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Assessment and Effectiveness of E-learning and Students' Satisfaction with Online Classes: The Example of Polish Universities

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Abstract:

Purpose: *The article is an attempt to assess the effectiveness of e-learning as well as the satisfaction of students with online learning.*
Design/Methodology/Approach: *The study was conducted in 2021 on a random sample of 1203 students of chosen Polish universities. The methods used in the study was CAWI. In the first stage of the analysis attempts were made to define the variables influencing the effectiveness of e-learning as well as the degree of the satisfaction of students with the online classes.*
Findings: *The studies demonstrate a close correlation between the student's satisfaction with e-learning and the lecturer's involvement in the classes, good support and functioning of the university's ICT system, an technical and methodological preparation of the university for the implementation of e-learning.*
Practical Implications: *The results of the research show clearly that authorities should put emphasis on good support and functioning of their university's ICT system, on technical and methodological preparation and on lecturer's involvement in the classes conducted, because it will result in a higher degree of student satisfaction with e-learning. These variables should also be systematically monitored and analysed as this would be mutually beneficial for both university and students and would contribute to the effectiveness of distance learning.*
Originality/Value: *A set of variables that affect students' satisfaction was identified and the strength of influence between endogenous variables was shown.*

Keywords: *E-learning, effectiveness, satisfaction.*

JEL codes*: I21, I23.*

Paper type: *Research article.*

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1. Introduction

The development of didactics is becoming a permanent phenomenon, while its increasingly popular form is e-learning, commonly used at Polish universities. During the COVID-19 pandemic, it is the most popular form of learning and is becoming available to an increasingly wider extent. The purpose of the article is to determine the variables that influence the effectiveness of e-learning and the degree of satisfaction with this form of education felt by students of Polish universities. The authors attempt to show that during the COVID-19 epidemic, e-learning has become an effective method of education, though not without its shortcomings. Its aim was to determine the variables influencing the effectiveness of e-learning and the degree of student satisfaction with the classes conducted in this system. Additionally, the strength of relationships between these variables was measured using statistical methods.

The results of these studies will make a huge contribution to the process of remote education of students. This topic was addressed due to its up-to-date nature and great importance. In the article, the authors tried to demonstrate statistical relationships. In order to verify them, the χ^2 test of independence was used. Thanks to the results of this research, it is possible to present recommendations for Polish universities which may effectively raise the level of e-learning and eliminate the existing weaknesses.

2. Background

2.1 E-learning as a Modern Teaching Tool Society

The term e-learning is an abbreviation of electronic learning, a didactic process that uses a specific range of means. This notion can be defined as a form of education which can be provided by means of any electronic medium, such as a computer connected to a network, the radio or the television. Therefore, it should not be associated only with the Internet, as it can employ any digital medium of information, such as a hard disk or optical discs, e.g. CDs and DVDs. Teaching takes place through correspondence, text, graphics, CD-ROMs, audio and video conferences, audio and video tapes, and interactive television (Nixon *et al.,* 2018; Matthews *et al.,* 2018; Hall, 2017; Hall and Witek, 2016; Khan *et al.,* 2020).

E-learning remains one of the forms of distance learning, at the same time, it should be pointed out that it is much more than just that (Olszewska, 2020; Kumar Basak *et al.,* 2018; Srivastava, 2019; Maatuk *et al.,* 2021; Bishop, 2018). Distance learning is an organised form of education in which the lecturer has no physical contact with the student. E-learning includes various teaching techniques, such as CBL (Computer-Based Learning), WBT (Web-Based Training) or virtual classrooms. This learning system allows one to learn anywhere and anytime. It makes it possible to enrich and diversify traditional classes, eliminating factors that limit students' educational

opportunities (Aljawarneh, 2020; Akugizibwe and Ahn, 2020; Valencia-Arias *et al.*, 2019; Shih *et al.*, 2017).

Contemporary e-learning takes many forms and is addressed to a wide range of people. The tools of modern computer science and suppliers of e-learning products make distance learning possible for virtually every potential user of computer equipment. Learning is offered in many areas of knowledge, often for students from distant fields of study.

The coronavirus pandemic has caused an extremely dynamic development of e-learning, which also results from the growing interest in various forms of acquiring knowledge. Thanks to the wide access to computers and the Internet, remote education is becoming an even more popular and accessible form of conducting classes. The great advantage of such education is its independence of place and time. In this model, it is the lecturers who determine the rules for conducting and accessing classes.

