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Evaluation of Quality of Innovative E-Learning in Higher Education: An Insight from Poland

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Abstract: The paper presents the results of research on the quality of e-learning in Polish higher education. The authors used an internet questionnaire for the study. The research sample was 621 students. Firstly, the researchers determined 14 variables that are important for the quality of e-learning. Then the students evaluated these variables with scores from 1 to 5. The students agreed the most with the following statements: "using the e-learning platform is convenient" (average: 4.20 and median 5.00), and "logging in to the e-learning platform is easy" (average 4.38, median 5.00). Moreover, the authors studied the relation between the quality of e-learning in Polish universities and the following variables: the ease with which the student can acquire content in traditional teaching and e-learning, the student's knowledge of information technology and their possession of the resources necessary for e-learning, and the student's assessment of the innovation of e-learning solutions used by the university where the student studies.

Keywords: e-learning; quality; innovative education; study resources

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1. Introduction

The rapid advancement of digital technologies has significantly reshaped the educational landscape, starting a new era of e-learning. As society transitions to Industry 4.0 and Society 5.0, where digitalization and automation are increasingly integrated into daily life, traditional methods and tools of education are being redefined. E-learning and hybrid learning have emerged as important components of modern education, using innovative technologies to provide flexible, personalized, and accessible learning experiences that meet diverse needs across generations. The new generation of students grows up with mobile technologies and naturally expects them to be integrated into their education. This change reflects their desire for a more connected, flexible, and personalized education that aligns with their digital lifestyles, making it essential for educational institutions to adapt and meet these expectations. On the other hand, universities compete for students, and therefore they must offer interesting, modern, and digitalized methods of studying and teaching. Technological developments have opened up new opportunities for teaching and learning, providing artificial intelligence, virtual and augmented reality, and data analytics to enhance educational outcomes. The digital classroom offers engagement in interactive simulations, and collaboration with peers, breaking down geographical and temporal barriers. It is worth noting also that the digital skills required to navigate new learning environments are significant, not only for students but also for educators who must adapt to new teaching methods and technologies. The shift to e-learning demands investments in technological infrastructure, from good internet access to the latest digital devices, which is a challenge for financial resources and can also exacerbate inequalities. Furthermore, the need for continuous professional development for educators is paramount to keep pace with the rapidly evolving digital tools and platforms. In this context, the topic of e-learning becomes a crucial area of study, particularly in understanding how these technological advancements are being integrated into educational systems.

The article provides a fresh perspective on the quality assessment of e-learning worldwide by presenting the results of a survey directly completed by students. This approach lends the study greater credibility and reliability, as it reflects the authentic experiences and perceptions of the students themselves, rather than those of educational institutions, which may have biases. The article is valuable for readers because it explores various dimensions of e-learning from the students' point of view, such as content quality, resource availability, communication, and learning effectiveness, and many more. Understanding the quality of e-learning from students' perspectives is crucial, especially as e-learning has become a core component of modern education systems, particularly in an increasingly globalized world. As primary users, students offer unique insight into the strengths and weaknesses of e-learning, which can help us to identify areas for improvement. This makes this article essential for educators, decision-makers, and parents, offering them reliable data on the true benefits and drawbacks of e-learning, and emphasizing that its quality is shaped not only by technology, but also by how well it aligns with students' needs. Also, from a scientific point of view, it is vital to examine how students perceive the quality of e-learning and the factors that influence this quality. Examining the Polish experience with e-learning, especially during the pandemic, provides valuable insights into the challenges and opportunities presented by digitalization.

