



Article

An Analysis of the Factors Influencing the Selection of a Given Form of Learning

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Abstract: In modern times, we observe many new trends, including technological, economic, cultural, ecological, and economic changes, which are part of the fast and uneven process of globalization. The current educational system is undergoing global changes caused by the current situation related to the COVID-19 pandemic, forcing both academic teachers and students not only to change the way they function or operate, but also to change attitudes and beliefs, especially regarding new media and remote learning. The article presents an analysis of the factors influencing the selection of a given form of learning in technical faculties from among three hypothetical options: stationary learning, remote learning, and hybrid learning. This analysis was based on the results of a survey conducted among students after two years of experience studying in the COVID-19 pandemic. The obtained results allowed for the selection of features influencing the choice of a given form of learning by the students. The knowledge of these factors is especially valuable for university authorities making decisions about the form of student learning after the end of the COVID-19 pandemic.

Keywords: remote learning; survey-based analysis; innovation in learning



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1. Introduction

Open innovation (OI) is currently one of the newer concepts in the field of management sciences. Open innovation means that innovation is supported by using both external and internal influences in the innovation process [1–6]. Innovations are the basis of interest in all fields of science, because for each individual unit in society, life-long learning, gaining new knowledge, and engineering are goods of the highest order [7,8]. It is a widely recognized fact that knowledge and science are the basis for innovation in technology development. This means that, as a rule, individuals should adopt the latest technological knowledge on an ongoing basis in order to develop and create new innovations [9,10]. Innovations related to the use of information and communication technologies (ICTs) are a response to changes in the science and education system, and are compatible with all dimensions of the work of modern society [11,12]. The open engineering innovation perspective made higher education, both in Poland and around the world, the driving force in the field of economic development and various innovations [13,14]. Moreover, universities are strongly associated with open innovation engineering in their specific role as entrepreneurial agents in terms of the ability to transfer knowledge and commercialize research results [15,16].

The COVID-19 pandemic has changed learning processes. There was a sharp shift from direct contact of the academic teacher with students to the virtual world, which influenced the entire teaching process, favoring one of the most important features of open innovation in universities, namely the ability to manage the flow of knowledge [17–19]. Open innovations in the situation of the COVID-19 pandemic contributed to the coping of universities with difficulties and the use of opportunities to increase the production of knowledge [20–22].

E-learning is a form of teaching conducted with the use of information and communication technologies, which allows one to complete a course, training, and study without

the need to be physically present in the classroom. It is characterized by the fact that the teacher is separated from the student, and the knowledge is transferred via electronic media using personal computers, smartphones, tablets, and the internet [23]. Until now, e-learning was only an option that academics teachers could use to some extent, but due to the COVID-19 pandemic, it became a necessity. Remote learning has often become the only way of conducting various educational activities available to everyone [24].

Remote learning, as one of the forms of distance education has many common features with distance education. The main feature of remote learning is the variability in terms of the type of media intermediating in the learning process, educational goals, type of educational activities (e.g., lectures, seminars, workshops, etc.), number of participants (students), subject matter taken into account, interactivity, kind of communication (e.g., multimedia, film, text, etc.), learning model, overall duration, accessibility, and many others [25]. It is assumed that remote learning uses over eighty percent of the content provided online. For comparison, in hybrid-type education it is from thirty to seventy-nine percent, and in the web-facilitated version up to twenty-nine percent [26,27]. Web-based models contain such types of connections such as online courses (e-learning), access to internet sources, online conferences (webcasts and webinars), mentoring, virtual classrooms, virtual schools (cyber schools), virtual universities, and online coaching. Nowadays, basically all of the above-mentioned forms are also based on mobile devices, e.g., telephones, smartphones, tablets, readers, etc. [28,29]. These categories are fluid because they can be combined or expanded depending on the competences, technical possibilities, or didactic goals.

The main reasons for the use of remote learning result primarily from needs such as: the inability to gather people in a designated place and time, geographical dispersion of training participants, lack of an in-house or traditional education offer, geographical dispersion of teachers, and when gathered gathering them in one place and time would be difficult, the need to access teaching content at different times of the day (also in the evening and night hours), and when the compared results are achievable through distance learning in comparison to traditional education [25,29]. Moreover, the advent of the COVID-19 pandemic also became the basis for recommending remote teaching [30,31]. Remote learning is currently used in both technical and humanities [25,32]. The most essential thing seems to be the ability to adjust the place and time of learning to the individual needs of the student [33,34].

Some universities, long before the outbreak of the COVID-19 pandemic, implemented a system of delivering or supporting teaching using remote work tools or e-learning platforms [35]. Although the majority of academic teachers, and students before the COVID-19 pandemic had a basic course of operation of the LMS Moodle platform (Learning Management System Modular Object-Oriented Dynamic Learning Environment), but not all of them used the platform regularly [36]. The rapid pace of changes, and the lack of time to prepare the e-version of classes made the transformation of some classes into the remote form a huge challenge for academic teachers, and a source of technical and organizational problems. Various aspects of distance learning that must be taken into account are not only the content of the classes, and the scope of material, but also the methods of delivering the content in a form adapted to the technical and collaborative capabilities of students, especially those from international groups who decided to return to countries they come from, often even several time zones apart [37]. The lectures turned out to be the easiest to transfer to the remote version, as they can be held in a synchronous or asynchronous version with the use of webinar platforms and simple screen recording tools. In the case of many universities, the use of an appropriate plug-in of a given webinar service provider, e.g., Zoom, BigBlueButton, Cisco Webex, WizIQ, and ClickMeeting, made it possible to organize classes directly through university didactic platforms without the need to use external websites. In turn, the greatest difficulty was the transfer to the remote version of the classes focused on practical experience, including workshops and laboratories, where students' independent performance of the task, and familiarization with specialist

equipment constituted a significant part of the activities carried out in the contact form before the COVID-19 pandemic [38,39].

