On adopting e-learning in maritime higher education in South Africa

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Abstract- The purpose of this study is to explore selected lecturers' and students' awareness regarding the benefits and impedimentsof e-learning at maritimehigher education (MHE) institutions in South Africa, including their readiness to adopt this form of knowledge transfer. In fact, the study focuses on e-learning benefits and challenges in emerging environments, with the South African MHE institutions as examples. The inspiration is found in the Durban University of Technology (DUT) strivings to put forward this type of transformative MHE as a part of postgraduate programs at Maritime Studies Department. In order to highlight the most significant issues regarding e-learning implementation, a quantitative study based on one-shot survey was used to solicit data from carefully selected respondents. The chosen research methodology empowered respondents to express their genuine opinions on issues, which they consider important when making decisions to introduce e-learning.The analysis of the received responses have been done in Microsoft Excel Module (specially imbedded procedure) and Statistical Package for the Social Sciences (SPSS) via multiple-linear regression technique. The discussion on the obtained results, including recommendations for further research workin the field are provided.

Keywords- Maritime Higher Education (MHE), e-learning, adoption, emerging environment, multiple linear regression.

I. INTRODUCTION

The maritime cluster is one of the key enablers for growing global industry and trade. It requires skilled and competent workforce in administration, business, and industry, including those who operate contemporary ships and port equipment for cargo handling and transportation. Maritime business and industry should respond effectively to growing demands of international trade and ongoing changes, especially in the context of advanced technology. Seafarers are the first in line to implement the conventions and regulations developed by maritime authorities. Improving seafarers' education and competences would help enhance safety, efficiency and effectiveness of navigation, including marine environmental protection.The International Maritime Organization (IMO) reported that the human element and poor competence are among the main causes of accidents at sea (IMO, 2014; ILO, 2015). Competence of seafarers can be described as worthy performance on-board. This places emphasis on the need for effective maritime higher education to overcome the issue of human factor and keep pace with rapid technology driven changes in maritime. *Ships are only as good as the seafarers who operate them.* For this reason, the need for proficient seafarers seems to be a global concern for maritime effectiveness, especially in the light of shifting shipping trends, increasing ships' size and capacities, as well as the overall demand for marine transport.

South Africa as a developing country can easy transition to become a developed country by raising citizens' education, knowledge and skillsregarding contemporary labor needs(Whiting, 2020). Twenty-five years ago, the majority of the population in South Africa did not have access to higher education. Today, the situation has changed significantly although there is still a room for improvements. People need sound lifelong education and skills to keep up with technology driven, complex society. Life-long learning can be realized through formal and informal learning channels. As a huge virtual library, the internet can help in this respect. However, people should have access and a certain level of prior knowledge and education in order to utilize opportunities offered via internet. A good way of using internet smartly for educational purposes is through technology basedlearning.

Consequently, the purpose of this study is to explore the lecturers' and students' awareness of the benefits and impediments of e-learning at MHE institutions in South Africa and their readiness to adopt this form of knowledge transfer. The research is conducted among lecturers and students, including ex-students (who are currently seafarers) at selected MHE institutions in South Africa as Durban University of Technology (DUT), Cape Peninsula University of Technology (CPUT), Nelson Mandela University (NMU) and Umfolozi Maritime Academy (UMA). The selection of these institutions is motivated by the fact that these do not have yet any e-learning officially approved program. Maritime students/ex-students-seafarers have to upgrade their knowledge and skills continuously to be competent in the world maritime labor market. Maritime students are supposed to (or already) work as seafarers; they have regularly to upgrade their knowledge and refresh the certificates of competences, at the same time, so that e-learning should become an excellent solution.

The findings of this research have to assist South African MHE institutions to model and evaluate feasibility of accrediting e-learning programs through innovative educational methods and technology. Once successfully implemented, e-learning programs could serve as a model for MHE in different developing countries across African continent and wider.

South African legislation in the sphere of highermaritime education has to be modernized in terms of recognition, proper interpretation and implementation of the international Standards of Training, Certification and Watch keeping for Seafarers (STCW) Convention requirements to fast-track the deployment of e-learning as a supplement or substitute to the traditional education of seafarers. It is important not to lose sight of the fact that the STCW Convention itself calls for a proper education as the foundation of successful training and acquisition of competences. This observation is justified by the STCW Manila Amendments (Chapter II, Section B-II/1), which among others state: "The scope of knowledge is implicit in the concept of competence. This includes relevant knowledge, theory, principles and cognitive skills, which to varying degrees underpin all levels of competence. It also encompasses proficiency in what to do, how and when to do it, and why it should be done. Properly applied, this will help to ensure that a candidate can: work competently in different ships and across a range of circumstances; anticipate, prepare for and deal with contingencies, and adapt to new and changing requirements" (IMO, 2010; Bauk et al. 2013). Additionally, the newest STCW Code amendments strongly recommend the introduction of contemporary training methodologies including e-learning to uplift seafarers' knowledge and skills.

II. RESEARCH BACKGROUND

Today seafarers need e-education and training because they live and work in constantly changing and complex environment, which is technologically driven. One of the most flexible ways of transferring and acquiring new knowledge is via internet. Online courses reduce costs and make education affordable, particularly for marginalized groups such as those in removed rural areas, people with disabilities, the elderly, etc.

The STCW Convention strongly recommends implementation and adoption of e-learning at MHE institutions. The South African national legislation in the sphere of MHE has to be modernized in terms of recognition, proper interpretation and implementation of the STCW Convention requirements, and in terms of faster deployment of technology based teaching and learning as a supplement and/or substitute to the traditional pedagogical approaches. As an initial step towards achieving this goal, the study explores a cohort of lecturers and students at several MHE institutions in South Africa. More precisely, it explores whether the lecturers and students are well informed about the common advantages and disadvantages of the innovative technology-based ways of knowledge transfer and enrichment. It also investigates their readiness to introduce and adopt these teaching and learning methods. Answering this key research question is a milestone in the process of introducing, adopting and routinizing e-learningat MHE institutions in South Africa and other developing countries that function in similar economic, socio-cultural and political conditions.

The development of e-courses at MHE institutions can foster further development of collaborative online international learning (COIL) or virtual engagement/exchange (VE) that already exist at some higher education institutions in South Africa (Sabia et al., 2016; Bauk, 2017; Bauk, 2019; Bauk & Fajardo, 2020; Bauk & Gasparini Fernandez, 2021; Bauk, 2021; Bauk, 2022). These programs are currently treated as supplementary forms of regular face-to-face (F2F) or *in situ* education, but they are not recognized as formal or as official educational programs. The students, future seafarers, need both the education and its appropriate recognition. Therefore, this research should provide justification for the establishment of recognized e-learning study programs in South Africa and consequently in transitional countries worldwide.Regarding the newest changes in MHE, the afore described problem can be rephrased into: developing a model of rational, intelligent, or smart deployment of info-communication technologies and tools in transforming *transmission* (teacher-centered) into *transformative* (student-centered) MHE within the South African emerging educational environment and wider.