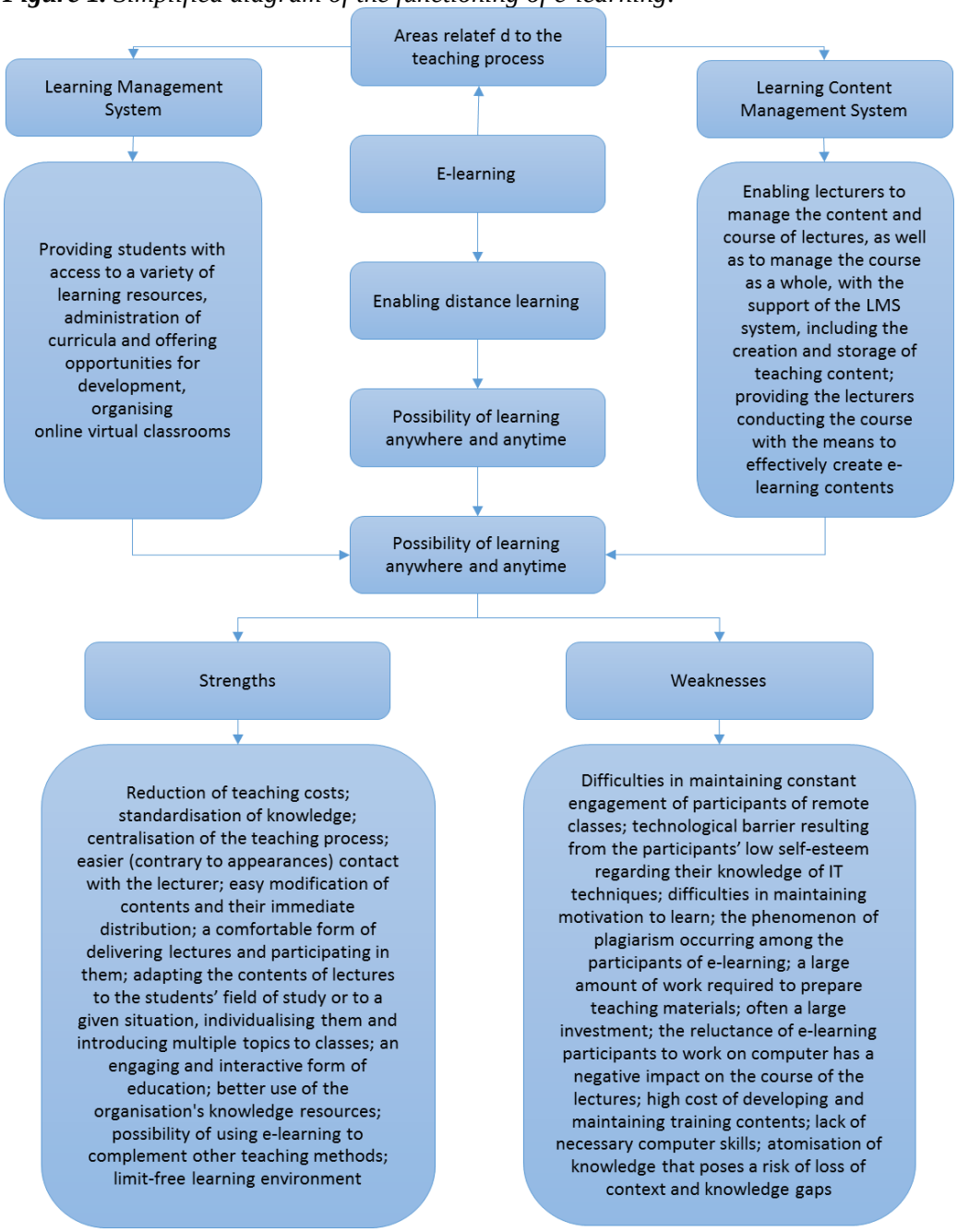
Nowadays, acquiring knowledge is closely related to improving professional qualifications, as well as to broadening one's interests. University lecturers are looking for new forms of transferring knowledge to students and verifying their skills. An interesting form of such teaching are e-learning courses in various subjects. They enable both comprehensive contact with the student and an ongoing assessment of their progress in learning, engagement and class participation.