In Poland, research on e-learning conducted by universities has already been carried out, but before the COVID-19 pandemic, this type of teaching was usually only an additional or complementary form of the traditional education system [40,41]. During the COVID-19 pandemic, also in Poland, scientific papers dedicated to experiences related to remote learning at universities have already been published, addressing various aspects, including mental health of students (e.g., [42]), problems with access to technology (e.g., [43]), online medicine learning problem (e.g., [44–46]), online practice implementation (e.g., [47]), and other issues [48].

Taking into account, on the one hand, the efforts of the university authorities to maintain the quality and continuity of education, and to make it as least stressful as possible for students, while at the same time meeting legal requirements, and, on the other hand, seeing the uncertainty of students and academic teachers, it was decided to analyze the factors influencing the choice of a given form of learning by the students. In fact, students cannot choose the form of learning at the university, as this form is regulated by the relevant ordinances of the Minister of Education and Science, and the applied ordinances of the university rector. Nevertheless, getting to know the opinions of students on this subject can be a valuable source of information in the field of planning future forms of classes at universities, also in post-COVID-19 times.

Hence, the main aim of the conducted research was to identify factors that increase the probability of a choice by a student of one of the three forms of learning among the hypothetical options:

- A 100% of stationary learning;
- A 100% of remote learning;
- Hybrid learning.

By “100% of stationary learning” it is meant that 100% of classes are conducted in the form of contact on the basis of the principles that were at the university in force before the period of the COVID-19 epidemic. While, by “100% of remote learning” it is meant that 100% of classes are carried out remotely with the use of software enabling free, two-way communication between the teacher and the student, e.g., zoom, MS Teams, etc. In addition, by “hybrid learning” it is meant that hybrid classes, i.e., lectures conducted online (with the use of software enabling free, two-way communication between the academic teachers, and the students, e.g., zoom, MS Teams), and exercises and laboratories are conducted in the form of contact in the proportions specified by the university regulations.

This paper consists of six sections. After the introduction, the second section presents the most important statistical data characterizing the higher education system in Poland in recent years. In the third section, reference is made to the latest research works describing experiences in the field of educating students in the conditions of the COVID-19 pandemic. In the next, fourth section, the materials and methods used are presented, i.e., the characteristics of the survey research conducted along with a description of the variables selected for the modeling process. The most important part of the paper is the fifth section, in which the constructed logit models are presented, allowing for the identification of features influencing the probability of choosing a given hypothetical form of education by students (stationary, remote, and hybrid). The last, sixth section of the paper contains conclusions.

2. Higher Education in Poland

In Poland, the higher education system has been systematically changed, and reformed in recent years. A number of changes were introduced to adapt the educational offer to the expectations of employers, among others by implementing a practical profile, dual studies, longer student internships, consulting the university’s educational offer with employers, and implementing a qualification framework combining knowledge, skills and social competences instead of just imparting knowledge. These changes were introduced to

change the structure of students through the so-called commissioned faculties and various initiatives, e.g., “Girls at Polytechnics” [49–51].

As reported in the Central Statistical Office in Poland [52], 349 universities operated in Poland in the previous (2020/2021) academic year, among which were 130 public universities and 219 non-public universities. In latest years, the number of students in Poland has systematically decreased (from 1,841,300 in the 2010/2011 to 1,204,000 in the year 2019/2020). In the 2020/2021 academic year, however, there was a little increase to 1,215,300 students, including 69.8% students in public universities. A systematic decrease was also observed with regard to the number of graduates, the number of which decreased from 4,975,000 in the 2010/2011 to 2,934,000 people in the 2019/2020 academic year (only in the 2016/2017 academic year there was a slight increase observed) [52].

According to data presented in Central Statistical Office [52], in 2020 1,215,300 people studied at universities in Poland. It was 113,000 more students compared to the previous year. In the 2019/2020, 293,400 graduates received a diploma. This is 20,400 less than in the 2018/2019 academic year. In the 2020/2021 academic year, women accounted for 58.0% of students. In total, 796.7 thousand people studied in full-time studies (there was 65.6% of all students), while in part-time studies there was 418.6 thousand people. First-cycle studies were chosen by 62.7% of all students (761.6 thousand people), while 22.9% of students attended second-cycle studies, and 14.1% of uniform master’s studies. The most (253,400) people studied in the Mazowieckie voivodship, and the least (there were 119,000 students) in the Lubuskie voivodeship [52].