III. PROBLEM STATEMENT

The main objective of this case study is to provide an overview of the quantitative analysis of the processes and factors which are crucial to students and lecturers in their decision to embark on e-learning in maritime studies. The empirical work was conducted with a diverse group of lecturers and students from three different universities, i.e. Durban University of Technology (DUT), Cape Peninsula University of Technology (CPUT), Nelson Mandela University (NMU), andUmfolozi Maritime Academy (UMA). Even though the chosen universities offer different programs, having respondents from four different academic institutions provides wholesome perspective on lecturers' and students' motivationfor enhancing e-learning in MHE.

The readiness of lecturers and students to adopt e-learning in relation to two sets of independent variables in the proposed model were correlated. The lecturers' attitude towards e-learning were evaluated through variables such as the way of rising students' curiosity and creativity, collaboration between students and lecturers, improving learning outcomes, bringing innovation into teaching and learning, providing availability of digital instructional materials, allowing asynchronous modes of teaching and learning, overcoming physical distance barriers, etc. In the case of the students, their willingness to adopt e-learning was evaluated through their computer skills, availability of gadgets, internet access, readiness to learn alone, belief in e-learning benefits and their capacity to make learning easier and more convenient (Masuku, 2021).

IV. APPLIED METHODOLOGY

In order to underpin the most significant issues regarding the importance of e-learning, quantitative analysis in the form of questionnaires were carried out with the lecturers and students. The chosen research methodology empowered the respondents to

express their honest opinions and underline issues that they consider important when making decisions to implement e-learning in MHE.In conceiving the questionnaires we applied triangulation or reconciliation of two theories of adoption and expansion of info-communication technologies, i.e. *theory of diffusion of innovations* (Rogers, 2003) and *theory of a technologically acceptable model* (Davis, 1989; Davis et al., 1989). We also refer to *theory of reasoned action* (Fishbin&Ajzen, 1975) and *theory of planned behavior*(Ajzen, 1991). The proposed model on which the survey is based includes one dependent variable: intention to adopt e-learning in maritimehigher education in South Africa. The independent variables are organized into two subsets regarding lecturers' and students' affinity towards e-learning. These variables include: critical thinking skills, quality of learning outcomes, making learning easier, merging formal and informal learning styles, digital literacy and skills, accessibility, flexibility, self-discipline, and costs (Figure 1).Multiple linear regression analysis in Microsoft Excel Module and SPSS are applied upon the data collected through the questionnaires.

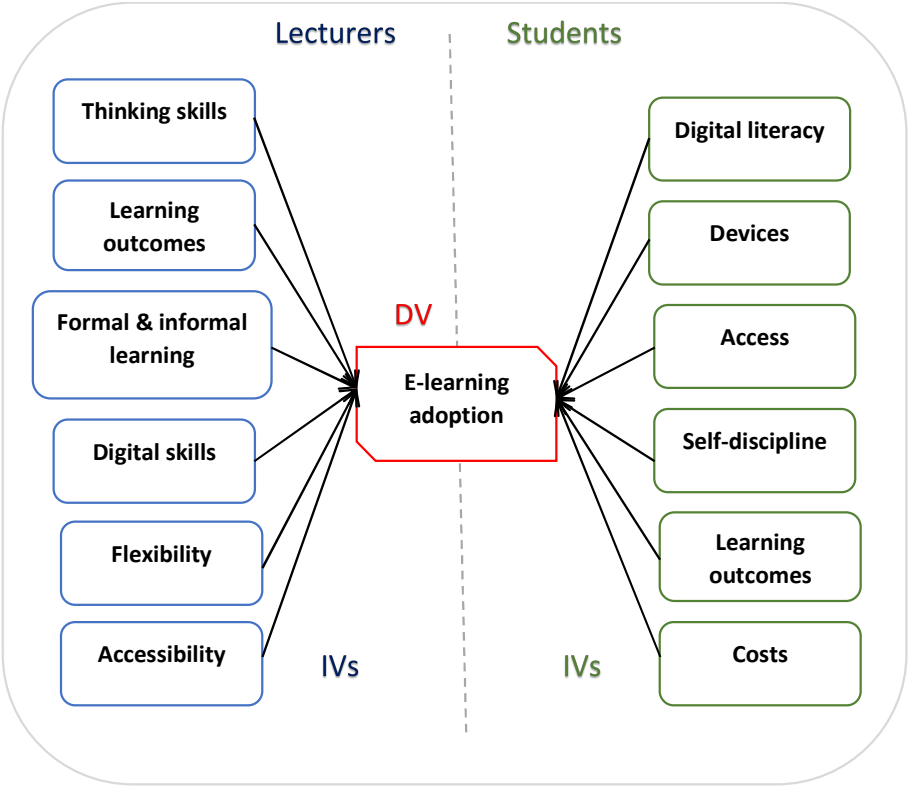


Figure 1. Dependent and independent variables encompassed by the survey (Source: Own).

The questionnaires for the lecturers and students were conceived upon the key research question:

How would you assess the real need for implementing e-learning in maritime higher education in South Africa?

This question is the core constituent of the quantitative analysis conducted among carefully selected lectures and students at tertiary MHE institutions in South Africa (DUT, CPUT, NMUand UMA). The accompanying questions were identified through extensive and critical review of relevant literature sources on the following issues:

- E-learning and MHE competence based learning;
- E-learning benefits for students and lectures;
- Knowledge about e-learning and virtual engagement in general;
- Capacities and attitudes for e-learning adoption;
- Rising MHEaccessibility and affordability; and,
- Respective costs concerns.

The first construct in the model, merging of e-learning and MHE competence based learning will be analyzed through the research question on the impact of e-learning in increasing maritime knowledge and competences. In addition, the question on e-learning as a path to the global MHE e-classroom will be also posed. The second construct considers e-learning benefits for students and lectures through increasing digital skills, fostering curiosity, easier learning, innovativeness of e-learning, its flexibility and effectiveness in comparison to F2F learning, including benefits of blended learning. The third construct, knowledge on e-learning and virtual engagement or exchange (VE) in general considers respondents' knowledge aboutthe taxonomy and familiarity with VE as a form of

educational tele-collaboration. The fourth construct, capacities and attitudes for e-learning adoption in MHE in South Africa, investigates infrastructural capacities such as computers labs, laptops, tablets, virtually smart phones, internet access and lecturers' and students' attitudes towards e-learning, time management and self-discipline issues. The fifth construct considers MHE accessibility and affordability in the context of e-learning benefits for the students from rural areas, marginalized groups and particularly seafarers who would like to continue their education and training. The sixth construct, costs, interrogates some expenditure exemptions when it comes to e- and blended learning in comparison to F2F one (Masuku, 2021).

