faculty was delivered using traditional mode and methodics.

Experimental work aimed at introduction of adaptive learning in Higher Mathematics course for future seafarers was conducted using existing information system

(https://mdl.ksma.ks.ua/login/index.php), which is adequate enough for learning separate disciplines and utilizes mediated interaction of distantiated participants of education and training process in specialized environment functioning on the basis of modern psycho-pedagogical and information-communication technologies [19].

When learning professional disciplines students need quite high level of mathematical background. For example, before starting learning the course of Celestial Navigation students are proposed to take diagnostic testing aimed at defining gaps in mathematical background. In case of passing the test with high or sufficient level a student receives access to electronic course of Celestial Navigation. To the contrary, failing this test (the result of the test is average or lower than average) a students is sent to by the link to special course of Mathematical Foundation of Navigation, which in its turn has cyclic and adaptive nature of learning materials delivery (Fig.2).

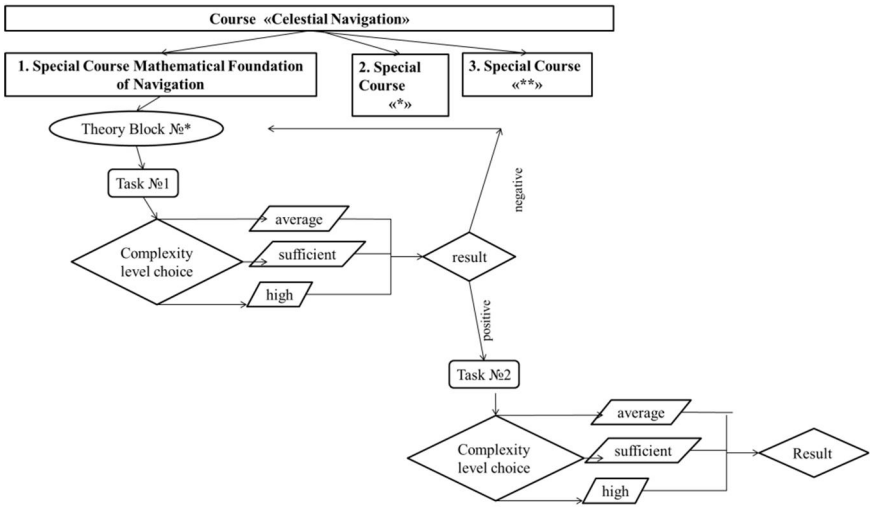


Fig. 2. Model of cyclic management of students' adaptive learning (special course Mathematical Foundation of Navigation)

Model of cyclic management of students' adaptive learning for electronic special course Mathematical Foundation of Navigation includes following steps:

Familiarization of students with the programme of special course Mathematical Foundation of Navigation and with evaluation and assessment criteria as well as with the specifics of learning the material using MOODLE platform.

Students' independent choice out of the proposed learning materials of the course of: a) level of the course materials (high, sufficient, low); b) types and number of mathematical tasks corresponding to the chosen level of complexity; c) forms of current check.

Coordination with the teacher of the chosen types of learning materials, forms and schedule of current check.

Student's mapping out of individual plan for completion, recording and reporting of the chosen individual tasks connected with the Module 1 (individual learning path) and introduction of it to the teacher through filling in and downloading of corresponding Google form.

Teacher's familiarization with students' individual plans, their systematization according to the levels, arrangement of corresponding groups of students.

Drafting of group online consultation schedule.

Providing of online consultation of students' groups differentiated according to the levels of complexity in line with the schedule.

Presentation of completed individual tasks (projects, laboratory works, solved applied problems, etc) through Internet.

Online discussion of the presented tasks: their peer review, possible improvement proposals, defining the best works, etc.

Doing current stop and check tasks, taking online progress tests and offline final test on Module #*.

Assessment of all tasks and tests, putting marks in e-register and proposing final module #* mark for every student.

Student's reflection of the proposed final mark for the Module #* and development of correction programme as well as defining its terms of completion in case of insufficient result.

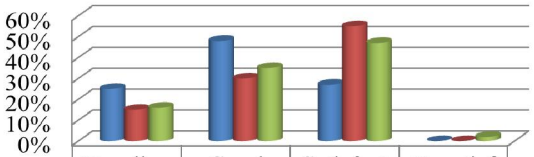
Correction of learning outcomes through doing additional tasks, having next final evaluation and assessment and putting final mark for Module #* in e-register.

Adaptive learning of Higher Mathematics course for future navigators was implemented through: adaptive provision of learning content of the course; support for problems solving in the form of examples and designed algorithms of solving for typical problems of the course; adaptive testing; analysis of answers of the testing tasks; scheduled teacher's consultations; creation of conditions for constant support in students' individual tasks completion; adaptive course navigation, etc [19-20].