In the case of studies in economics, most theoretical instruction (classes, lectures or seminars) can be successfully carried out remotely. This form has gained great importance during the coronavirus pandemic. In recent years, the popularity of the e-learning system of education has grown dynamically, which is caused, among others, by the growing degree of computerisation of the society, as well as the increasing access to broadband Internet. A simplified diagram of the functioning of e-learning is presented in Figure 1.

2.2 The Role of the Internet as the Most Important Medium in the E-learning Process

In modern times, the Internet has become an inseparable and integral part of education. Currently, the Internet remains a valuable source of information and a tool for quick communication, offering an ever wider range of its services both for average and demanding users. The Internet can be considered the most democratic global medium and a completely new qualitative means of exchanging ideas. The culture of infocivilisation cannot do without the Internet, which constitutes a cultural phenomenon (Ozturk, 2018; Bunce, 2017; Banica *et al.*, 2017; Stošić and Stošić, 2015).

Figure 1. *Simplified diagram of the functioning of e-learning.*



Source: *Own study.*

Mass access to global information infrastructure has become a fact and the Internet is a new educational space (Reimers and Schleicher, 2020). The transfer of knowledge through the Internet has resulted in outlining a new reality which changes

the traditional approach to education and the values associated with it. The specificity and trends in education are a consequence of changes that have taken place in the entire society. During the coronavirus pandemic, learning is mostly done remotely. This forces the introduction of many changes in education, making the Internet a key technology in these changes (Aboyage *et al.*, 2021; Radha *et al.*, 2020; Shahzad *et al.*, 2020; Maatuk *et al.*, 2021; Ebner *et al.*, 2020; Dumford and Miller, 2018).

The development of e-learning enables not only conducting lectures, practical classes and training courses remotely, but also a smooth flow of information which the teacher adapts to the pace of the students. Such a modern model of distance learning requires the creation of specialised tools that streamline the organisation of didactic process characterised by a high degree of interactivity. Certainly, e-learning is becoming a standard and can be seen as a goal and a manner of managing the process of education in a broader scope. The topic of e-learning should therefore be constantly verified and discussed in order to increase its effectiveness and eliminate its weaknesses.

3. Materials and Methods

The aim of the research was to determine the variables that influence the effectiveness of e-learning, and the degree of students' satisfaction with the classes conducted in this system. Furthermore, the strength of these variables and relationships were determined using statistical methods. The CAWI technique was used, in which the respondent receives a link to the survey and then completes it in an electronic form. The information for the research was collected using the technique of survey and questionnaire interview. The obtained empirical data were analysed using selected statistical methods. The empirical material obtained from the surveys was subjected to qualitative and quantitative analysis using the statistical software STATISTICA 13 and Microsoft Excel 2016. This material was used to determine the relationship between variables using the chi-square test of independence as well as strengths of correlations using C-Pearson's coefficient.

The chi-square test x^2, which verifies the hypothesis about the independence of two variables [X, Y], was used to test the relationship between the variables. According to the null hypothesis, variables X and Y are independent, while an alternative hypothesis states that the variables X and Y are dependent. The chi-square test of independence x^2 is used to infer about the relationship between features that do not need to be measurable. On the basis of the chi-square statistics, a standard measure of the strength of feature correlations called the C-Pearson's coefficient was determined. *C* is calculated from the formula:

$$C = \sqrt{\frac{x^2}{x^2+n}}$$

C assumes values from the range $1 \leq C \leq 0$. *C*=0 means that the features are independent, and *C*=1 when the number of fields in the table approaches infinity. The upper value of the coefficient depends on the dimensions of the independence table. Therefore, the calculated value *C* is related to its maximum value *Cmax* that depends on the dimensions of the table. In the case of square tables (r=s) *Cmax* is determined as:

$$Cmax = \sqrt{\frac{\text{r-1}}{r}}$$

For rectangular tables ($r \neq s$):

$$Cmax = \frac{\sqrt{\frac{r-1}{r}} + \sqrt{\frac{s-1}{s}}}{2}$$

Corrected value of the coefficient Ccor:

$$Ccor = \frac{C}{Cmax}$$

The following ranges were adopted to assess the strength of correlation:

0 - 0.30 - weak correlation,
0.30 - 0.60 - moderate correlation,
0.60 - 1 - strong correlation.