2. Literature Review

In the beginning, it is worth noting that the pandemic has caused major changes in the labor and education sectors. Manners and tools of work that were not very popular before the pandemic have become something common and normal during it. An example of this is work outside the office (for example, home office) [1], remote work [2], using IT tools, such as Zoom.us, MS Teams and special dedicated platforms, and in relation to education, an example is the use of various e-learning tools [3]. Remote work allowed us to continue working despite successive waves of the pandemic. On the other hand, it disturbed the balance of life and the possibility of separating private time from work [4]. It could also have some impact on the quality of work [5]. It is similar in e-learning, as it has many advantages but also many disadvantages [6]. However, it should be noted that the tools used for e-learning were not applied on as large scale a before the pandemic as they were during it [7,8]. It should also be noted that the current young generation of students and pupils can quickly learn how to use online tools for remote learning. They have problems with focusing on traditional lectures compared to achieving new skills in the field of internet activities. Moreover, according to Betto et al. [9], e-learning lectures allow students to learn at their own pace, so they are better suited to students' needs. Modern education is increasingly using modern technological achievements, because in the modern world we are dealing with a different type of student model than decades ago. A modern student is interested in new technologies, IT tools, and also quick distractors. They need attractive content during learning. This is due to the fact that they follow this content every day on their own on Facebook, YouTube, Instagram, TikTok [10], etc. On the other hand, they easily learn to operate new technologies that can also be used for modern education, and, especially in the technical field of studies, for example, engineering [11], these technologies can include 3D printing [12,13], programming [14], gaming [15], sustainable transport [16–18] and the use of virtual reality [19–21].

E-learning is very popular in today's world, evidenced by a very large number of articles that have appeared and continue to appear. However, it cannot be forgotten that e-learning can be of different qualities. Quality is a very broad term and can be perceived from different perspectives [22,23]. However, the fact that a given university uses e-learning does not mean that it is characterized by high quality and innovative teaching. Evaluating the quality of e-learning is important. In the literature, there is some research on the topic of e-learning; among others, there are publications that show the results of evaluations of e-learning at given universities. In the paper [24], the authors analyzed scientific publications on e-learning in higher education in Germany over the past decade

to observe trends and shifts in academic interest. They conducted a survey of students and teachers at the University of Konstanz to gather insights into the use of e-learning tools and their perceptions of e-learning. The study revealed a decline in academic interest in e-learning in Germany, with a slight increase during the coronavirus pandemic, but found that teachers showed a strong interest in e-learning tools, while students exhibited mixed feelings. In another study [25], the authors examined the impact of the COVID-19 pandemic on teaching and learning at universities in Germany, focusing on the shift to Emergency Remote Teaching during the online term of 2020. They assessed whether this change could accelerate the digitalization of higher education, and explored how to build on this development. The study involved a longitudinal analysis of students' media use behavior and investigated changes in the acceptance of e-learning tools, finding that while acceptance had been declining, the pandemic pressures and increased commitment from teachers might positively influence digital innovations in university teaching. The perception of learning by students was also examined in the publication of [26]. The authors studied readiness and media resources. The method used in the study was based on secondary empirical data obtained from surveys of students from Germany, Poland, India, Pakistan, Nepal, Indonesia, Philippines and the USA. The conclusion was that high-income countries have a higher level of students satisfied with learning. Another study [27] was conducted in Germany and evaluated the influence of strategic operations on learning development during the COVID-19 era. The authors of the paper [28] conducted a qualitative study to explore the learning experiences and expectations of nursing students in Spain who transitioned from traditional to distance learning during the first month of COVID-19 confinement. They interviewed 32 students and identified six main themes related to the challenges and impacts of this sudden shift to e-learning. Another study in Spain [29] investigated the experiences of 68 Spanish high school students in grades 9 and 10 who participated in online mathematics classes during the first trimester of the 2020–2021 academic year, due to COVID-19 restrictions. The findings revealed a shift from students attending live online classes to preferring prerecorded sessions, as they valued the ability to rewatch explanations, although maintaining student engagement in distance learning remained challenging. There are more studies on e-learning in Spain [30,31]. Synchronous e-learning was also evaluated by an engineering student in France during the pandemic [32]. The perception of e-learning was also explored in Romania and Moldovia in the paper of [33], and in Portugal and Italy in [34]. In a study among Greek students, an evaluation of the acceptance and effectiveness of e-learning during the pandemic was carried out [35]. The acceptance of this type of learning was also evaluated by a student in Portugal—it was referred to laboratories of animal science training [36]. The effects of e-learning on Generation Z during the pandemic were studied in Italy in [37]. When it comes to the Czech Republic, Ref. [38] conducted a qualitative case study, involving interviews with content administrators and learners, to explore factors and trends in e-learning at a workplace. The analysis highlighted the advantages, challenges, and future trends of e-learning, emphasizing its growing role in workplace training. The study [39], carried out within the ELEPHANT project on e-learning in the humanities in the Czech Republic, Italy, Lithuania, Poland and Slovakia, features a comparative analysis revealing best practices and challenges on the topic of e-learning. An investigation of the impact of COVID-19 on e-learning within EU countries was conducted in [40].

