



Three Managerial Solutions for E-learning Technologies Related to the Covid-19 Pandemic

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Paper ID: 13A4L

Volume 13 Issue 4

Received 20 December 2021

Received in revised form 14
March 2022

Accepted 28 March 2022

Available online 08 April
2022

Keywords:

University authorities;
Educational management;
University management
solution; e-learning
technologies; Educational
services; Student needs;
University offers; Polish
students; Ukrainian
students; Educational
services market.

Abstract

The purpose of this experimental study is to prepare management solutions for University authorities regarding e-learning technologies related to the COVID-19 pandemic. The research methods were literature review, sociology, and statistics. 349 Polish and Ukrainian respondents participated in this study. For the first time, the student's needs and the university's offers in e-learning technologies were empirically measured. The alternative hypothesis was accepted. The authors accepted the Alternative hypothesis. This is the first study that revealed the University offers in e-learning technologies do not meet the students' e-learning needs in Poland and Ukraine. The significance level of 99.0% was accepted. It shows that the decisions are correct in about 99.0% of cases. And the decisions are not correct in about 1.0% of all the cases. Finally, there were prepared three managerial solutions for e-learning technologies related to the Covid-19 pandemic. Two of them have practical significance whereas the other one has theoretical significance.

Disciplinary: Education (HEI Education Management, Education Technologies).

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Cite This Article:

Okulich-Kazarin, V., Losiyevska, O., Fesenko, O., Zhurba, A., and Bondarchuk, Y. (2022). Three Managerial Solutions for E-learning Technologies Related to the Covid-19 Pandemic. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*, 13(4), 13A4L, 1-10. <http://TUENGR.COM/V13/13A4L.pdf> DOI: 10.14456/ITJEMAST.2022.75

1 Introduction

The final goal of educational technologies is to create optimal conditions for the development of society, engineering, management, and technologies (Belentsov et al., 2020;

Alsobhi et al., 2021).

There are three reasons why the results of this experimental study are important. The first reason is that civilization faces a global threat of a COVID-19. Many universities have started to use e-learning technologies more widely. The second reason is that e-learning is a normal form of teaching. This form was not widely used in East European universities before. And finally, after the collapse of the socialist camp, students of East European universities began to be perceived as consumers of educational services with their own needs.

This interdisciplinary research will address the issues of management of the educational services using e-learning technologies related to the COVID-19 pandemic. This experimental study involved Polish and Ukrainian respondents. This experimental study is the second part of research published earlier (Okulicz-Kozaryn, 2020). The authors use the same methods of forming groups of respondents, groups of respondents, and methods of scientific research. The difference between the first and second parts of the study is for research and in the results obtained. Based on the scientific analysis, three management solutions will be given to university authorities. These solutions were not clear before this research.

2 Literature Review

2.1 Common Information on e-Learning Technologies

E-learning technologies formally entered universities and businesses in 1999 (Academic, 2019). In educational institutions, e-learning is one of the ways to meet the needs of modern society, where students can no longer see their life without a computer and a mobile phone (HR school, 2020). Today e-learning is not a new form of teaching for universities. E-learning is an electronic learning system that is synonymous with such terms as distance learning, computer-based learning, online learning, virtual learning, and learning using information and electronic technologies (Academic, 2019). So, here will be used different definitions associated with e-learning, such as distance learning, online learning, and virtual learning. Researchers at the University of Catalonia have proposed to consider e-learning as an educational paradigm (Sergeev et al., 2012). They define e-learning as an innovative approach to learning and a method of providing a well-designed interactive learning environment for any student, anywhere and at any time, using the resources of various digital technologies along with other forms of educational materials.

Many scientists study various aspects of e-learning, such as methods, tools, programs, quality, effectiveness, general problems, particular questions, and so on. For example, Tucker and Gentry (2009) explore e-learning strategies in universities. Rodríguez-Ardura and Meseguer-Artola (2018) have made practical recommendations for higher education organizations, policymakers, and university teachers in e-learning technologies. The article (Afifi, 2011) deals with the potential advantages and disadvantages of using e-learning for students in the field of tourism. The authors (Seale et al., 2008) study the e-learning practice of disabled students in one higher education institution.