The questionnaire was sent to Polish students chosen by means of purposive sampling (non-random sampling). The minimum sample size calculated at a confidence level α = 0.95 and a margin of error of 5% for the population of adult Poles was defined as 385. Sample Size Formula (Sample Size Calculator) used to calculate the sample size was:

$$\mathbf{n = z^2 * p * (1-p) / e^2} \quad (1)$$

$$\mathbf{n} \text{ (with finite population correction)} = [z^2 * p * (1-p) / e^2] / [1 + (z^2 * p * (1-p) / (e^2 * N))] \quad (2)$$

where:
n is the sample size,
z is the z-score associated with a level of confidence,
p is the sample proportion, expressed as a decimal,
e is the margin of error, expressed as a decimal,
N is population size.

The study was conducted in February 2021. The research sample consisted of 1203 students from various Polish universities. The most numerous group were students from the WSB University. The rest of them studied at the University of Technology and Economics and the Vistula Academy of Finance and Business. The socio-demographic characteristics of respondents are presented in Table 1.

Table 1. *Socio-demographic characteristics of respondents*.

	Variables		Frequency	Percentage N = 1203
1	University	WSB	670	56
		Vistula	303	25
		UTH	230	19
		Total	1203	100
2	Age	< 20	192	16
		20 - 25	763	63
		26 - 30	111	9
		31 - 35	57	5
		35 <	80	7
		Total	1203	100
3	Level of studies	1st degree bachelor	631	53
		1st degree engineering	326	27
		2nd degree master's degree	246	20
		Total	1203	100
4	Form of studies	Full-time	463	38
		Part-time	740	62
		Total	1203	100
5	Employment status	Full-time contract	577	48
		Job order contract	255	21
		Self-employed	63	5
		Non-active	308	26
		Total	1203	100

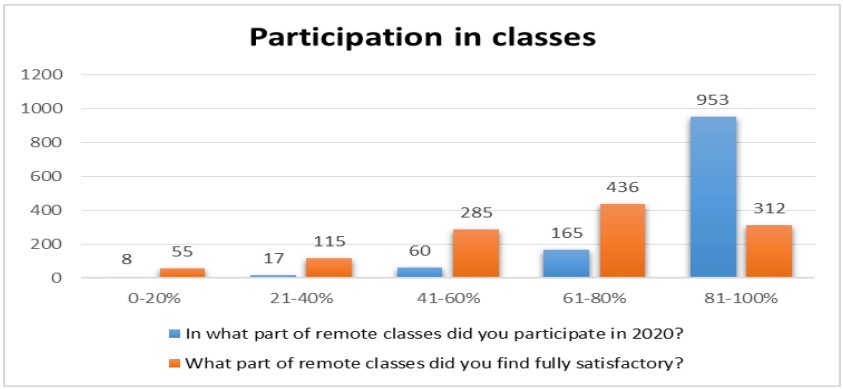
Source: *Own study.*

4. Results and Discussion

The study was aimed at assessing students' satisfaction with the conducted remote classes. The issue was analysed in relation to remote classes in which the respondents participated in 2020. The research results are not optimistic (Figure 2).

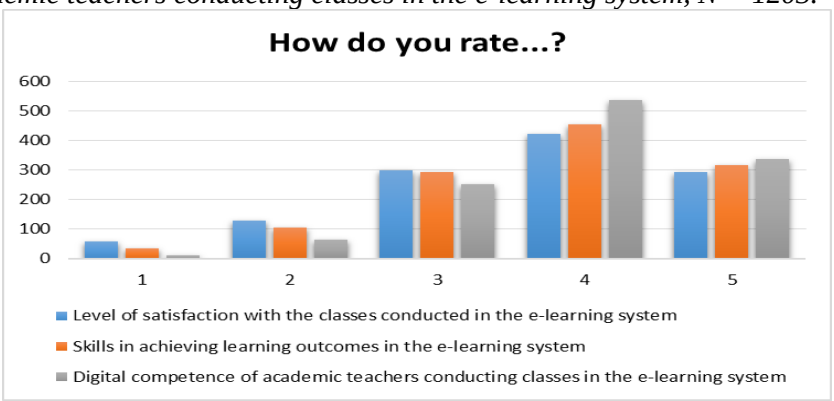
During the study the level of satisfaction with the classes conducted in the e-learning system, student's skills in achieving learning outcomes in the e-learning system and digital competence of academic teachers who conduct classes in the e-learning system were also analysed. Likert scale 1 – 5 was used to estimate the level of measured issues, where 1 – definitely negative, while 5 – definitely positive. In relation to this issue, most ratings were good (Figure 3).