The key research question was treated as a dependent variable in the model, while associated research questions were developed onto the independent variables. Based on the dependent and independent variables in the model hypotheses are developed. By testing the relations statistically, it became feasible to obtain reliable information on what kind of relationships exist among the variables operating in the proposed model. The hypotheses are developed based on extensive and critical literature review, includingboth 'grey' and academic sourcesasEBSCO, Science Direct, ProQuest, Web of Science, and IEEE Explore:

- H1: Actual use of e-learning in MHE in South Africa is at a modest level of development;
- H2: Introducing and adopting e-learning more extensively will bring innovations into both teaching and learning, and it is a step towards creating digital campuses;
- H3: E-learning is more flexible than traditional learning, since instructional materials are available at any time, from any device, which is connected to internet and has a browser;
- H4: E-learning can provide access to MHE to students who for some reasons cannot attend F2F classes, e.g. seafarers who have to sail and upgrade their knowledge simultaneously, students with disabilities, students from distant rural areas, and other underrepresented groups;
- H5: E-learning can reduce the costs of space, energy, infrastructure and commuting;
- H6: Some students do not have their own devices to work on, and/or permanent and reliable access to internet;
- H7: There is insufficient number of computer labs at South African campuses that can provide students and teachers with computers and uninterrupted internet access;
- H8: Some teachers and students do not have appropriate information communication knowledge and skills and they need additional training;
- H9: Through e-learning students can learn faster, but teachers have to put additional effort to prepare their classes, and this extra work is usually unpaid; and,
- H10: After some time, instructional materials may become obsolete. Therefore, return of investment into creating electronic instructional materials is vague.

The above listed hypotheses were tested through questionnaires sent via e-mail to selected South African MHE lecturers, students, and ex-students, i.e. seafarers. They populated the questionnaires voluntarily and sent them back to the researchers. The hypotheses and questionnaires were conceived on the basis of an extensive, critical literature review, discussions with colleagues and the researchers in the field. The preliminary version of the questionnaires had been sent to the expert in maritime education with the intention of improving clarity and eliminating ambiguity of the questions. The obtained results are presented in the next section.

V. DATA ANALYSIS, RESULTS AND DISCUSSION

A. Data collection

Data was collected through a questionnaire as a written set of questions to which respondents record their answers. Respondents answer the questions by choosing one number on the Likert interval scale to the best of their knowledge, experience and/or intuition. The Likert scale is designed to examine how strongly respondents agree or disagree with the statements on a five-point scale with the following anchors, which can be modified depending on the question formulation: strongly disagree (1); disagree (2); neither agree nor disagree (3); agree (4) and strongly agree (5). The questionnaire was sent to the respondents via email. After completing the questionnaire, the respondents send it back. The preliminary questionnaire contained: 37 questions for lecturers and 35 questions for students. After consultation with experts the number of questions was reduced to 25 for teachers and 25 for students. The questionnaires were designed in accordance with the code of conduct and ethical requirements at DUT. The final version of questionnaires for both lecturers and students are given in the Appendix I. After getting ethics approval, questionnaires were sent vial email to 40 lecturers and 100 students at DUT, CPUT, NMU, and UMA. The prospective respondents were reminded twice to send back their responses in due time. Thanks to their kindness after less than a month the responses (29 from lecturers and 63 from students) were collected. The acquired data were stored and their validity were tested. All received responses passed the preliminary data validity test.

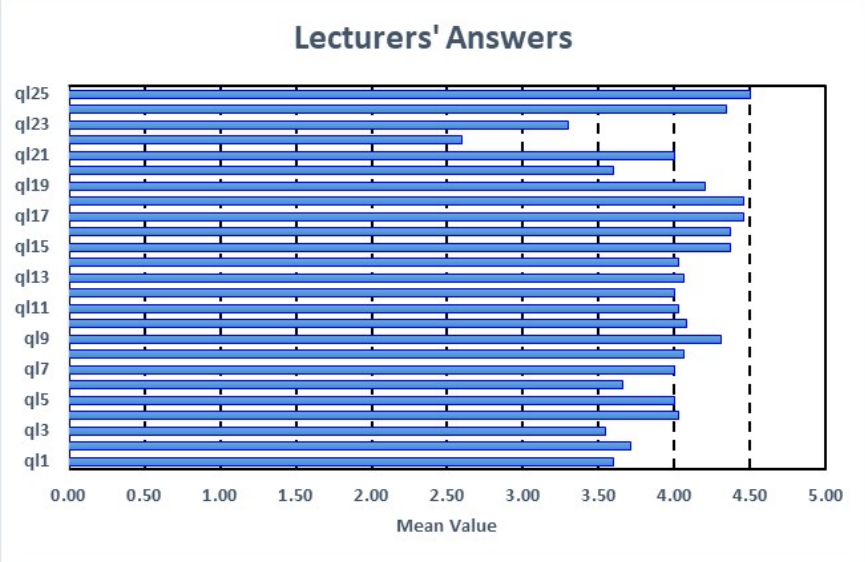
B. Data analysis

The hypothetico-deductive approach chosen for this study corresponds to quantitative analysis of collected data. The multiple linear regression method was used since the whole set of independent variables encompasses both lecturers' and students' attitudes towards e-learning. Prior to multiple regression analysis, basic statistical descriptors of the data set were tested. Quantitative analysis conducted in Excel Module and SPSS were used for multiple linear regression numerical and graphical analysis. Simulations were

done in a very short time frame over a couple of minutes. Proposed hypothesis were tested in terms of the strength of correlation between dependent and independent variables for the lecturers' and students' sets of responses. Statistical relevance of observed correlations was tested in ANOVA and it was proven to be major over the whole set of data. Upon the proven hypothesis, the researcher offered a theoretical proposal for higherer MET stakeholders in terms of faster and more effective implementation of e-learning. It must be emphasized that emergency situations such the Covid-19 pandemic urged the researchers to undertake the study. At the time of writing, all teaching and learning activities at the DUT were moved to virtual platforms such as Moodle and MS Teams, while all communications between lecturers and students were conducted via Zoom, WhatsApp and other social media like Facebook, Twitter and Instagram.