The most frequently chosen study groups were administration and law, as well as business where 22.3% of all students studied. Then, technology, industry, construction (14.8%, respectively), journalism and information, social sciences, health, and social welfare (11.9% each). In total, 84,700 foreigners, including 42,700 of women planned to study in Poland at least one academic year, which is 3.0% more than in the previous academic year. Most of the foreigners came from European countries, with the largest group being people from Ukraine (38,500, which constitutes 45.4% of all foreigners), from Belarus (9700, which constitutes 11.5% of all foreigners), and from India (2600, which constitutes 3.0% of all foreigners). Full-time studies were undertaken by 73,200 foreign students (there were 86.5%). Nearly one third of all foreigners (24,500) chose universities in the Mazowieckie voivodship [52].

In the 2019/2020 academic year, 293,400 people graduated from studies, including 185,600 women (63.2%). Most of the graduates (180,000) completed uniform master’s studies and first-cycle studies, while 38.6% were graduates of second-cycle studies. Graduates most often completed their studies in the fields of study included in groups [52]:

- Law, business, and administration (23.6%);
- Technology, industry, construction (16.5%);
- Health, and social care (11.2%);
- Journalism, social sciences, and information (10.6%).

Among 14,800 foreign graduates, the most, as in the case of students, came from Ukraine (51.7%), from Belarus (8.7%), and from India (6.9%). More than half of the foreign graduates were women (55.3%). In total, 65.5% of foreigners completed full-time studies, and the largest number of people graduated from the fields of business, administration, and law (34.3% of the total number of foreign graduates) [52]. Figure 1 shows the distribution of the number of students and graduates in Poland in 2008–2021.

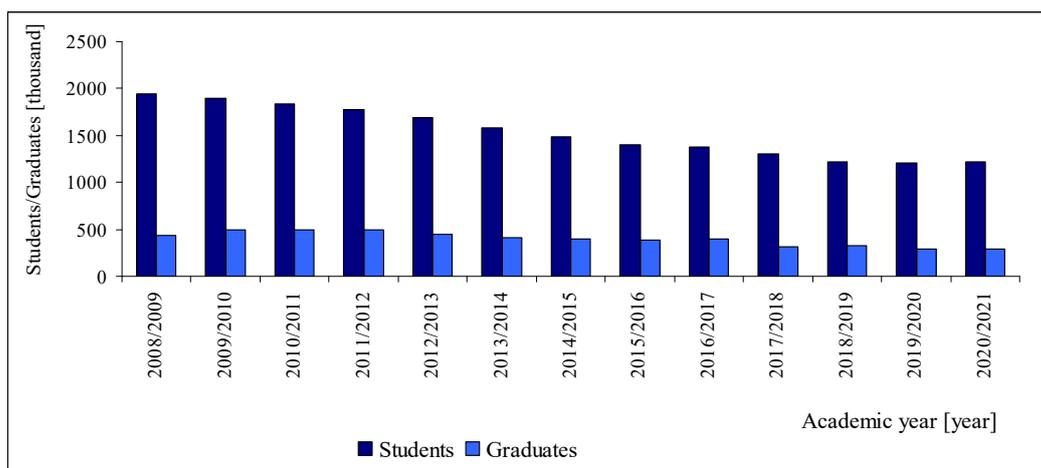


Figure 1. Students and graduates of universities in Poland in 2008–2021. Source: Own research based on data [52].

3. Literature Review of Works Relating to the Education of Students in the Conditions of the COVID-19 Pandemic

Along with the COVID-19 pandemic, a lot of research works analyzing the impact of the pandemic on various sectors of the economy, transport, industry, and trade, including science at various levels of education, appeared in the scientific literature on the subject. In these works, experiences were presented, and conclusions in the field of remote learning were formulated.

In the research works [53] can be found the conclusions that face-to-face learning cannot be replaced by distance learning, especially when it comes to laboratory classes, based on the analysis of data from a questionnaire of students from five Greek universities. The results also show that students have to deal with inequality in access to education, which is exacerbated by the lack of digital equipment, and underdeveloped technological infrastructure.

An interesting SWOT analysis on contactless higher education during COVID-19, showing strengths and weaknesses, as well as opportunities, and threats for three stakeholders of students, faculty, and institution, was presented in [54]. In the case of students, strengths include students flexibility and performance (many students adapt properly to this online context), weaknesses include: technical issues encountered almost on a daily basis, a lack of interaction may have affected student motivation and retention, technology was largely inaccessible, first-generation students' lack of adequate study spaces free from distractions, and lack of technology to attend virtual classes at scheduled times, financial, and emotional distress as well as lack of emotional support. Opportunities were indicated such as family responsibilities, flexibility for those with work, opportunities for mentoring, access to lecture-captured platforms, use of new teaching methods, students' routine (students can implement new schedules, and timings). Threats include the following features: isolation from social, spiritual, and practical supports, higher rates of mental health disorders, increased rates of anxiety, housing insecurity, and financial hardship.

In turn, the research work [55], based on the results of the survey, indicated that both academic teachers and students stated that remote learning is not more interesting than contact learning at the university. In addition, university teachers must conduct at least 50% of their classes in a contact mode, which hinders the overall planning of classes. Recommendations at the didactic, and technical level, such as the need for technical support, and training in the use of these tools, are presented to strengthen and promote distance learning.