No one has studied the students' needs in e-learning Coronavirus (2020) that danger zones cover many socio-geographical regions, including Eastern Europe. Thus, we'll look at educational needs related to e-learning technologies in Eastern Europe. The experimental study will consider educational services in the form of e-learning in the example of Poland and Ukraine.

2.2 Theoretical Brief of Educational Services

The definition of "educational services" was on the top more than 30 years ago. However, problems in the world markets of educational services have received interest in this topic again.

For example, it was not so long ago that the article (Bunce et al., 2017) was published. It is shown that the English government has defined students as customers, although educators did not agree with this approach. The authors show that consumer orientation has positively impacted academic performance. The findings of the article (Lei and Hazri, 2019) have provided empirical evidence to inform university authorities to tailor well-planned courses to meet students' needs and their satisfaction. Although there are many other articles on the subject of educational services (for example, Macakova and Wood, 2020; Walsh et al., 2020; Alqurashi 2019; Elliott and Healy, 2001). Bunce et al. (2017) and Lei and Hazri (2019) set the tone for this entire study.

A comparison of distance learning offers by Polish and Ukrainian Universities before the COVID-19 pandemic is in the article (Okulicz-Kozaryn, 2020). It was shown that Polish and Ukrainian University offers in e-learning technologies are equal. This will be done by comparing students' e-learning needs with students' opinions on the level of e-learning offers. It will be shown how the coronavirus affected the satisfaction of students' e-learning needs. And, in the very end, the authors will create three managerial solutions for university authorities.

3 Method

This empirical study was done by the authors from May 2017 till November 2021. The research methods were such as literature review and sociology (planning of ascertaining experiments, questioning of students, a grouping of the obtained data), and statistics (primary processing of the obtained data, verification of statistical hypotheses).

The purpose of this experimental study is to prepare a few managerial solutions for e-learning technologies related to the Covid-19 pandemic in such countries as Poland and Ukraine.

The main hypothesis: University offers in e-learning technologies meet students' e-learning needs in Poland and Ukraine.

The object of the study is e-learning technologies. The subject of the study is the difference between Universities' offers and students' e-learning needs.

3.1 Planning the Experiments

Making a plan of the ascertaining experiment the authors included a comparison of students' needs and University offers in Poland and Ukraine just before the very beginning of the COVID-19 pandemic. The planning and execution of the experiment are described in detail in a previous article by one of the co-authors (Okulich-Kazarin et al. 2020).

The authors used serial sampling (Kravchenko, 2014) for doing experiments. Serial (nested) sampling means that groups of the student population must be selected. In this empirical study, the groups were selected randomly according to the sources (Kravchenko, 2014). The maximum diversity of selected groups was tried to ensure. The characteristics of the respondents participating in this empirical study, after the rejection of substandard answers, are in Table 1.

Table 1: Characteristics of the groups of respondents. These groups of respondents were published in the first part of the study (Okulicz-Kozaryn, 2020)

No	Specialty	Number, n	Forms of study	University
1. Poland				
1	Administration	69	part-time, 2 degree, 2 year	Pedagogical University of Kraków
2	Social economy	20	full-time, 1 degree, 1 year	
3	Social economy	12	full-time, 1 degree, 2 year	
4	Social economy	14	full-time, 2 degree, 2 year	
5	Law	10	full-time, 1 degree, 4 year	
6	Finance and Accounting	29	full-time, 1 degree, 3 year	Kraków University of Economics
7	Management	17	full-time, 1 degree, 2 year	University of Technology, Koszalin
8	Economics	16	full-time, 1 degree, 2 year	
9	Tourism and Recreation	20	full-time, 1 degree, 3 year	
	Total respondents:	207	-	
2. Ukraine				
10	Pharmacy	30	full-time, 1 degree, 2 year	Rivne Medical Academy
11	Electromechanics	15	full-time, 1 degree, 3 year	Kharkiv National University of Urban Economy of A.N. Beketova
12	Medical business	27	full-time, 1 degree, 5 year	Vinnitsia National Medical University of N. I. Pirogova
13	International economic relations	15	full-time, 1 degree, 4 year	Dnipro National University of O. Gonchar
14	International economic relations	15	full-time, 2 degree, 1 year	
15	Law	25	full-time, 1 degree, 3-4 years	Wolodymyr Dahl East Ukrainian National University
16	Law	15	full-time, 2 degree, 1-2 years	
	Total respondents:	142	-	-
	Total number of respondents:	349	-	-