On the other hand, in the research [41], the authors analyzed the perceptions of technology and e-learning among vocational education and training (VET) teachers in Poland, Italy, and Germany. They conducted a quantitative study using a standardized questionnaire to evaluate VET teachers' interest in and acceptance of online teacher training tools. The study aimed to assess the relevance of e-learning for teacher training, and to provide insights related to improving online education formats. The findings reveal a positive response to online training among VET teachers, emphasizing the importance of quality in e-learning modules, although the study had limitations due to the varied cultural and educational contexts in the countries involved.

When it comes to countries and research outside the European Union, the paper of Bismala [42] presents the results of research on the evaluation of the quality of e-learning. The authors examined 345 students of management at the Universitas Muhammadiyah Sumatera Utara. The authors used the research method of a survey questionnaire. The study revealed an effect of self-efficacy and e-learning quality on the e-learning users' satisfaction. Puriwat and Tripopsakul [43] carried out their studies on the quality of e-learning in Thailand. The study concerns the impact of e-learning on student satisfaction. The research trial featured 185 higher education students. The main conclusion was that the quality of e-learning is a second-order construct consisting of three elements (course content and design, then administrative and technical support, and finally instructor and learner characteristics). It is worth highlighting that the first element, which is course content and design, was the crucial dimension of general e-learning quality. It must also be mentioned that the quality of the e-learning had a positive impact not only on student satisfaction, but also on motivation towards continued usage towards e-learning platforms. Alkinani [44] presented a similar topic, but the evaluation was made among Saudi Arabian undergraduate students. The main results of the study included the following: positive perception was connected with flexibility, cost effectiveness, availability of electronic research databases, and well-designed online classroom interfaces. However, some elements, such as lecturer's delayed feedback, lack of technical support from the lecturers, low self-esteem and self-motivation, feeling of isolation, singularity of educational methods, and poorly designed class materials were negatively assessed.

Makhachashvili et al. [45] conducted a study that evaluated individual experiences with digital distance and blended learning in university-level programs for Oriental (Mandarin Chinese, Japanese) and European (French, Italian, Spanish, English) languages in Ukraine. The research utilized surveys and analyses of various ICT tools to assess the quality and challenges associated with translating traditional, in-person foreign language learning into a digital and blended format. This evaluation focused on the effectiveness of integrating interdisciplinary skills and cross-sectoral activities through ICT tools, comparing the quality of e-learning and hybrid learning experiences to traditional face-to-face methods. The study also examined the design of the learning process, the achievement of programmed learning outcomes, and the development of projected competencies in these language programs. In other research [46], Esmaeili Givi et al. focused on identifying key characteristics that are crucial for enhancing quality. They employed asymmetric impact–performance analyses to explore the uneven relationship between user satisfaction and specific website features. Their research was carried out within the context of the University of Tehran's e-learning website, the leading university in Iran, seeking to assess how various website elements influence user satisfaction. Saxena et al. [47] investigated how the perceived benefits of maintaining social distance influenced the quality of e-learning during the COVID-19 pandemic, examining the moderating effects of these perceptions on the overall e-learning experience. Makhachashvili [48] conducted research focused on developing a comprehensive framework for assessing the quality of digital learning in the context of COVID-19. The study involved a survey of European and Oriental language programs to evaluate the effectiveness and challenges of digital learning during the pandemic. In the paper by Ali et al. [49], the authors found answers to two questions about e-learning. They included questions such as "Do students prefer face-to-face (traditional) learning methods or e-learning technology enabled solutions?", and "Does perception of e-learning, and/or device preference, vary between individuals?" The authors present a complex discussion of the topic connected to these questions, and answers to them.