The research paper [56] presents the results of research dedicated to the factors influencing the satisfaction of students from studying in Hong Kong when the learning tools are Moodle and Microsoft Teams. The obtained results were neutral (4.11 on a 7-point Likert

scale). Most of the students were technology competent, and had no problem accessing learning devices or Wi-Fi; however, contact learning at university proved to be preferable to Moodle, and Microsoft Teams, and this proved to be the most important predictor. In addition, it has been shown in this work that the level of effort by the instructors, agreement on the appropriateness of adapted assessment methods, and perception of successful online learning are very important in determining satisfaction scores.

The study [57] analyzes the impact of the COVID-19 pandemic on learning and mental health of students. The results of this analysis indicated that 42.9% of the respondents had experienced symptoms of generalized anxiety disorder, and 53.6% had moderate to severe functional disorders. The obtained results suggest that mental stress and anxiety states may influence the ability of students to coordinate social and professional activities, and performance during distance learning.

In the scientific literature on the subject, one can also find research works pointing to some positive aspects of remote learning. For example, [58] indicated that first-year students were significantly less motivated in the distance learning process than older students, and they perceived distance learning as less valuable and less interesting than others. The research also found several positive consequences of the pandemic. They are working according to students' own schedules in a relaxed environment, re-viewing a lecture if necessary, feeling free to ask questions and communicate with teachers, and saving travel time. The authors of the study recommend that university teachers show a greater understanding of at-risk first-year students in developing their motivation to learn and help them cope with learning anxiety by encouraging them to gain self-confidence, and providing them with additional support in learning during the process of studying.

In the scientific literature on the subject, research works dedicated to the post COVID-19 time can also be found. These research works indicate that although e-learning has so far played a marginal role in many countries' formal education systems in higher education, in the post-COVID period, due to its advantages, it should be expected to be much more widely used [59]. Moreover, it should be assumed that the demand for digital teaching offers at universities will rather increase [60]. Despite some reluctant reactions, it can be assumed that the current COVID-19 situation will have a positive impact on teaching digital innovation at universities due to the pressure of the crisis, high involvement of many teachers, and increased expectations.

In a post-COVID-19 time, the use of remote learning and e-learning may become an integral part of the higher education system [61]. Some research papers provide valuable tips on how to conduct remote learning in universities in order to maintain focus and keep students' attention (e.g., [62]).

4. Materials and Methods

4.1. Characteristics of the Conducted Survey Research

The research presented in the paper was conducted in the period from April 2020 to December 2021 and concerned the preferences of students to choose the form of learning in engineering studies: transport, civil engineering, and logistics. As stated in the second section, these fields of study belong to the group of technology and construction fields of study, and are one of the most popular fields of study in Poland. The respondents were full-time and part-time students of first- and second-cycle studies, residents of the Śląskie, Małopolskie, and Kujawsko-Pomorskie voivodships. With the assumption level of confidence equaling 95%, and a maximum error of 5%, the minimum sample size was calculated to be 384 questionnaires. In sum, 450 students took part in the survey, selected in such a way that their age distribution did not statistically significantly differ from the composition of the population of all students engineering studies at the analyzed universities and fields of study. A quota sample selection was used (two-stage selection, first a year of study, then a selection from each subgroup of cases in an appropriate proportion). The Pearson's chi-square compatibility test showed that the two structures did not statistically significantly differ.

In the case of students in Poland, there are no definition problems when it comes to determining the lower age limit, because it results from the so-called traditional access pathway to higher education. This means that a person who graduated from high school and passed the high school diploma (usually 18–19 years of age) can become a student. However, the situation is not so obvious in terms of the upper age limit. In Poland, apart from academies of physical education, academies of fine arts, military, and maritime universities, there is no upper age limit for applicants.

A questionnaire divided into thematic blocks was adopted as the research tool. The survey questionnaire consisted of several parts. In the survey, respondents answered questions about:

- Data that are characterized by the respondent’s profile: gender, age, and nationality;
- Characteristics of the respondents’ educations: type, degree, year, and field of study, number of fields of study, possibly the name of an additional field of study, participation in additional activities (e.g., courses, training, learning to play the piano, English lessons, dance lessons, etc.), the average of grades in the last year of studies (semester in the case of the first semester of studies);
- Family situation (marital status, caring for parents, caring for children, caring for disabled children) and professional situation (if applicable);
- Sense of security during classes, and during obtaining materials for classes, as well as during sending final papers to the academic teachers.

Due to the epidemic situation prevailing in the country, the research did not use the quantitative research technique of the PAPI type (Paper and Pencil Interview). In the study, the data were collected using the CAWI (Computer Assisted Web Interview) quantitative research technique.

4.2. Description of the Variables Used in Modeling

In order to verify the formulated research hypothesis, three logit models were developed in order to assess what factors determine the students to make a hypothetical choice of one of the three forms of learning. Three dependent variables were adopted:

- Variable Y_1 —100% of classes carried out in the contact form, at the university,
- Variable Y_2 —100% of classes carried out remotely;
- Variable Y_3 —classes carried out in a hybrid form, i.e., lectures conducted online (with the use of software enabling free, two-way communication between the academic teachers, and the students, e.g., zoom, MS Teams), and exercises as well as laboratories conducted in the form of contact at the university.