Figure 2. *Participation in remote classes in 2020 and the level of satisfaction, N = 1203.*



Source: *Own creation.*

Figure 3. *Level of satisfaction with the classes conducted in the e-learning system, skills in achieving learning outcomes in the e-learning system, digital competence of academic teachers conducting classes in the e-learning system, N = 1203.*

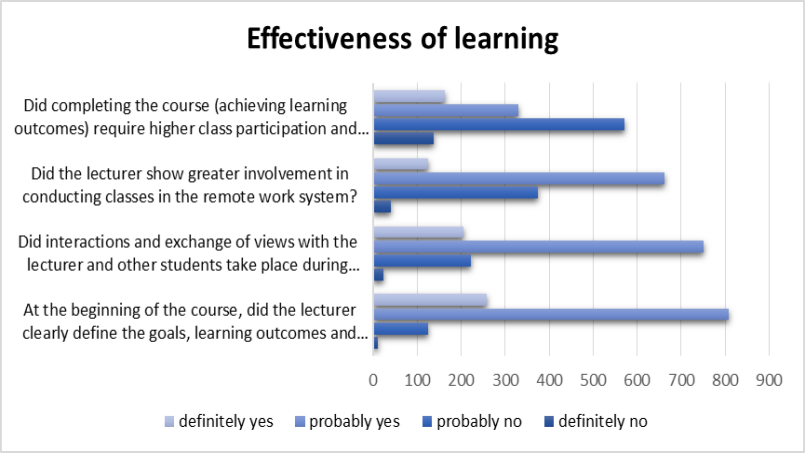


Source: *Own creation.*

An assessment of the effectiveness of learning turned out to be an important aspect of the study. The research results are optimistic in this regard. A large part of the students who participated the research evaluated positively and very positively the fact that the lecturer presented the goals, learning outcomes and the rules for completing the course at its beginning. Similarly, respondents evaluate positively and very positively other issues:

- interactions and exchange of views with the lecturer and other students,
- greater involvement of the lecturer in conducting classes in the remote work system,
- higher class participation and involvement of students than in the traditional system.

Figure 4. *Assessment of the effectiveness of various aspects of e-learning, N = 1203.*



Source: *Own creation.*

The study mainly referred to non-measurable properties of statistical objects. The applied measures of relationships and the strength of stochastic correlations of features have their justification in the analysis of non-measurable features. In this way, the strength of the relationships between the variables was determined. It was found that:

1. The level of satisfaction with the classes conducted in the e-learning system depends on the age of the respondent - this relationship is statistically significant but weak ($p < 0.05$; $C = 0.18$).
2. The level of satisfaction with the classes conducted in the e-learning system depends on the form of studies - this relationship is statistically significant but weak ($p < 0.05$; $C = 0.20$).
3. The level of satisfaction with the classes conducted in the e-learning system depends on professional activity - this relationship is statistically significant but weak ($p <0.05$; $C = 0.25$).
4. The level of satisfaction with the classes conducted in the e-learning system depends on whether the lecturer showed greater involvement in conducting classes in the remote work system - this relationship is statistically significant and moderate ($p < 0.05$; $C = 0.42$).
5. The level of satisfaction with the classes conducted in the e-learning system depends on how the respondent assesses the support and functioning of the university's ICT system - this relationship is statistically significant and moderate ($p < 0.05$; $C = 0.38$).
6. The level of satisfaction with the classes conducted in the e-learning system depends on how the respondent assesses the technical and methodological preparation of the university for conducting classes in the e-learning system - this relationship is statistically significant and moderate ($p < 0.05$; $C = 0.44$).

7. The level of satisfaction with the classes conducted in the e-learning system depends on how the respondent assesses the effectiveness of conducting classes in the e-learning system compared to the traditional system - this relationship is statistically significant and, what is more, strong ($p < 0.05$; $C = 0.60$).