It should also be mentioned that there are many other articles in the literature dealing with the problem of e-learning assessment. They focus on evaluating aspects other than the general quality of e-learning. The first example is the evaluation of mobile learning in plants in English [50]. Taiwanese students provided feedback on their preferences and requirements for digital learning materials. The analysis revealed that most of the students preferred teaching materials that included text and images optimized for mobile web

pages and preferred a simple user interface. They also suggested improvements, such as improving maps, words, and images. Additionally, they recommended incorporating forum feedback and an audio guide to further improve the user experience with the system. Another example refers to learning engagement [51]. The authors used an infrared (IR) imaging sensor to obtain clear images in an online learning environment, which were used to analyze facial expressions to assess learning engagement. They developed an integrated model consisting of two sub-models utilizing the VGG-16 convolutional neural network. The first sub-model assessed the learning engagement level based on IR images captured during the learning process, while the second sub-model evaluated engagement levels based on mouse movement patterns. Yawson and Yamoah [52] conducted a quantitative study on the gender perspectives of e-learning, focusing on the differences across Generations X, Y, and Z. In a study involving 611 respondents enrolled in a mandatory online course at a Business School, the authors utilized multi-group partial least-squares analysis to reveal that while gender differences in e-learning utility exist, they vary significantly across generational lines. These generational nuances might be overlooked when only gender is considered, leading to premature conclusions about the narrowing gender gap in e-learning. The study suggests that to effectively implement e-learning in traditional undergraduate programs, course development, learner support, assessment, and user characteristics must be contextualized according to gender and generational differences. Additionally, in developing countries, strengthening institutional support is essential to advancing e-learning adoption. Shabunina et al. [53] explored the effectiveness of e-learning by focusing on the characteristics of online courses that contribute to the emotional stability of students. Their research demonstrated that, in addition to maintaining the educational process's effectiveness, the introduction of an experimental e-learning course significantly enhanced students' emotional resilience. In particular, the study found a 27% increase in the level of joy among students compared to traditional learning methods, highlighting the potential of well-designed online courses to positively impact students' emotional well-being. Another study aimed at explaining teachers' adoption of digital technology in education was carried out [54]. The authors discussed various models that explain the factors and mechanisms influencing technology use in classrooms, with a particular focus on the Technology Acceptance Model (TAM) and its various iterations. They delve into the model's effectiveness in predicting teachers' adoption of technology and provide insights and implications for both research and practical application, emphasizing the model's relevance in understanding and enhancing technology integration in educational settings.

When it comes to research on the quality of e-learning conducted in Poland, it can be claimed that the literate is poor. Developing the literature review, we found a few papers that refer in some way to the evaluation of e-learning in Poland, but none of the articles directly addressed the assessment of the quality of e-learning on the example of Polish universities. Articles related to e-learning assessment included the following topics: the perception of e-learning by students of medical universities in Poland [55], good practices in asynchronous e-learning for Polish medical studies [56], factors determining satisfaction with e-learning [57], teachers' perspective of the chosen elements of e-learning [58], opinions of Polish students about e-learning and blended learning [59], and a method of integrated assessment of managing academic e-learning [60]. Based on the analysis of publications, it can be claimed that there is there is a lack of papers that evaluate the quality of innovative e-learning in Poland. Therefore, it is justified to conduct research on this topic.

3. Methodology

The research was carried out in Poland in December 2021. The participants included 621 students from Polish universities. In our study, we used an online questionnaire (Google questionnaire). Google Forms offers the possibility of creating a form with questions, automatically collecting data and saving them to an MS Excel file. We gathered the surveys by posting the survey using Facebook pages. Links to the previously prepared survey were posted on the pages of all Polish technical universities.

The research process is presented in Figure 1. The SERVPERF methodology, which is used to measure the level of service quality, was utilized in the development of the survey. The SERVPERF methodology [61,62] is a type of SERVQUAL methodology [63,64], which involves measuring service quality by asking customers to rate their perceptions of a service on a set of attributes. These attributes can vary between different industries.