C. Numerical and graphical results – basic statistics

The results are presented and discussed into two lines: one contains descriptive statistics derived in SPSS, and the other multiple linear regression model analysis in Excel Module.Descriptive statistics gives an overview in terms of minimum, maximum and mean values of the constructs, i.e. respondents (lecturers' and students') answers due tothe line with Likert's scale (1-5). Seventeen constructs (ql1-17) have been analyzed through the lecturers' questionnaires and fifteen of these(qs1-15) through the students' questionnaires. The mean values of the acquired numerical answers are shown in Figure 2, for both sets of analyzed data.



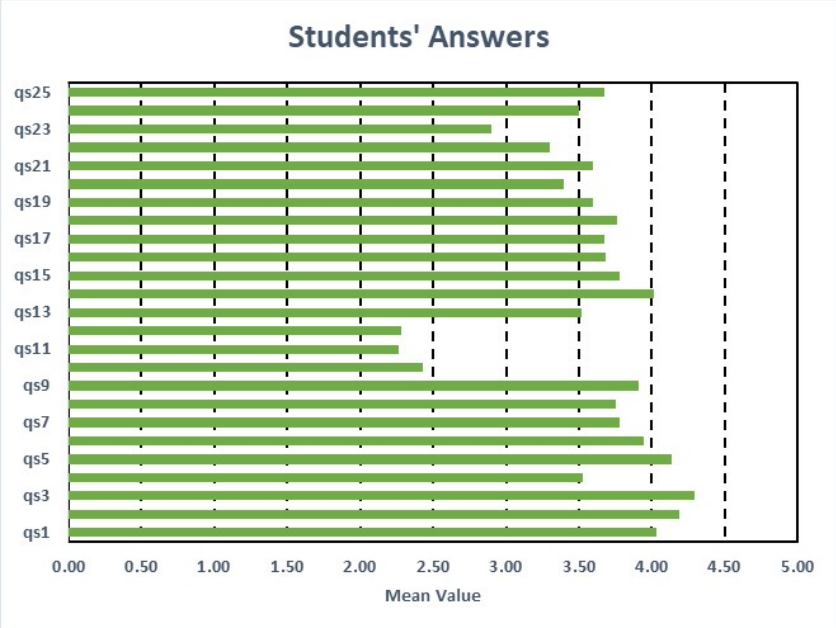


*Figure 2.*The responses per each considered construct (Source: Own).

On the basis of key statistics, in particular mean values of examined variables, upon the sets 29 lecturers' responses and 63 students' responses, the following was observed:

- *Lecturers* - The surveyed lectures assessed real needs for introducing e-learning in MHE in South Africa as relatively higher (3.6 at 1-5 Likert's scale). They emphasized the need for free internet access to lecturers and students (4.5), as well as the need for permanent institutional technical support towards realizing e-learning (4.4). On the other hand, they expressed skepticism towards the hypothesis that e-learning can enable access to higherer maritime education to students living in rural areas and to those who are somehow socially marginalized. Moreover, lecturers were skeptical about the assumption that e-learning can upraise lecturers' and students' digital skills. This opens room for further investigation through in-depth interviews with lecturers at all considered MHE institutions.

- *Students* -The surveyed students assessed the real need for introducing and adopting e-learning at MHE in South Africa as a higher one (4.03 at 1-5 Likert's scale). They believed that e-learning can support them to reach higherer digital skills (4.29) and to upraise their thinking skills (4.14). However, they were also higherly aware that the number of South African MHE institutions, which can provide e-lecturers and students with internet access and computer labs, is constrained (4.01). The investigation revealed that a small percentage of students has personal tablets, laptops or smart phones (2.28). Students were not well informed about similarities and differences in meaning among blended-, e-, computer based-, web based-, and Cloud-learning (2.43). Moreover, students were a bit skeptical that e-learning is a good way of knowledge transfer, knowledge refreshment and lifelong learning for seafarers' (2.91). All the above findings should be further interrogated through in-depth interviews with the students.

Besides the basic statistics, this sub-section gives cross-correlation analysis among all constructs in the model. The results are presented in Tables 1 and 2 in a way that "*" represents strong positive correlation (Pearson coefficient < 0.05) and "**" represents significantly strong positive correlation (Pearson coefficient < 0.01) among each pair of the considered constructs.

Table 1. Cross-correlation analysis upon lecturers' responses (Source: Own).

ql	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	1	+*	+*															-*							
2		1																							
3			1	+**		+*											+*					-**			
4				1	+**	+**						+*	+*												
5					1	+**		+*			+**	+**	+**	+*											
6						1							+*	+**					+**	-**					
7							1		+*		+*	+*													
8								1	+*		+*	+*										-**			
9									1						+*				+*						
10										1	+**	+**								+*		+**		+**	+**
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The data in Table 1 can be interpreted as follows: the assumption that e-learning enhances students' interest is in the strong positive correlation with the assumption that e-learning appraises students thinking skills and allows integration of formal and informal learning along with fostering students' curiosity and creativity. Also the assumption that e-learning enhances students' interest is in the positive correlation with statistical significance to the hypothesis that e-learning is a tool that allows teachers to interact with student in real time. By analogy the other pair of constructs, which are in strong positive correlation can be coupled and further analyzed. The data in Table 2 can be interpreted like: the students' willingness to further their studies online is in strong positive correlation with the several constructs as students' capability of using computer and internet; possession of laptop, tablet or smart-phone; possibility to check e-courses daily; capability to set own schedule and work on time; maintaining schedule and completing work without direct supervision; preparedness to learn and study in e-learning environment; considering e-learning as innovative approach; belief that e-learning can reduce costs of space, infrastructure and commuting; as well as believing that e-learning makes learning process easier. In a similar manner the rest of the positively correlated pairs of hypothesis can be described.

Table 2. Cross-correlation analysis upon students' responses (Source: Own).

sb	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	1	+**	+**		+**	+**	+**	+**	+**	-**			+**	+**	+**		+**								
2		1	+**		+**	+**	+**	+**	+**	-**		+**	+**	+**	+**						+*				
3			1	+**		+**	+**	+**	+**	-**		-**	+**	+**			+*				+*				
4				1			+**					+*								+*					+*
5					1	+**	+*	+**	+**		+*	-**	+*	+**	+**		+**	+**	+**	+*	+**				+**
6						1	+**	+**	+**				+**	+**	+*		+**	+*			+**				
7							1	+*	+**				+*	+**	+*		+**	+*			+**				
8								1	+**				+**	+*			+*						+**		
9									1			+**	+**	+**	+**			+**		+*		+**			

10										1	+**	+**	+**									+*			
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The cross-correlation analysis of each pair of constructs, led us to the observations:

- *Lecturers* - Upraising students' thinking skills is in positive linear correlation with integration of formal and informal learning styles; level of e-learning adoption at South African MHE institutions is in a positive correlation with availability of internet access and computer labs; lecturers' readiness to adapt curricula is positively correlated with availability of online assessments, etc. On the other hand, easier learning through e-courses is in negative correlation with allowing e-learning access to socially marginalized groups, which can be explained through the assumption that such a way of learning might not be the most convenient one for those learners. Moreover, reducing costs by introducing e-learning is in a negative correlation with making learning easier to socially marginalized students. This might be explained by the assumption that marginalized students are anyway prevented from participating due to the absence of internet access, data, gadgets, etc. By analogy, the other pairs of constructs which were in strong correlation with certain significance can be discussed in the similar manner.