Table 1 shows that the authors surveyed three hundred and forty-nine respondents from Poland and Ukraine. There were 16 groups of respondents of sizes from 12 to 69 people in each (Okulicz-Kozaryn, 2020). Undergraduate and graduate students were surveyed. Full-time and part-time students were surveyed also. And finally, respondents of Humanity and Natural Sciences, as well Engineering specialties were among the students. The statistical processing was aimed at the calculation of important statistical indicators, such as the expected value (\bar{X}), the standard deviation for the sample (δx), and the standard deviation for the population (δ_{x-1}).

3.2 Questionnaire Survey

Two questions were prepared by the authors. The authors have asked students like consumers of higher education services. In relation to the present stage of the study, the main research questions for students were about a share of e-learning at the university where the

students study. Students were asked to write two numbers:

1) e-learning technologies are needed by me today - the percentage of the total amount of academic hours,

2) e-learning technologies are offered by the University in reality, how do I assess - the percentage of the total amount of academic hours.

Each respondent gave two answers in percentages from 0% to 100%. Thus, this empirical study analyzed the opinions of three hundred and forty-nine students. Answers were statistically processed for each group of students. These opinions were about two aspects of e-learning technologies: the students' needs and the University's offers just before the very beginning of the COVID-19 pandemic in Poland and Ukraine.

3.3 Verification of Statistical Hypotheses

The authors have verified statistical hypotheses in accordance with the standard way (Minashkin, 2008; Okulich-Kazarin et al. 2020). It verified the difference between two known mathematical expectations $\check{X}_1 - \check{X}_2$ (Minashkin, 2008). The first mathematical expectation \check{X}_1 relates to students' e-learning needs. The second one \check{X}_2 relates to University offers in e-learning technologies. To estimate the differences between two known mathematical expectations \check{X}_1 and \check{X}_2 , it was used a standard way (Minashkin, 2008). If the standard significance level is accepted as 99.0% ($p = 0.01$), at that time $z_{\text{tabl}} = 2.58$ (Minashkin, 2008). The verification process made it possible to transform the individual opinions of three hundred and forty-nine respondents into objective scientific knowledge.

4 Result and Discussion

4.1 Primary processing of the obtained data and grouping of results

The Polish students' needs and Ukrainian students' needs and the University's offers in e-learning technologies are given in Table 2. There are data obtained just before the very beginning of the COVID-19 pandemic in Table 2.

Table 2: The Polish students' needs and Ukrainian students' needs and the University offers in e-learning technologies.

Respondent group number	Indicator	Statistical indicators			
		n	\check{X} , %	δ_x , %	δ_{x-1} , %
1	students' needs	69	41.64	18.72	18.85
	University offer		17.18	13.43	13.55
2	students' needs	20	55.58	17.47	18.01
	University offer		33.53	15.28	15.78
3	students' needs	12	54.62	22.74	23.67
	University offer		25.00	9.81	10.21
4	students' needs	14	37.50	14.65	16.05
	University offer		13.33	7.99	8.76
5	students' needs	10	42.50	12.50	13.17
	University offer		15.70	9.56	10.07
6	students' needs	29	-	-	-
	University offer		20.00	13.72	14.14
7	students' needs	17	27.33	29.99	31.04
	University offer		5.33	8.84	9.15