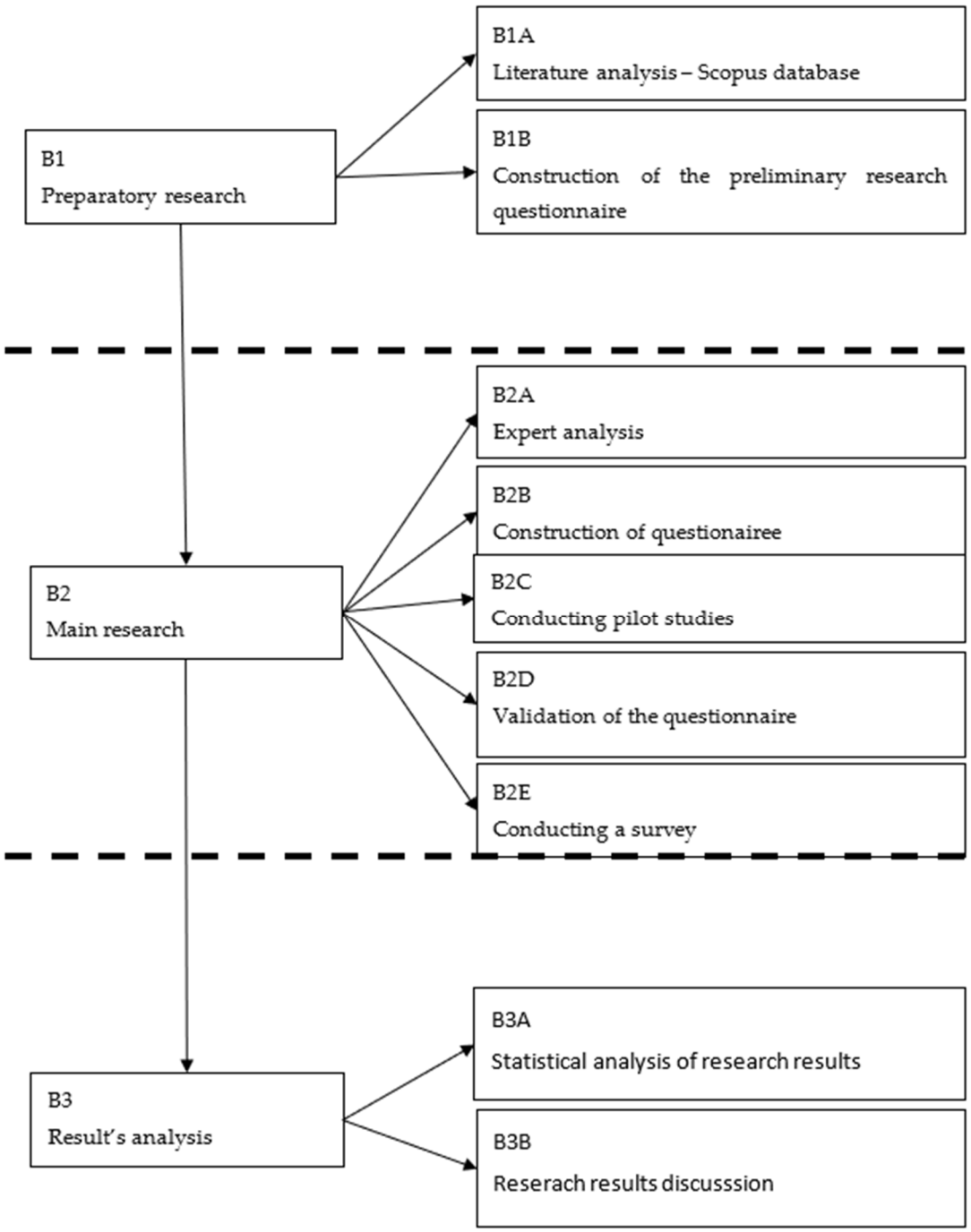

Figure 1. Stages of the applied research procedure.

Based on a literature review [65–80] (B1A stage), we prepared a list of 20 questions related to typical aspects of service quality, covering dimensions such as reliability, responsiveness, empathy, assurance, and tangibles (stage B1B).

The original set of 20 questions was evaluated using the expert method (stage B2A). To assess whether a given question should be included in the survey to measure service

quality, a survey was conducted among professionals who are engaged in e-learning and apply e-learning in their professional practice.