- *Students* - The level of students' preparedness for e-learning is in a strong positive linear correlation with their ability to manage their time well, self-discipline and belief that e-learning is more engaging than classical F2F one. Moreover, upraising students' digital skills through e-learning is in a strong positive correlation with the significance of fostering students' curiosity, innovativeness, and virtual engagement in the global e-classroom. On the other hand, students' belief that e-learning can increase their digital skills is in a strong negative linear correlation with the low level of their familiarity with e-learning terminology and basic principles, including the lack of personal laptops. In a similar, manner the rest of the positively and negatively correlated pairs of constructs in the model can be discussed.

D. Numerical and graphical results – multiple linear regression

In addition to the key statistical descriptions given in the previous sub-section, some more complex analysis will be presented within this sup-section. The considerations include developing a multiple linear regression model upon some of the selected key constructs. This means that further analysis may take into consideration other constructs, but the idea here was to show how this advanced statistical tool can be used for better understanding of the obtained results. The idea is to determine a mathematical model

using multiple linear regression analysis, i.e. a functional relationship between the dependent variable (Y) and independent variables (X_1, X_2, X_3, X_4, X_5, and X_6) over the sets of lecturers' and students' responds in thestudy (Appendix II).Firstly, the analyses are realized over the set of lecturers' responds, where the dependent variable (Y) is: willingness to adapt curricula in accordance to the requirements of new technology (ql12) and independent variables (X_1, X_2, X_3, X_4, X_5, and X_6) are as follows:

- E-learning appraises students' thinking skills and allows integration of formal and informal learning along with fostering students' curiosity and creativity (ql6);
- E-learning enables smooth collaboration between students and teachers (ql7);
- E-learning can improve learning outcomes (ql9);
- Introducing and adopting e-learning more extensively, will bring innovations into both teaching and learning, and it is a step towards creating digital campus (ql15);
- E-learning is more flexible than traditional learning, since instructional materials are available at any time, from any device, which is connected to Internet and has a browser (ql16); and,
- E-learning can provide access to higherer education to the students, who are prevented from some reason to attend F2F classes, e.g. seafarers, who have to sale and to upgrade their knowledge simultaneously, students with disabilities, students in rural areas, and other underrepresented students (ql17).

Secondly, the analyses are done over the set of students' responses, where the dependent variable (Y) is: willingness to further studies online (qs1) and independent variables (X_1, X_2, X_3, X_4, X_5, and X_6) are as follows:

- Student is comfortable using a computer and internet (qs2);
- Student has personal tablet, laptop or smart phone (qs3);
- Student has reliable internet connection (qs4);
- Student is prepared to learn and study in an e-learning environment (qs10);
- Student believes that e-learning can reduce costs of space, infrastructure and commuting (qs14); and,
- Student believes that e-learning makes learning easier (qs15).

Our goal was to estimate the expected mean values of the dependent variables in both cases, based on individual estimation of the respondents. Our task was, in line with the requirements of multiple linear regression, to determine the coefficients (b_1, b_2, b_3, b_4, b_5, and b_6) and to calculate mean expected value of the dependent variable by equation (1), for lecturers' and students' sets of responds separately:

$$\overline{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 \quad (1)$$

Where is,

$\overline{Y}$ - mean expected value of the dependent variable;

b_0 - Y-axis intercept, determined on the basis of an appropriate sample; and,

$b_1, b_2, b_3, b_4, b_5, b_6$ - vector of linear coefficients for the variables X, respectively, or slopes of the corresponding lines.

This practically means that for any new value of each independent variable from a predefined interval, we can estimate the value of the dependent variable. The mean expected value of the dependent variable is average estimated value, because it is the mean value of the probability distribution of possible values of Y for a given value of X. To determine this value, the least-squares method is used (Bertskas et al., 2008). In fact, our goal here is to determine the coefficients (b1, b2, b3, b4, b5, and b6), so as to minimize the sum of squared errors (SSE), which is represented by formula (2):

$$SSE = \sum_{k=1}^{n} \left(Y_k - \overline{Y}_k\right)^2 = \sum_{k=1}^{n} \left(Y_k - \left(b_0 + b_1X_{1k} + b_2X_{2k} + b_3X_{3k} + b_4X_{4k} + b_5X_{5k} + b_6X_{6k}\right)\right)^2 \quad (2)$$

Where is,

Y_k - real value of the dependent variable, given by the k respondents, k=1,n;

$\overline{Y}_k$ - the estimated value of the dependent variable on the basis of the model, in the case of k respondents, k=1,n; and,

n - number of respondents (29 for lecturers and 63 for students), k=1,n.

Using the least-squares method, here is actually determined a straight line, which minimizes the sum of vertical differences for each pair of points (Balakrishnan et al., 2007). In other words, identified is a straight line that best fits the given set of points, by determining the optimal value of Y-axis intercept (b_0), as well as coefficient (b_1, b_2, b_3, b_4, b_5, and b_6), in order to obtain a more accurate value of the estimated value of the dependent variable for the given values of X and Y. The realization of multiple linear regression is very complex, and therefore it is better to leave it to the computer. For this purpose can be used, e.g. SPSS (Coakes, 2013) and special Excel VBA tools as Excel Module solver, which we used in these analyzes.In addition to the forecasted average

value of the dependent variable and vector of coefficients b, based on the model applied, determined can be the following statistical values: mean absolute deviation, mean square error, mean absolute percent error, standard error of regression estimate, correlation coefficient and coefficient of determination. The formulas used to calculate these values are given below, along with their brief explanations.

- *Mean absolute deviation* (MAD), indicates the numbers on how much the value of the dependent variable, obtained through multiple regression analysis, corresponds to the estimated value by the respondents, or in other words, to what extent the model reflects the perception of the respondents (3).
- *Mean square error* (MSE) is the mean value of squares of the individual errors of assessment. In other words, if we have n number of respondents, MSE value is calculated using the formula (4). MSE points expressed deviations.
- *Mean absolute percent error* (MAPE), indicates the error between the estimated value and value of dependent variable as a percentage, obtained by using the model. MAPE is the simplest statistical value for interpretation (5).