Interactive lecture material is delivered in small portions, after every portion student receives stop and check questions and, in case of wrong or insufficient answer system sends a student to the page of lecture containing necessary information. Access to the learning content of the next level is provided only in case of sufficient completion of previous task. Every module ends up with final evaluation and assessment. After being tested students have the possibility to review the questions with wrong answers; to receive necessary online teacher's consultation and to be tested and evaluated once more. All tests and tasks of the course are compiled in unified base, which is used for the final evaluation and assessment test at the end of the course of higher Mathematics. Thus both a student and a teacher can anticipate final performance and achievement after having the results of every test.

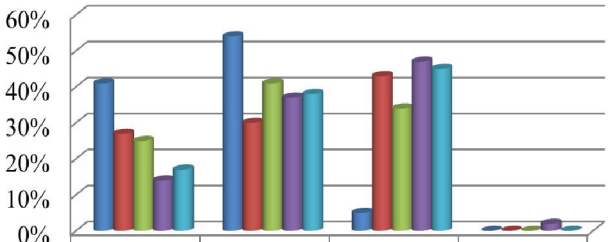
The experiment for checking efficiency of information adaptive system during the course of Higher Mathematics was held during the process of students' selection for their first onboard practice by the company Marlow Navigation. The selection consisted of two stages: internal and final one. It took place right after completion of the course of higher mathematics. The aim of the selection was to check readiness of students to implement their mathematical competences in practice of real industry. We compared adaptive course of higher mathematics (Navigation Faculty students) and traditional one (Marine Engineering Faculty students). Test in mathematics, provided by the company, was aimed at checking the level of mathematical competence development of future maritime specialists and their readiness to solve problems of navigation and marine engineering onboard. The results of this test we consider to be valid ones as the test was created by stakeholder's representative from the industry and was checking the applied nature of students' competence level.

The content of the test tasks was aimed at checking following mathematical skills: solving triangles on a plane; solving rectangular and spherical triangle; finding of the differences in vessel's location between sets of coordinates (latitude, longitude); finding the shortest distance between ports (orthodromic distance); finding distances at sea and azimuths of ports from vessels; usage of proportion to solve maritime problem; finding latitude of parallel etc. Content of all these tasks correspond to International Maritime Organization Model Course for higher mathematics [18-20].



	Excellent (90-100)	Good (74-89)	Satisfactory (63-73)	Unsatisfactory (0-62)
221	25%	48%	27%	0%
222	15%	30%	55%	0%
321	16%	35%	47%	2%

Fig. 3. Distribution of Marine Engineering Faculty students according to levels of mathematical competence



	Excellent (90-100)	Good (74-89)	Satisfactory (63-73)	Unsatisfactory (0-62)
121	41%	54%	5%	0%
122	27%	30%	43%	0%
123	25%	41%	34%	0%
124	14%	37%	47%	2%
125	17%	38%	45%	0%

Fig. 4 Distribution of Navigation Faculty students according to levels of mathematical competence

Diagrams given in Fig.3-4 reveal that students of Navigation Faculty showed higher level of mathematical competence development than students of Marine Engineering Faculty. The highest quality level of mathematical competence was found among the students of Group 121. This group has the highest percentage with high and sufficient levels (41% and 54% correspondingly). Groups 121-123, 125 have 100% performance results according to the test results. Group 221, also showed quite high results in the tests, but in general Marine Engineering Faculty students have the indices that are much lower than those of the students of Navigation Faculty. Thus, students being delivered with adaptive learning through adaptive learning environment showed good results.

4. Conclusions

Implementation of adaptive learning in the course of Higher Mathematics for future seafarers is done through designing of adaptive learning environment, which implies: creation of individual learning path (pace of learning, complexity level, terms for completing individual tasks); possibility to conduct constant monitoring and consulting and to evaluate objectively the learning activity of students; promotion of research activity and motivation through high level of autonomy; encourage development of students' research skills; creation the atmosphere of partnership and cooperation. Usage of the e-learning platform creates conditions for more effective development of mathematical competence. One of the most important elements of this environment is psychological adaptation of students for learning process in the educational establishment. This adaptation is effectively done in the friendly environment created both by teachers and by students. Further research is needed in order to elaborate possibilities of adaptive learning environment for future maritime officers education and training.

5. References

[1] International Convention on Standards of Training, Certification and Watchkeeping for Seafarers as amended, including the 1995 and 2010 Manila Amendments. STCW Convention and STCW Code. URL: https://www.imo.org/en/OurWork/HumanElement/Pages/STCW-Convention.aspx.

[2] S. A. Voloshynov, F. M. Zhuravlev, I. M. Riabukha, V. V. Smolets, & H. V. Popova, 2021. Application of VR technologies in building future maritime specialists' professional competences, 2021. URL: http://ceur-ws.org/Vol-2898/paper03.pdf.