The logit model is used to calculate the probability of a given phenomenon. If the dependent variables are qualitative, their representatives in the model are dichotomous variables. In the model, these variables take the following values [63–65]:

$$Y_i = \begin{cases} 1 & \text{if } \text{the phenomenon occurs} \\ 0 & \text{if } \text{the phenomenon does not occur} \end{cases} \tag{1}$$

where:

Y_i —dependent variable.

The logit model for the dependent variable Y_i is expressed as [63]:

$$p = (Y_i = 1 | x_1, \dots, x_k) = \frac{e^{\alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \dots + \alpha_k x_k}}{1 + e^{\alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \dots + \alpha_k x_k}} \tag{2}$$

where:

Y_i —dependent variable ($i = 1, 2, 3$);

k —number of independent variables;

$x_1, x_2, x_3, \dots, X_k$ —independent variables;

$\alpha_1, \alpha_2, \alpha_3, \dots, \alpha_k$ —structural parameters of the model.

The model (2) is transformed using logarithm to the form:

$$\log_{it}(p) = \ln\left(\frac{p}{1-p}\right) = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \dots + \alpha_k X_k \quad (3)$$

The choice of this econometric model for further analysis is due to the fact that the dependent variables are dichotomous. Students who chose a given form of learning could only answer the following questions: yes or no, so the following entry applies:

- 0—given determinant does not exist;
- 1—given determinant is present.

This makes it impossible to perform the traditional analysis of variance. Moreover, the applied method allows the use of nominal predictors in the analysis. Outcome variables were set to “0” (not choosing) and “1” (choosing). Among all students, 38.5% admitted that they prefer contact classes in the university building, as many as 40.1% chose 100% of classes in a remote form, and only 21.40% chose the hybrid form.

The questions included in the research questionnaire allowed for the selection of many independent variables, which were later used in the analysis to calculate their impact or lack of impact on the choice by students of a given hypothetical form of learning (Y_i). At the beginning of the analysis, all characteristics of the respondents were taken into account. These were the characteristics included in the questionnaire, and which were intuitively considered to have an impact on the choice of a given form of learning. Moreover, in the case of choosing a given scenario, the respondents had the opportunity to indicate the most important determinants of the choice of a given form of learning. These choices were described by dichotomous variables. In order to determine the probability of the student’s choice of a specific form of learning, the following variables were taken into account:

- X_1 —gender (1—female; 0—male);
- X_2 —age (0—below 22 years old; 1—from 22 years old and up);
- X_3 —type of studies (0—full-time; 1—part-time);
- X_4 —degree of studies (0—first degree; 1—second degree);
- X_5 —year of study (0—the remaining years of study; 1—the first year of study);
- X_6 —field of study (1—transport; 0—civil engineering and logistics);
- X_7 —nationality (0—Polish; 1—foreigner);
- X_8 —place of stay during the pandemic (0—house; 1—dormitory/rented apartment);
- X_9 —number of fields of study (0—one; 1—two);
- X_{10} —participation in additional activity/activities (0—yes; 1—no);
- X_{11} —average grade point in studies (0— ≤ 4.0 ; 1— >4.0);
- X_{12} —performing professional work (0—no; 1—yes);
- X_{13} —caring for parents (0—no; 1—yes);
- X_{14} —caring for disabled children or siblings (0—no; 1—yes);
- X_{15} —marital status (0—single; 1—married/cohabiting);
- X_{16} —having children (0—no; 1—yes);
- X_{17} —living alone (0—no; 1—yes);
- X_{18} —means of transport used in commuting to the university (0—private means of transport; 1—public means of transport);
- X_{19} —average travel time to the university (0— \rightarrow 0–30 min; 1— \rightarrow 30 min and more);
- X_{20} —having your own car (0—no; 1—yes);
- X_{21} —assessment of knowledge and skills obtained by the student thanks to 100% online classes compared to 100% contact classes (0—unsatisfactory (i.e., at a lower level than the knowledge obtained during contact classes); 1—satisfactory (at the same or higher level than the knowledge obtained during contact classes));
- X_{22} —place of obtaining materials for scientific work before the COVID-19 pandemic (0—internet resources, library, and others; 1—only the library);

- X_{23} —students’ trust in privacy during online classes (in the context of third parties, undesirable persons during classes), and a sense of security of the information provided (files of final papers, presentations) (0—no trust; 1—trust);
- X_{24} —technical quality of online classes (0—unsatisfactory; 1—satisfactory);
- X_{25} —the quality of the online classes in terms of content (0—unsatisfactory; 1—satisfactory).

The above-mentioned independent variables have been selected because, in our best knowledge, there are factors that may affect the probability of choosing a given form of learning. The next stage of the analysis was a stepwise selection of independent variables. This selection included four stages:

- In the first stage, the independent variables (Y_1, Y_2, Y_3) were assigned to the independent variables that may, from the physical point of view, affect the given dependent variable;
- In the second stage, variables that showed too small dispersion of values among the analyzed data were excluded from further analysis. To select independent variables in this stage, the coefficient of variation was used:

$$V_i = \frac{S_i}{|\bar{x}_i|} \tag{4}$$

where:

S_i —standard deviation of the variable x_i ;

$|\bar{x}_i|$ —average value of the variable x_i .