The formulas for determining the values of the previously generally described errors in the model are given below:

$$MAD = \sum_{k=1}^{n} |A_k - F_k| / n \tag{3}$$

$$MSE = \sum_{k=1}^{n} (A_k - F_k)^2 / n \tag{4}$$

$$MAPE = 100 \sum_{k=1}^{n} [|A_k - F_k| / A_k] / n \tag{5}$$

Where is,

A_k - real value of variable (value estimated by respondents), k=1,n;

F_k - estimated value of variable, k=1,n; and,

n - number of respondents (29 for lecturers and 63 for students).

- *Standard error* of the regression estimate (SE), is also called the standard deviation of regression. This statistical value is suitable for the formation of the so-called confidence intervals around the regression line. It indicates how much the value of the dependent variable, obtained by the model, can vary (numerically) (6).
- *Correlation coefficient* – r, is used to estimate the strength of linear relationships. Generally, if correlation coefficient is higherer than 0.6, it is considered to be a strong linear relation (7).
- *Coefficient of determination* - r^2, is a value between 0 and 1, which indicates to what extent (percentage) dependent variable depends on the independent variables included in the model. E.g. if r^2 is 60%, it means that the value of the dependent variable 60% depends on the independent variables in the model, and 40% on other factors (variables) that are not included in the model (8).

General formulas for calculating the standard deviation, correlation coefficient, and coefficient of determination are given below:

$$SE = \sqrt{\sum (A_k - F_k)^2 / (n-2)} \tag{6}$$

$$r = \frac{n\sum A_k F_k - \sum A_k \sum F_k}{\sqrt{\left[n\sum A_k{}^2 - \left(\sum A_k\right)^2\right]\left[n\sum F_k{}^2 - \left(\sum F_k\right)^2\right]}} \tag{7}$$

$$r^2 = \left\{ \frac{n\sum A_k F_k - \sum A_k \sum F_k}{\sqrt{\left[n\sum A_k{}^2 - \left(\sum A_k\right)^2\right]\left[n\sum F_k{}^2 - \left(\sum F_k\right)^2\right]}} \right\}^2 \tag{8}$$

Where is,

A_k - real value of variable, k=1,n;

F_k - estimated value of variable, k=1,n;

n - number of respondents (29 for lecturers and 63 for students).

The respondents, namely, 29 lecturers and 63 students, were asked to estimate the dependent (Y) and six independent variables (X_1, X_2, X_3, X_4, X_5, and X_6) in the corresponding models, each with a number on a scale from 1 to 5. Also, the values of statistical parameters, described afore, have been determined in order to analyze the reliability of the resulting predictive model.

By using Excel Module solver, the results of multiple regression analysis are obtained, for both categories of respondents. More precisely, determined are coefficients in function of the dependent variable, that is, the slice on the Y-axis (b_0) as well as the coefficients (b_1, b_2, b_3, b_4, b_5, and b_6), which correspond to the independent variables X, seriatim. Based on these values and values estimated by the respondents for each of the independent variables are calculated average values of the dependent variable (Table 3).

Table 3. Mean values of the dependent variable: lecturers' and students' responses (Source: Own).

	Lecturers	**Students**
b_0	0.832	3.190
b_1	-0.089	0.385
b_2	0.477	0.020
b_3	0.033	0.030
b_4	0.149	-0.645
b_5	0.204	0.049
b_6	0.064	0.050
$\overline{Y}_s$	**4.208**	**5.102**

Table 4 contains numerical values for mean absolute deviation (MAD), mean square error (MSE), mean absolute percent error (MAPE), standard error of the regression estimate (SE), correlation coefficient (r), and coefficient of determination (r^2).

Table 4. Errors, coefficients of correlation and determination (Source: Own).

	Lecturers	**Students**
MAD	0.169	0.497
MSE	0.043	0.485
MAPE	4.00%	15.58%
SE	0.238	0.739
r	0.886	0.741
r^2	**78.50%**	**54.90%**

Based on the data in Table 4, the following has been observed:

- Mean absolute percent errors in the analyzed cases (lecturers and students) are respectively: 4.00% and 15.58%; $\overline{Y}_s$ value can vary based on standard error of regression estimate (SE) for the values: ± 0.238 in the case of lecturers' responds, and ± 0.739 in the case of students' responds;
- Correlation coefficient values (r) are both above 0.6 that indicates strong linear correlation among considered dependent and independent variables in both analyzed cases; and,
- Coefficient of determination (r^2) indicates that $\overline{Y}_s$ is determined in 78.50% samples in the first analyzed case, suggesting a strong linear dependence, while in the second case it is 54.90%, which is slightly weaker than the coefficient of determination that could be considered as strong.

Figures 3 and 4 show the actual values of the dependent variable Y, determined on the basis of subjective estimation of 29 surveyed lectures and 63 surveyed students in the study versus those calculated by the model.