Respondent group number	Indicator	n	Statistical indicators		
			\bar{X} , %	δ_x , %	δ_{x-1} , %
8	students' needs	16	13.50	28.03	28.95
	University offer		3.75	8.56	8.85
9	students' needs	20	31.50	25.54	26.21
	University offer		10.00	10.95	11.23
10	students' needs	30	24.66	26.98	27.94
	University offer		13.50	13.67	13.90
11	students' needs	15	52.50	24.19	25.27
	University offer		35.83	39.25	41.0
12	students' needs	27	20.92	23.13	23.57
	University offer		5.40	11.46	11.67
13	students' needs	15	38.57	12.45	13.45
	University offer		12.86	8.81	9.51
14	students' needs	15	38.47	33.99	35.27
	University offer		12.67	27.19	28.15
15	students' needs	25	54.20	21.33	21.77
	University offer		26.12	23.42	23.90
16	students' needs	15	68.66	21.86	22.63
	University offer		22.00	21.03	21.77

Table 2 shows the expected value (\bar{X}) for the student's needs and the University's offers in e-learning technologies in Poland and Ukraine. Table 2 does not provide an answer to the question:

Q1. Is there a significant difference in students' needs and University offers in e-learning technologies for these two countries as a whole?

Thus, the authors presented the data in Table 2 as a diagram (Figure 1). The numbers of the respondent groups are located along the horizontal axis. The vertical axis shows the size of the expected value of students' needs and University offers as a percentage. Here the group expected value (\bar{X}) is entered.

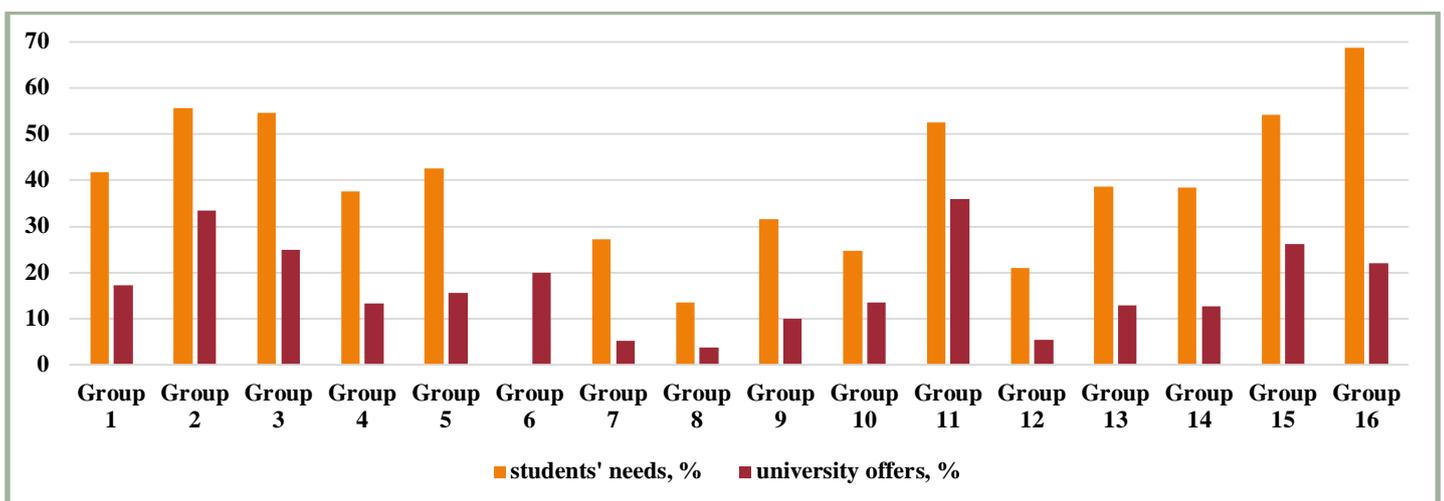


Figure 1: The students' needs and University offers in e-learning technologies in Poland and Ukraine.

What does Figure 1 show? Figure 1 clearly shows that the students' needs are higher than the University offers in e-learning technologies in Poland and Ukraine. But, Table 1 and Figure 1 do not provide an answer to the question Q1.

Verification of statistical hypotheses provides a correct, reliable, and scientifically-based answer to this question. The verification allows you to get absolutely new scientific knowledge

about e-learning technologies for Polish students and Ukrainian students. For this, the authors made two new samples to statistically compare the Polish and Ukrainian needs and offers of e-learning technologies (Table 3). The expected values (\bar{X}_1 and \bar{X}_2) of each group were taken from Table 2. They were used for the calculation of the new group statistical indicators (Table 3).