Based on [66], the value of 0.1 was adopted as the border value of the coefficient of variation.

- In the third stage, variables showing a strong mutual correlation were excluded. Strong mutual correlation of independent variables causes the phenomenon of catalysis, i.e., an increase in the multiple correlation coefficient resulting not from properly selected independent variables and a correctly constructed regression model, but as a result of mutual correlation of the explanatory variables. Based on the scientific literature on the subject [66,67], it was found that a strong correlation between the variables occurs when the correlation coefficient $R \geq 0.70$;
- In the fourth stage, variables showing too weak correlation with the dependent variable were excluded. The analysis assumed that a low level of correlation occurs when the correlation coefficient $R < 0.20$.

Tables 1–3 present, respectively the variables after the selecting process, which were further taken for the assessment of a given form of education (Y_i). These variables characterized by a correlation with dependent variables (Y_i), and a weak correlation with each other.

Table 1. Independent variables adopted for assessment of the factors that may affect the decision to choose the form of learning as 100% of the activities carried out in the contact form after selection showing correlation with the dependent variable (Y_1).

No.	Independent Variables (X_i)	Correlation Coefficient Value (R)
1.	X_1	0.35
2.	X_2	0.44
3.	X_3	0.21
4.	X_5	0.24
5.	X_7	0.22
6.	X_{10}	0.33
7.	X_{15}	0.29
8.	X_{20}	0.46

Table 1. Cont.

No.	Independent Variables (X_i)	Correlation Coefficient Value (R)
9.	X_{21}	0.52
10.	X_{22}	0.40
11.	X_{23}	0.37
12.	X_{24}	0.63
13.	X_{25}	0.26

Table 2. Independent variables adopted for assessment of the factors that may affect the decision to choose the form of learning as 100% of the activities carried out remotely after selection showing correlation with the dependent variable (Y_2).

No.	Independent Variables (X_i)	Correlation Coefficient Value (R)
1.	X_2	0.32
2.	X_3	0.27
3.	X_4	0.35
4.	X_9	0.31
5.	X_{10}	0.46
6.	X_{12}	0.28
7.	X_{18}	0.49
8.	X_{19}	0.33
9.	X_{21}	0.24
10.	X_{24}	0.30
11.	X_{25}	0.37

Table 3. Independent variables adopted for assessment of the factors that may affect the decision to choose a hybrid form of learning after selection showing correlation with the dependent variable (Y_3).

No.	Independent Variables (X_i)	Correlation Coefficient Value (R)
1.	X_{10}	0.21
2.	X_{12}	0.34
3.	X_{13}	0.42
4.	X_{17}	0.38
5.	X_{20}	0.35

5. Modeling the Influence of Selected Features on the Choice of a Given Form of Learning

5.1. Factors Influencing the Choice of Learning as 100% of Contact Classes at University

After excluding statistically insignificant variables, the structural parameters of the model described by the formula (1) were estimated. The verification of the statistical significance of the predictors for the dependent variable Y_1 using the Wald coefficient (Table 4) showed that the decision to choose 100% contact learning is significantly influenced by features such as (i.e., for which $p < 0.05$) $X_1, X_2, X_3, X_{10}, X_{20}, X_{21}, X_{22}, X_{23}, X_{24}$, and X_{25} . The calculated structural parameters of the model Y_1 together with the level of statistical significance of the predictors are presented in Table 4.

Based on the values of the coefficients Pseudo $R^2 = 0.32$, R^2 Nagelkerke = 0.52, and R^2 Cox-Snell = 0.36, the satisfactory quality of the model fit can be stated. According to R^2 Nagelkerk’s calculated value, it explains 52% of the variance of the dependent variable. At the same time, the model is statistically significant (p -value < 0.000001). The result of the Hosmer and Lemeshow test ($p = 0.257487$) indicates no significance. In the case of the Hosmer–Lemeshow test, the lack of significance is desirable as it indicates the similarity of the observed rates and the predicted probability. The collective test of the

model coefficients showed its significant difference compared to the model containing only the intercept ($p < 0.001$).

Table 4. The structural parameters of the model Y_1 together with the level of statistical significance of the predictors.

Explanatory Variables (X_i)	α_k	Wald Statistics	Significance Level p -Value	Exp (α_i)
X_1	0.108	6.791	0.0030	1.114
X_2	-0.216	6.908	0.0029	0.806
X_3	-1.12	1.497	0.0061	0.326
X_{10}	0.468	5.70	0.0138	1.597
X_{20}	0.598	0.354	0.0749	1.818
X_{21}	-1.99	4.729	0.0152	0.137
X_{22}	0.21	16.462	0.0120	1.234
X_{23}	-0.451	42.515	0.0120	0.637
X_{24}	-0.17	1.621	0.0341	0.844
X_{25}	-0.12	0.353	0.0749	0.887
α_0	-3.212			
Log Likelihood	-74.005673			
-2 Log Likelihood	148.011346			
Log Likelihood (for α_0)	-97.498702			
2 Log Likelihood (for α_0)	194.997404			
Chi-square statistics	38.372654			
* p -value	<0.000001			
Pseudo R^2	0.324260			
R^2 Nagelkerke	0.518953			
R^2 Coxa-Snella	0.357946			
Hosmer-Lemeshow test results:				
Chi-square statistics	10.646431			
p -value	0.257487			

* p -value < 0.000001.