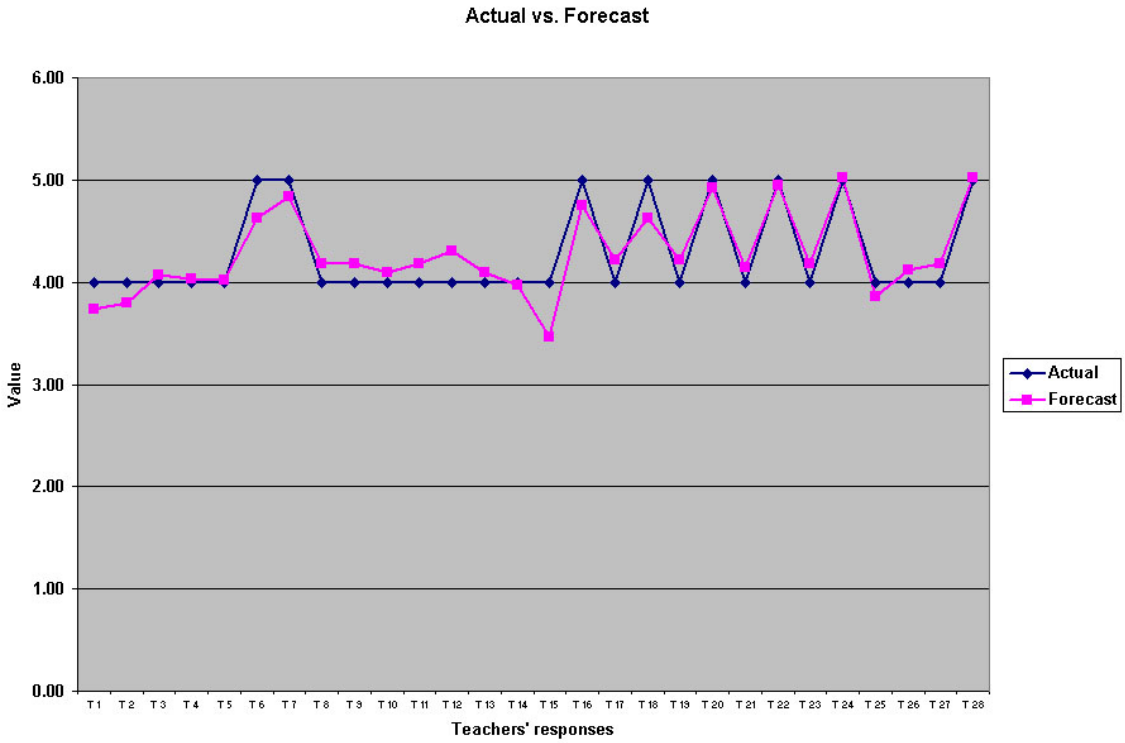


Figure 3. The values of the dependent variables, estimated by the lecturers and those determined by the model (Source: Own).

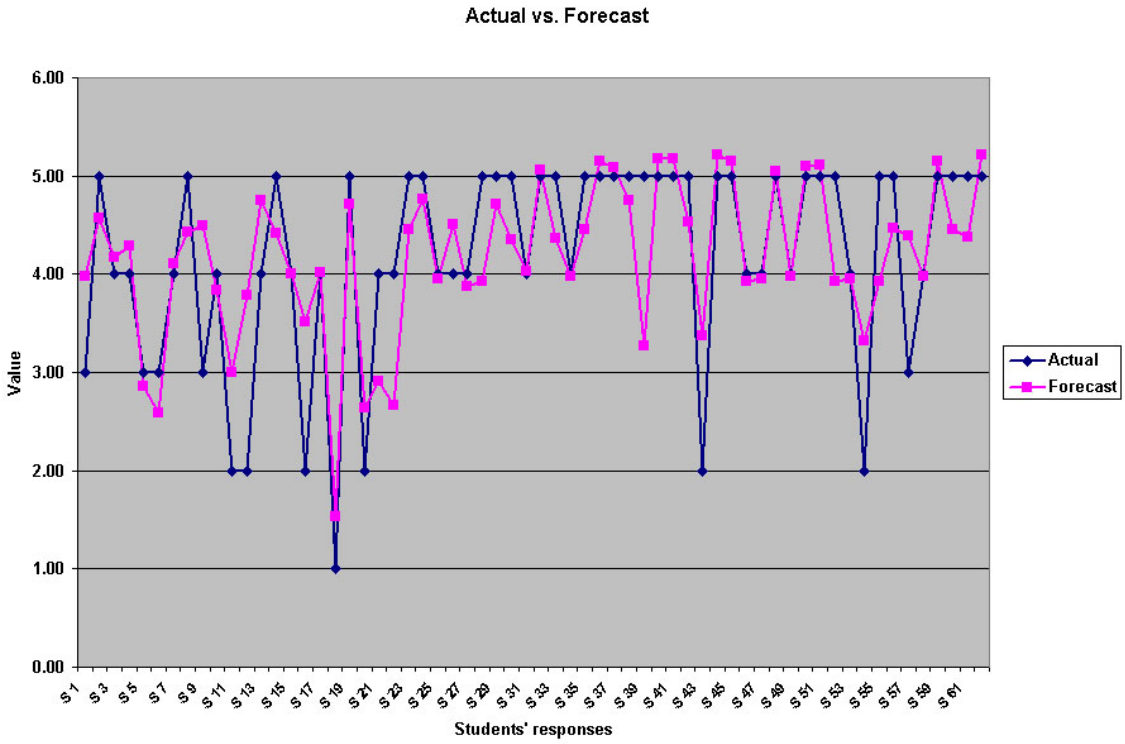


Figure 4. The values of the dependent variables, estimated by the students and those determined by the model (Source: Own).

VI. CONCLUSION

The research results on the e-learning in South Africa are more or less similar to those in other developing environments. Nevertheless, there is need to upgrade higherer education through employing e-learning mechanisms. This is an imperative in the digital age in which we live. Furthermore, everything is going global and classrooms are on the road to become global. Moreover, qualifications in MHE should be globally recognized and accredited to meet safety, efficiency and effectiveness requirements. In addition, the development and implementation of MHE policies in South Africa still lags behind other countries in the first world, thus slowing down these institutions development and harmonization with the higherest standards in the field. It is noteworthy to mention that the Covid-19 pandemic has higherlighted the necessity for e-learning in developing environments and the results of the study show the positive benefits of e-learning. Further investigations should be done using a larger cohort of lecturers and students at MHE institutions in South Africa. In addition, relevant stakeholders from Department of Higherer Education and Training (DHET), South African Maritime Agency (SAMSA), European Maritime Safety Agency (EMSA), and researchers in the field of higher education should be involved as respondents. In future studies, in-depth interviews should be conducted instead of questionnaires. This can give better insight into the analyzed preferences, needs and constraints in relation to introducing and adopting e-learning across MHE in South Africa. Besides quantitative analysis, in-depth interviews will provide better background for additional qualitative analysis. Moreover, instructional design components should be involved in future investigations. Benchmarking with MHE in other developing countries in Africa, Asia, South-East Europe, and Latin America should be done. This will give a broader picture on smart deployment of online distance learning. In addition, opportunities of collaborative online international learning with other developing and/or developed countries should be explored in more detail. The issue of lecturers' intellectual properties should be examined as well, since it is an important dimension of the challenges that e-learning faces. Using specific cases, the impact of Covid-19 on MHE should be explored. This can reveal some important facts about (un)successful practices in implementing e-learning, especially in emerging environments. Besides the pragmatics of raising competences and achieving positive economic effects, exploring e-learning adoption at MHE in South Africa should include social dimensions, along with lecturers' and students' emotions about working separately, i.e. in some kind of isolation. This important constructivist component should be a part of future investigations on MHE e-learning niche.

APPENDIX I

Lecturers' questions bank.