Table 3: Students' needs and University offers in e-learning technologies in Poland and Ukraine.

№	Indicators	Statistical indicators			
		n	\bar{X} , %	δ_x , %	δ_{x-1} , %
1	Students' needs	15	40.00	15.00	15.00
2	University offers	16	17.00	9.00	10.00

Table 3 line 1 shows data for a combined sample of needs of Polish students and Ukrainian students in e-learning technologies. Table 3 line 2 shows data for a combined sample of offers from Polish and Ukrainian Universities in e-learning technologies.

There is a difference between students' needs in line 1 and University offers in line 2. Statistical indicators (Table 3) allow for verification of statistical hypotheses to get absolutely new scientific knowledge for making managerial solutions related to e-learning technologies and COVID-19.

4.2 Verification of statistical hypotheses

Table 3 and Figure 1 clearly showed that students' needs for e-learning are higher than University offers in Poland and Ukraine. Is this difference significant? Or the difference is a result of random deviations?

So, will be verified the difference between two known mathematical expectations (\bar{X}_1 and \bar{X}_2) at a confidence level equal to 99.0 (Minashkin, 2008). For correct testing of the main hypothesis, it was divided into two hypotheses. The first hypothesis is a Research one. The second hypothesis is an Alternative one.

The Null hypothesis is $H_0: \mu_1 - \mu_2 = 0.0$. In other words, it sounds: like there are no significant differences between University offers and students' needs in e-learning technologies if one does not take into account random deviations.

The Alternative hypothesis is $H_1: \mu_1 - \mu_2 \neq 0.0$. In other words, it sounds: like there are significant differences between University offers and students' needs in e-learning technologies if one does not take into account random deviations.

Table 4 presents the results for the verification of two new statistical hypotheses. Table 4 shows that $|z_{stat}| = 7.19$ is more than $z_{tabl} = 2.58$. That is why the Alternative hypothesis is accepted: there are significant differences between University offers and students' needs in e-learning technologies if one does not take into account random deviations. This is an absolutely new scientific knowledge: before the COVID-19 pandemic universities offered e-learning technologies do not meet students' e-learning needs in Poland and Ukraine. The result is useful for university authorities.

Table 4: Data for verification of two new statistical hypotheses.

No	Indicator	Students' needs	Universities' offers
1	the size of a sample, n	15	16
2	the expected value, \bar{X} , %	40.00	17.00
3	$ \bar{X}_1 - \bar{X}_2 $	23.00	
4	$\mu_1 - \mu_2$	0.00	
5	the standard deviation for the sample, δ_x , %	15.00	9.00
6	average error, $\bar{S}_x = \delta_x / \sqrt{n}$	0.039	0.023
7	S^2	0.0015	0.0005
8	$\bar{S}_1^2 - \bar{S}_2^2$	0.0010	
9	$\sqrt{(\bar{S}_1^2 - \bar{S}_2^2)}$	0.032	
10	$ z_{stat} $	7.19	
11	the value z_{tab1} for the significance level of 99.0	2.58	
12	Result, $ t_{stat} > t_{tab1}$	Yes	

So, the difference between students' needs and University offers in e-learning technologies should be used for solving management tasks for e-learning technologies related to the Covid-19 pandemic in Poland and Ukraine.

The Alternative hypothesis was accepted. It means that this result is stronger compared to the case when the Research hypothesis is accepted.

4.3 Discussion

4.3.1 What Did the Results Show?

The results of this experimental study are a reason for discussion. We cannot accept our results as a new scientific theory, as a new science construct, or as a new science regularity. We have got new scientific knowledge. This knowledge allows us to prepare management solutions for e-learning technologies related to the Covid-19 pandemic in Poland and Ukraine. The results of this experimental study are a reason for discussion.

The results show that University offers of e-learning technologies do not meet students' e-learning needs in Poland and Ukraine before the very beginning of the COVID-19 pandemic. The University's offers in e-learning technologies are 17.00% before the very beginning of the COVID-19 pandemic. The students' needs for e-learning technologies are 40.00% before the very beginning of the COVID-19 pandemic.