Moreover, the following correlations were determined:

1. The effectiveness of the classes conducted in the e-learning system compared to the traditional system depends on the lecturer clearly defining the goals, learning outcomes and rules for completing the course - this relationship is statistically significant but weak ($p < 0.05$; $C = 0.28$).
2. Greater class participation and involvement of the student learning in the remote system compared to the traditional one depends on the effectiveness of conducting classes in the e-learning system compared to the traditional system - this relationship is statistically significant and moderate ($p < 0.05$; $C = 0.32$).
3. Interactions and exchange of views with the teacher and other students during classes depend on how the respondent assesses the level of satisfaction with the classes conducted in the e-learning system - this relationship is statistically significant and moderate ($p < 0.05$; $C = 0.32$).
4. Interactions and exchange of views with the teacher and other students during classes depend on how the respondent assesses his/her skills in achieving learning outcomes in the e-learning system - this relationship is statistically significant and moderate ($p < 0.05$; $C = 0.32$).
5. The effectiveness of the classes depends on how the respondent assesses the digital competence of academic teachers conducting classes in the e-learning system - this relationship is statistically significant and moderate ($p < 0.05$; $C = 0.32$).
6. Interactions and exchange of views with the teacher and other students during classes depend on how the respondent assesses the effectiveness of the classes in the e-learning system compared to the traditional system - this relationship is statistically significant but weak ($p < 0.05$; $C = 0.29$).

5. Limitations and Further Research

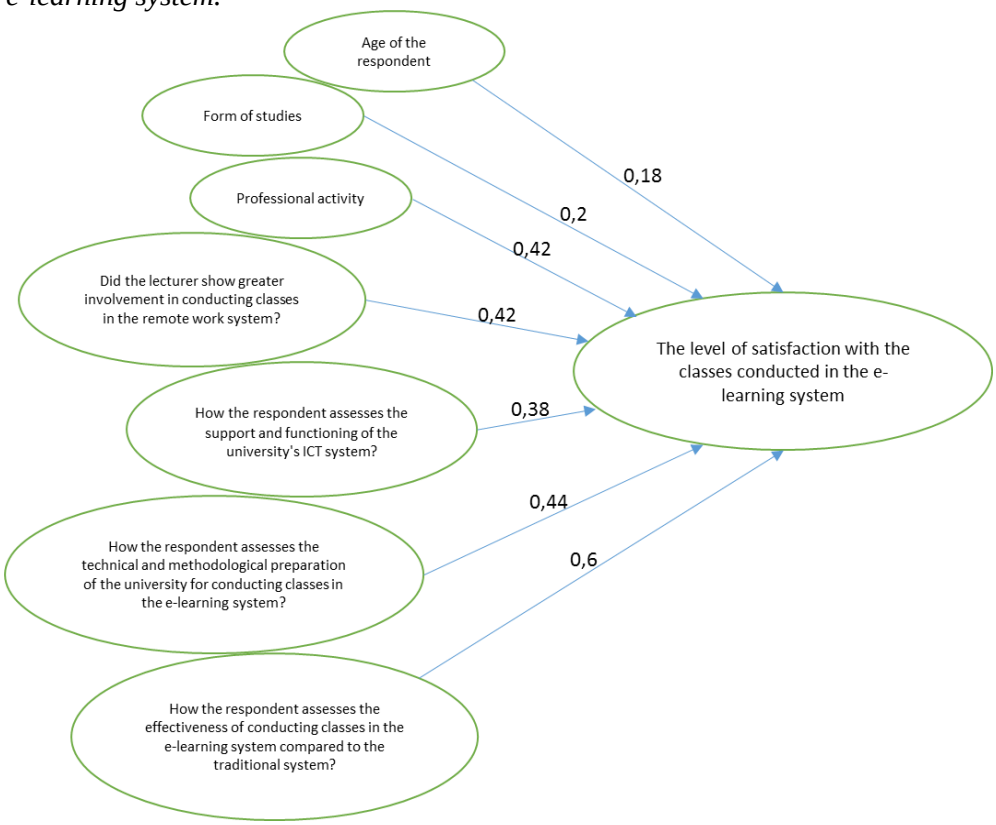
The study took place during the coronavirus pandemic; therefore, the authors of the research did not have the opportunity to meet the respondents in person and conduct a more detailed interview, which can certainly be considered a significant limitation of this study.

In the future, it would be interesting to carry out similar research among students of foreign universities. In this way, the effectiveness of distance learning in Polish universities could be compared with that in other countries and solutions that have been successful abroad could be implemented in Poland. These topics could provide interesting material for future research.

6. Conclusions

The conducted research and statistical analyses allowed for the identification of variables that affect the level of student satisfaction with the classes conducted in the e-learning system. The use of the chi-square test x^2 allowed the authors to illustrate the strength of correlations. The aforementioned correlations are specified in the authors' original models (Figures 5 and 6).