[3] O. Gnedkova, D. Kravtsov, Organization of Testing in Distance Learning (on the Base of Distance Learning System "Kherson Virtual University, 2.0"), Information Technologies in Education Scientific Journal 3 (2009) 209–215.
[4] V. Cherniavskyi, H. Popova, M. Sherman, S. Voloshynov, & A. Yurzhenko, Mixed reality technologies as a tool to form professional competency of sea transport professionals, (2020). URL: http://ceur-ws.org/Vol-2740/20200217.pdf.
[5] T. Zaytseva, L. Kravtsova, A. Puliaieva: Computer Modelling of Educational Process as the Way to Modern Learning Technologies, (2019). URL: https://lib.iitta.gov.ua/716616/2/paper_403.pdf.
[6] V. Osadchyi, H. Varina, E. Prokofiev, E. Serdiuk, S. Shevchenko. Use of ar/vr technologies in the development of future specialists' stress resistance: Experience of steam-laboratory and laboratory of psychophysiological research cooperation, (2020). URL: http://ceur-ws.org/Vol-2732/20200634.pdf.
[7] S. Semerikov, I. Teplytskyi, Y. Yechkalo, O. Markova, V. Soloviev, A. Kiv, Computer simulation of neural networks using spreadsheets: Dr. Anderson, Welcome Back, (2019). URL: http://ceur-ws.org/Vol-2393/paper_348.pdf.
[8] A. Kiv, M. Shyshkina, S. Semerikov, A. Striuk, M. Striuk, H. Shalatska, CTE 2019 – When cloud technologies ruled the education, (2020), pp. 1-59. URL: http://ds.knu.edu.ua/jspui/bitstream/123456789/2681/1/CTE%202019%20%e2%80%93%20When%20cloud%20technologies%20ruled%20the%20education.pdf
[9] K. Osadcha, V. Osadchyi, S. Semerikov, H. Chemerys, A. Chorna: The review of the adaptive learning systems for the formation of individual educational trajectory. Paper presented at the CEUR Workshop Proceedings, Volume 2732. URL: https://www.researchgate.net/publication/345948449_The_Review_of_the_Adaptive_Learning_Systems_for_the_Formation_of_Individual_Educational_Trajectory
[10] S. Voloshinov, V. Kruglyk, V. Osadchyi, K. Osadcha, S. Symonenko: Realities and prospects of distance learning at higher education institutions of Ukraine, Ukrainian Journal of Educational Studies and Information Technology, Volume 8, 2020, pp.1-16. doi:10.32919/uesit.2020.01.01
[11] V. Osadchyi, I. Krasheninnik, O. Spirin, S. Koniukhov, T. Diuzhykova: Personalized and adaptive ICT-enhanced learning: A brief review of research from 2010 to 2019. Paper presented at the CEUR Workshop Proceedings, Volume 2732, 2020, pp.559-571. URL: https://lib.iitta.gov.ua/722284/1/Personalized%20and%20Adaptive%20ICT-Enhanced%20Learning.pdf
[12] L. Smetanyuk, G. Kravtsov: To the theory and practice of use adaptive tests. Information technologies in education, 2009, pp.148 - 155. doi:10.14308/ite000066
[13] H. Trong: Virtual MET Institution: assessing the potentials and challenges of applying multi-user virtual environment in maritime education and training: Master of science / World Maritime University, Malmo, Sweden, 2012. URL: https://commons.wmu.se/all_dissertations/20/
[14] C. Froschl: User modeling and user profiling in adaptive e-learning systems (Unpublished master thesis). Graz University of Technology, Austria, 2005, p.175. URL: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.86.8861&rep=rep1&type=pdf
[15] A. Maron, L. Monahova, Major Trends in the Development Androgentic Research, Academic Bulletin of the Institute of Adult Education of Russian, Volume 1, Academy of Education, People and Education, 2001. pp.32-39.
[16] P. Moscal, D. Carter, P. Johnson: 7 Things You Should Know About Adaptive Learning, 2017. URL: https://library.educause.edu/resources/2017/1/7-things-you-should-know-about-adaptive-learning
[17] S. Rondon, F.C. Sassi, C. Andrade: Computer game-based and traditional learning method: a comparison regarding students' knowledge retention, BMC medical education, 2013. URL: https://bmcmededuc.biomedcentral.com/articles/10.1186/1472-6920-13-30
[18] IMO Model Course 7.02 Chief engineer officer and second engineer officer, 2014. URL: https://www.slideshare.net/ChairilAnam4/imo-model-course-702-edition-2014
[19] O. Dobroshtan, T. Spychak, Teaching mathematical disciplines in the adaptive environment of the higher marine educational environment foundation, Academic notes, Series: Problems of methodology physico-mathematical and technological education, Kropivnytskyi: EPC of Centralukrainian Volodymyr Vynnychenko State Pedagogical University, 2020.

[20] O. Dobroshtan, T. Spychak, Adapted higher mathematics education in higher marine educational institution, Adaptive Learning Management Technologies: Proceedings of the Fifth International Conference, Odessa, 2019.