1. How would you assess the real need, benefits and challenges for implementing e-learning in maritime higher education (MHE) in South Africa?
2. At which extent can e-learning bring benefits to competence based maritime higher education and training?
3. At which portion, due to your opinion, can e-learning adoption at maritime higher education and training institutions upgrade lecturers' and students' digital skills?
4. To which extent, due to your knowledge, maritime Conventions (primarily STCW) support e-learning?
5. Do you believe that e-learning appraises students thinking skills?
6. Does e-learning allow, due to your opinion, integration of formal and informal learning styles?
7. Do you agree that e-learning fosters students' curiosity and creativity?
8. Do you believe e-learning can make learning easier?
9. Do you consider intensive deployment of e-learningas a key enabler of MHE "global e-classroom"?
10. How convenient, from your perspective, is blended learning (combination of e-learning and F2F one)?
11. How well are you informed about similarities/differences in meaning of the following terms: e-, computer based-, web based- and Cloud-learning?
12. Are you familiar with the terms collaborative online learning (COIL) and international "virtual engagement"?
13. At which level of adoption is currently e-learning in South African MHE due to your knowledge/experience?
14. Is the number of South African maritime higher education institutions, which can provide lecturers and students Internet access and computer labs constrained, and to which extent, due to your knowledge/experience?
15. To which extent are you willing to adapt your curricular in accordance to the requirements of new technology and e-learning?
16. To which extent are you willing to put extra effort to develop e-instructional material?
17. Are you ready to put extra effort to design computer supported assessments/tests?
18. Would you be able to access your e-course(s) regularly (daily or weekly) to update the content and send the announcements?
19. Do you have doubts when it comes to your intellectual property protection in e-learning context?
20. At which piece can e-learning reduce the costs of space, energy, infrastructure, and commuting in maritime higher education and training?
21. Can e-learning enable access to higher maritime education to the students living in rural areas?
22. To which extent can e-learning provide access to higher maritime education to those who are somehow socially marginalized?
23. Do you consider e-learning as a good way of knowledge transfer for seafarers' knowledge refreshment and their life-long learning?

24. Do you think that e-learning requires permanent institutional technical support?
25. Is South Africa as developing country able to cover the costs of e-learning development and implementation, and to provide free Internet access to lecturers and students due to your opinion?

Students' questions bank.

1. How would you assess the real need, benefits and challenges for implementing e-learning in maritime higher education (MHE) in South Africa?
2. In which piece e-learning can increase your maritime knowledge and competitiveness?
3. In which extent e-learning can support you to reach higher digital skills?
4. Do you believe that e-learning can foster your curiosity and creativity?
5. Do you believe e-learning can make learning easier?
6. Do you consider e-learning innovative and to which extent?
7. Do you see e-learning as a path towards establishing "global e-classroom" in MHE?
8. Do you consider e-learning more flexible than traditional face-to-face learning?
9. How convenient, from your perspective, is blended learning (combination of e-learning and F2F one)?
10. Are you informed, and to which extent, due to similarities/differences in meaning of: blended-, e-, computer based-, web based and Cloud-learning?
11. Are you familiar with the terms collaborative online learning and international "virtual engagement"?
12. Do you have your personal tablet, laptop or smart phone?
13. Do you have (reliable) Internet access?
14. Are you able to read well and follow written directions well?
15. Are you willing to further your studies via e-learning?
16. Are you prepared to learn and study in e-learning environment?
17. Would you be able to access your e-course(s) regularly (daily or at least weekly) to check the announcements?
18. Would you be able to maintain a schedule and complete work in e-learning environment without direct supervision?
19. Do you believe that e-learning can assist you with time management and self- discipline?
20. Do you think that e-learning makes learning process easier?
21. Do you consider e-learning an effective learning channel/method?
22. Do you think that e-learning can reduce costs of space, infrastructure and commuting?
23. Do you think that e-learning can provide opportunities for students living in rural areas?
24. Do you think that e-learning can provide opportunities for students how are socially under-represented (marginalized)?
25. Do you consider e-learning as a good way of knowledge transfer for seafarers' knowledge refreshment and their life-long learning?

APPENDIX II

Categories of lecturers' questions for multiple linear regression analysis.

Dependent variable		
Q1	Real needs, benefits and challenges for adopting e-learning in SA	
Independent variables		
Q2	… Benefits to competence based MHE	*Category 1:* **MHE competence based learning**
Q4	… To which extent STCW supports e-learning	
Q9	… E-learningas enabler of MHE "global e-classroom"	
Q3	… E-learningand upgrading digital skill	*Category 2:* **Benefits for students and lecturers**
Q5	… Upraise students thinking skills	
Q6	… Integration of formal and informal learning styles	
Q7	… Students creativity and curiosity	
Q8	… Easier learning	
Q10	… Convenience of e-learning and F2F one	*Category 3:* **Lecturers' knowledge about e-learning**
Q11	… How well lecturers are informed about different e-Learning modes	

Q12	… Are lectures informed about COIL	**and complementary e-learning modes**
Q13	… Level of e-learningadoption in South Africa	
Q14	… Capacities for e-learning: Internet access and labs	
Q15	… Lecturers' willingness to adapt curricula to e-learning	*Category 4:* **Capacities and attitudes for e-learning implementing and adopting**
Q16	… Lecturers' willingness to develop e-instructional materials	
Q17	… Introducing computer/Internet supported assessments	
Q18	… Lecturers' time availability and schedules appropriateness	
Q19	… Intellectual property protection issues	
Q20	… Reducing costs of time, space and commuting	*Category 5:* **Rising MHE accessibility and affordability**
Q21	… Access to higher MHE for students from rural areas	
Q22	… Access to higher MHE for socially marginalized groups	
Q23	… Access to higher MHE for active seafarers	
Q24	… Need for technical support	*Category 6:* **Additional costs concerns**
Q25	… Free Internet access to lecturers and students	

Categories of students' questions for multiple linear regression analysis.

Dependent variable		
Q1	Real needs, benefits and challenges for adopting e-learning in South Africa	
Independent variables		
Q2	… Increasing maritime knowledge and competences	*Category 1:* **MHE competence based learning**
Q7	… path to the global MHE e-classroom	
Q3	… Increasing digital skills	*Category 2:* **Benefits for students and lecturers**
Q4	… Fostering curiosity	
Q5	… Easier learning	
Q6	… Innovativeness of e-learning	
Q8	… More flexible than face-to-face learning	
Q9	… Blended learning benefits	
Q20	… E-learning as more interesting way of learning	
Q21	… More effective learning	
Q10	… Taxonomy knowledge	*Category 3:* **Students' knowledge about e-learning and virtual engagement in general**
Q11	… Familiarity with term "virtual engagement"	
Q12	… Laptops availability	*Category 4:* **Capacities and attitudes for e-learning adoption**
Q13	… Internet access availability	
Q14	… Capability of following written instructions	
Q15	… Willingness to continue education via e-learning	
Q16	… Preparedness for adopting e-learning	
Q17	… Time management issue	
Q18	… Need for supervision	
Q19	… Self-discipline issue	
Q23	… Students from rural areas	*Category 5:* **Rising MHE accessibility and**
Q24	… Students belonging to marginalized groups	

Q25	… Seafarers	**affordability**
Q22	… Reducing costs	*Category 6:* **Costs concerns**

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