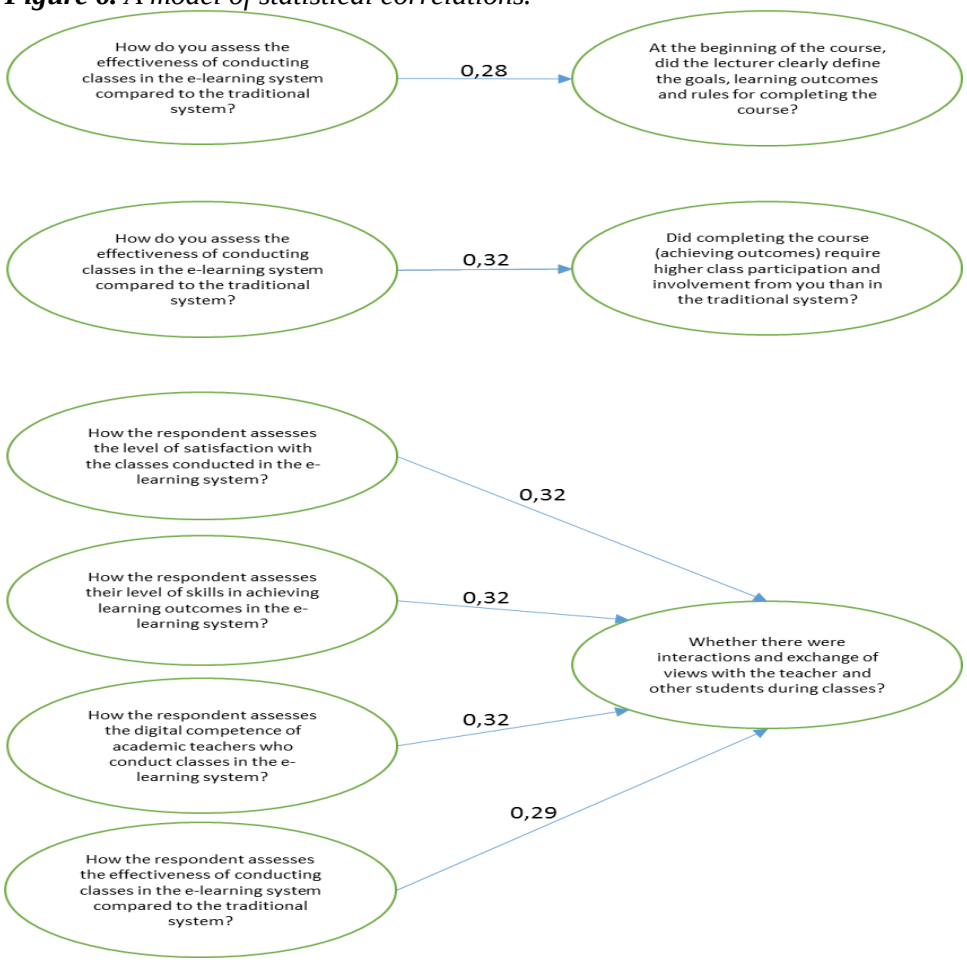
Figure 5. *Determinants of the level of satisfaction with the classes conducted in the e-learning system.*



Source: *Own creation*.

The above-mentioned level of satisfaction is most strongly influenced by the effectiveness of the classes in the e-learning system compared to the traditional system. Therefore, it becomes necessary to constantly improve this effectiveness. And this, in turn, as shown by statistical correlations, is a derivative of greater class participation and involvement of the student in the remote learning system compared to the traditional one, as well as of the lecturer clearly defining the goals, learning outcomes and rules for completing the course.

Figure 6. *A model of statistical correlations.*



Source: *own creation.*

Subsequently, the student's satisfaction with e-learning depends on the lecturer's involvement in the classes they conduct, good support and functioning of the university's ICT system, as well as technical and methodological preparation of the university for the implementation of classes in the e-learning system. The respondent's age, form of studies and their professional activity are of marginal importance for the analysed satisfaction.

Thus, it turns out that many of the analysed independent variables do not have a statistically significant impact on the effectiveness of e-learning. Therefore, it can be concluded that university authorities should put emphasis on the above-mentioned issues, as it will translate into a higher degree of student satisfaction. It is also worth systematically monitoring these variables and analysing their contribution to the effectiveness of distance learning. Thus, it could be a desirable practice to conduct surveys regularly.

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