An increase in X_i by one unit increases or decreases the ceteris paribus the odds ratio to $\text{Exp}(\alpha_i)$, $[(\text{Exp}(\alpha_i) - 1) \cdot 100\%]$. Hence, on the basis of the constructed model, and the odds ratios calculated for each predictor, it can be concluded that the probability of a student choosing learning in the form of 100% of contact classes:

- Increases by 11.40% if the student is a woman;
- Decreases by 19.43% if the student is at least 22 years old and older;
- It decreases by as much as 67.37% in the case when the student is studying in part-time studies;
- Increases by as much as 59.68% in the case when the student participates in additional activities;
- Increases by as much as 81.85% if the student owns a car;
- Increases by as much as 86.33% when the student negatively assesses his knowledge and skills obtained in online classes (i.e., the knowledge gained thanks to remote learning is at a lower level than the knowledge obtained during contact classes);
- Increases by 23.37% when the place to obtain materials for research work before the COVID-19 pandemic was only the library;
- Increases by 36.30% due to the students' lack of trust in privacy during online classes (in the context of third parties, undesirable people in classes), and the sense of security of the information provided (files, final papers, presentations);
- Increases by 15.63% when the technical quality of online classes is unsatisfactory;
- Increases by 11.31% when the quality of online classes is unsatisfactory in terms of scientific content.

5.2. Factors Influencing the Choice of Learning as 100% of Classes Carried out Remotely

A similar course of action as in the case of searching for factors influencing the choice of learning as 100% of contact classes at the university was carried out for the case of searching for factors influencing the choice of learning by students as 100% of remote learning. The analysis showed that the decision to choose 100% of classes carried out remotely is significantly influenced by features such as (i.e., for which $p < 0.05$):

- Age (X_2);
- Type of studies (X_3);
- Number of study fields of study (X_9);
- Participation in additional activities (X_{10});
- Performance of professional work (X_{12});
- Means of transport used to travel to the university (X_{18});
- Average travel time to the university (X_{19});
- Assessment of knowledge and skills obtained by the student thanks to 100% online classes compared to 100% contact classes at the university (X_{21});
- Technical quality of the online classes (X_{24});
- Content-related quality of online classes (X_{25}).

The results of this analysis are presented in Table 5. Based on the constructed model, and the odds ratios calculated for each predictor, it can be concluded that the probability of a student choosing the form of learning as 100% distance learning:

- Increases by 14.11% if the student is 22 years old and older;
- Increases by 61.93% in a situation where the student is studying in part-time studies;
- Increases by as much as 122.78% in a situation where a student studies two fields of study at the same time;
- Increases by as much as 140.85% in a situation where the student, apart from studying, also participates in additional activities;
- Increases by as much as 118.58% in a situation where the student, apart from studying, also performs professional work.
- Increases by as much as 101.17% in a situation where the student traveled to the university by means of public transport;
- Increases by as much as 179.55% when the average travel time of a student to the university is at least 30 min or more;
- Increases by 20.08% in a situation where the knowledge and skills obtained by a student in online classes are at the same or higher level than the knowledge acquired in contact classes;
- Increases by 34.18% in a situation where the quality of the classes is technically satisfactory for the student;
- Increases by 53.27% in a situation where the quality of the classes is satisfactory in terms of content.

5.3. Factors Influencing the Choice of Learning Provided in a Hybrid Form

Additionally, a similar course of action as in the two previous cases was carried out for the search for factors influencing the student's choice of hybrid learning. The analysis showed that the decision to choose 100% hybrid learning is significantly influenced by features such as (i.e., for which $p < 0.05$):

- Taking care of parents (X_{13});
- Living alone (X_{17});
- Owning a car (X_{20}).

The results of this analysis are presented in Table 6.

Table 5. The structural parameters of the model Y_2 together with the level of statistical significance of the predictors.

Explanatory Variables (X_i)	α_k	Wald Statistics	Significance Level p -Value	Exp (α_i)
X_2	0.132	31.253	0.0000	1.141
X_3	0.482	4.327	0.0250	1.619
X_9	0.801	5.874	0.0140	2.228
X_{10}	0.879	8.462	0.0020	2.408
X_{12}	0.782	12.471	0.0000	2.186
X_{18}	0.699	2.481	0.5100	2.012
X_{19}	1.028	10.392	0.0000	2.795
X_{21}	0.183	3.862	0.0240	1.201
X_{24}	0.294	6.392	0.0030	1.342
X_{25}	0.427	2.523	0.1240	1.533
α_0	6.353			
Log Likelihood	−62.543601			
−2 Log Likelihood	125.087202			
Log Likelihood (for α_0)	−85.904769			
2 Log Likelihood (for α_0)	171.809538			
Chi-square statistics	44.0528092			
* p -value	<0.000001			
Pseudo R^2	0.2894150			
R^2 Nagelkerke	0.4698181			
R^2 Coxa-Snella	35.908673			
Hosmer–Lemeshow test results:				
Chi-square statistics	10.6890232			
p -value	0.14923897			

* p -value < 0.000001.