Thus, the individual opinions of three hundred and forty-nine independent respondents were used by the authors to get new scientific knowledge that helps to prepare management solutions related to e-learning technologies and COVID-19 in Poland and Ukraine.

4.3.2 What Managerial Solutions can be Recommended for University Authorities?

In the practical part, Polish and Ukrainian university authorities must use e-learning technologies during the COVID-19 pandemic according to the students' needs in them. The share of e-learning should be about 40.00%. To take care of public health, University authorities should use other methods, not only distance learning at a rate of 100%. Such methods are:

- vaccination of university students and teachers;
- restriction of students' contact with each other and with university teachers;
- wide application of sanitary and hygienic measures, etc.

The practical significance of these research results means that University authorities must equip Universities for e-learning.

These are the first and second managerial solutions for e-learning related to the COVID-19 pandemic:

- University management must equip Universities for e-learning.
- Share of e-learning should be scheduled at about 40.00%, at least in Poland and Ukraine.

In the scientific part of the research, the individual opinions of three hundred and forty-nine independent respondents were used by the authors to get absolutely new scientific knowledge. Thus, the didactic theory should be corrected in Poland and Ukraine. Polish and Ukrainian professors must refocus the didactic theory on the needs of students as consumers of higher education services. They should look at e-learning as a new educational paradigm. They should define distance learning and e-learning as innovative approaches to learning used to provide a well-designed interactive learning environment for any student. And new didactic theory must reflect the students' needs in e-learning as quickly as possible. And every manager, policymaker, educator, and academic should explore the students' needs in e-learning in their country.

This is the third managerial solution for university authorities can be recommended for e-learning technologies related to the COVID-19 pandemic:

- To correct the didactic theory according to students' needs that equals 40.00%.

4.3.3 Can You Trust the Results?

1. The authors accepted the results with a high level of significance 99.0%. It shows that the three managerial solutions are correct in about 99.0% of cases and they are not correct only in about 1.0% of cases. It means that we have a process of making the decision with accurate, controlled probability.

2. In the research (Chukwuedo and Ogbuanya, 2020) it was 84 respondents only. In one more article, 153 persons were selected as the sample of the study (Abbasi & Zargar 2019). A number of 167 respondents took a participation in the study (Alqurashi 2019). So, we know that number of three hundred and forty-nine respondents is a good amount to get a reliable, correct, and scientifically based result.

3. The Alternative hypothesis was accepted, indicating there are significant differences between University offers and students' needs in e-learning technologies.

5 Conclusion

The purpose of this experimental interdisciplinary study has been achieved: three managerial solutions for e-learning technologies related to the COVID-19 pandemic were prepared. The main hypothesis was checked: University offers in e-learning technologies meet students' e-learning needs in Poland and Ukraine.

The results obtained have theoretical and practical significance. For the first time, the student's needs and the university's offers in e-learning technologies were statistically compared.

The individual opinions of three hundred and forty-nine independent respondents were used by the authors to get absolutely new scientific knowledge. The University's offers in e-learning technologies are 17.00% and the students' needs in e-learning technologies are 40.00% before the very beginning of the COVID-19 pandemic.

University authorities there were prepared three managerial solutions for e-learning related to the COVID-19 pandemic in Poland and Ukraine:

- 1) University authorities must equip Universities for e-learning.
- 2) Share of e-learning should be scheduled at about 40.00%, at least in Poland and Ukraine.
- 3) The didactic theory should be corrected according to students' needs which equals 40.00%.

In the management of higher educational services, it is better to use these results until the results relating to COVID-19 and e-learning in other countries are obtained. The next task is to measure the University offers and students' needs in e-learning technologies during the COVID-19 pandemic.

6 Availability of Data and Material

Data can be made available by contacting the corresponding author.

7 Acknowledgment

This work is supported by the project Quality of Educational Services and Values of European culture (Sobornist ZSL 20211204/1), Service Agreement No. EU-1/21 from October 15, 2021 - Scientific research "Analysis and Development of Recommendations for Teachers of Ukrainian Universities to Improve the Quality of Educational Services".

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