Table 6. The structural parameters of the model Y_3 together with the level of statistical significance of the predictors.

Explanatory Variables (X_i)	α_k	Wald Statistics	Significance Level p -Value	Exp (α_i)
X_{13}	0.365	7.160	0.1010	1.441
X_{17}	0.284	4.39	0.0489	1.328
X_{20}	0.480	6.457	0.0000	1.616
α_0	3.184			
Log Likelihood	−82.980315			
−2 Log Likelihood	165.96063			
Log Likelihood (for α_0)	−96.485928			
2 Log Likelihood (for α_0)	192.971856			
Chi-square statistics	32.104756			
* p -value	<0.000001			
Pseudo R^2	0.313822			
R^2 Nagelkerke	0.501837			
R^2 Coxa-Snella	0.457201			
Hosmer–Lemeshow test results:				
Chi-square statistics	8.473920			
p -value	0.115265			

* p -value < 0.000001.

Based on the constructed model, and the odds ratios calculated for each predictor, it can be concluded that the probability of a student choosing a hybrid form of learning:

- Increases by 44.05% in a situation where the student takes care of his parents;
- Increases by 32.84% when the student lives alone;
- Increases by 61.61% in a situation where the student has their own car.

6. Conclusions

Sudden, unexpected, and dynamic changes in the education system that were introduced around the world in March 2020, in connection with the COVID-19 pandemic, made the so far insufficiently regulated methodology of distance learning indispensable for the implementation of the planned curriculum, and basic computer skills began to play a key role in the continuation of conducting classes according to the new guidelines of individual universities. The article analyzes the factors increasing the probability of a hypothetical choice by a student of one of the three forms of learning from among the three options, which are 100% of classes carried out in the form of contact at the university, according to the rules applicable before the period of the COVID-19 epidemic, 100% of classes carried out remotely with the use of software enabling free, two-way communication between the academic teacher conducting the classes and the student, e.g., zoom, MS Teams, etc., and the classes carried out in a hybrid way, i.e., lectures conducted online, while exercises and laboratories in the form of contact in the proportions specified by the university. In fact, students cannot choose the form of education at the university, as this form is regulated by the relevant ordinances of the Minister of Education and Science, and the applicable ordinances of the university rector. Nevertheless, getting to know their opinions on this subject may be a valuable source of information in the field of planning future forms of classes at universities, also in post-COVID-19 times. The results obtained with regard to the general preferences of students turned out to be quite neutral. Among all students, 38.5% admitted that they prefer contact classes in the university building, 40.1% chose 100% of classes in a remote form, and only 21.40% chose classes in a hybrid form. On the one hand, this distribution proves almost equal preferences in terms of contact and remote classes, without one form of learning that clearly stands out. However, on the other hand, these results also show that, despite many supporters of traditional, contact-based classes in the university building, online classes and remote learning are also beginning to be appreciated by students. This conclusion is especially important for university authorities making decisions about the future form of student learning.

The analyses presented in the article allowed for the selection of factors determining the choice of a given form of education by students. When students indicated their willingness to carry out classes as 100% contact classes, the essential ones turned out to be factors such as gender, age, form of study, participation in additional activities outside of studies, owning a car, assessment of knowledge and skills acquired during the course of study, a place to obtain materials for scientific work, the students' lack of trust in privacy during online classes (in the context of third parties, undesirable persons during classes) and the lack of a sense of security of the information provided (files, final papers, presentations), the quality of the classes conducted technically, and the quality of the classes in terms of content.

On the other hand, for students who chose the form of learning as 100% of the classes carried out remotely the essential ones turned out to be factors such as age, form of study, number of fields of study studied at the same time (when the student studies two fields of study at the same time), participation in additional activities outside study, professional work, means of transport to travel to the university, average travel time to the university, level of knowledge and skills obtained by the student during online classes, and quality of classes in terms of technical and content.

For those students who indicated hybrid classes, features such as taking care of their parents, living alone, and having their own car turned out to be the most important. Taking into account the obtained results, it can be concluded that remote learning is no longer an innovation in teaching and has become one of the forms of education used nowadays in higher education. However, the question remains to what extent this form of education will be used in the future, in post-COVID-19 times. According to the research results presented in the work [68], the main advantages of remote learning include, first of all, improvement in learning conditions, improvement in teaching methods and materials, improvement in teaching methods, improvement in communication between teachers and students, as

well as development of new competences. Remote learning also has weaknesses related mainly to the deterioration of interpersonal communication, competency gaps both among students and teachers, quality of infrastructure and equipment, variety of platforms and didactic tools used, social problems related to weaker involvement and motivation of students, lower quality of the process in the context of practical and laboratory classes, the possibility of controlling the didactic process (verification of the obtained students' results), and the negative impact on the health of users.

As stated in the second section, in Poland, the higher education system has been systematically changed and reformed in recent years. A number of changes were introduced in order to adapt the educational offer to the expectations of employers, among others by implementing a practical profile, dual studies, longer student internships, consulting the university's educational offer with employers, and implementing a qualification framework combining knowledge, skills, and social competences instead of just imparting knowledge. At present, the higher education system is facing further changes related to the change in the form of learning taking into account remote learning.

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