The representatives of these two expert groups will differ in their competencies in various aspects. Therefore, it is necessary to establish a rule for assessing and selecting experts for the survey based on their competencies.

It is crucial, then, to determine the level of their competencies using an appropriate indicator, and to set a threshold value above which an expert can be qualified to participate in the survey. Assessments of the competencies of experts and their qualifications will be conducted based on a self-assessment questionnaire. As a result of the self-assessment, a competence coefficient (Kk) will be determined, representing the arithmetic mean of the coefficients Kz—i.e., the familiarity coefficient—and Ka—i.e., the argumentation coefficient [81]. The formula (1) shows the competence coefficient:

$$\mathrm{Kk} = \frac{\mathrm{Kz} + \mathrm{Ka}}{2} \quad (1)$$

The familiarity coefficient (Kz) aims to indicate the alignment between the expert's knowledge of the essence of the research problem and their actual expertise—where a narrow specialty of the expert signifies the highest rating. It is calculated for each expert by multiplying the chosen score from the questionnaire by 0.1. In this case, experts who have a satisfactory understanding of the problem are accepted—regardless of whether they are involved in its practical resolution—if they achieve a score for Kz $\geq$ 0.5 [81].

A questionnaire was used to assess the experts' qualifications for the survey. The questionnaire evaluated the experts' familiarity with the given topic on a scale of 0–10, where the numbers signify the following:

- 0—The expert is unfamiliar with the problem;
- 1–3—The expert has a weak understanding of the problem, but it falls within their area of interest;
- 4–6—The expert has a satisfactory understanding of the problem but does not participate in its practical resolution;
- 7–9—The expert has a good understanding of the problem and participates in its practical resolution;
- 10—The problem is within the expert's narrow specialization.

The argumentation coefficient (Ka) aims to determine the value of the arguments used by the expert, where judgments based on the experts' own experience are valued the highest, while generalizations of knowledge and intuitive opinions are valued the lowest (see Table 1). It is calculated for each expert by summing the selected scores in various categories of argumentation. In this case, experts whose argumentation collectively corresponds to a level of theoretical analysis and practical experience at an average level are accepted—i.e., Ka $\geq$ 0.5 [81].

Table 1. Survey to evaluate the argumentation coefficient (Ka) of the expert.

Argumentation			Source of Argumentation
High	**Average**	**Low**	
0.3	0.2	0.1	Theoretical analysis conducted by the expert
0.5	0.35	0.2	Practical experience of the expert
0.05	0.05	0.05	Generalization of works by local authors
0.05	0.05	0.05	Generalization of works by foreign authors
0.1	0.1	0.1	Expert's intuition

Source: Author's own work on the basis of [81].

Returning to the competence coefficient (Kk), if the minimum for Kz is set at 0.5 and for Ka at 0.55, the competence coefficient above which an expert can be qualified for the study is (0.5 + 0.55)/2 = 0.525.

Based on the conducted analysis, 17 experts from the group of academic researchers engaged in e-learning and 23 from the group of practitioners using e-learning were qualified for the study.

The next step is to determine the degree of agreement among experts regarding the assessment of individual survey questions, which will confirm or refute the appropriateness of the expert selection. This measure is determined using the Kendall/Babington–Smith concordance coefficient. The concordance coefficient, ω, can range from 0 to 1. A higher value of the coefficient corresponds to greater agreement among experts, with full agreement yielding ω = 1. The concordance ranges can be interpreted as follows [81]:

- Sufficient for the range—0.20–0.40;
- Good for the range—0.41–0.60;
- Very good for the range—0.61–0.80;
- Excellent for the range—0.81–0.95;
- Ideal for the range—0.96–1.

To determine the concordance, the following actions will be taken:

Calculation of the arithmetic mean of the sum of scores for evaluating individual questions.

$$\hat{S} = \frac{\sum_{j=1}^{n^*} S_j}{n^*} \quad (2)$$

Determination of the deviation of the sum of ranks of scores received by object j from the arithmetic mean of the sum of scores received by all objects, d_j (3),

$$d_j = S_j - \hat{S}, \quad j = 1, 2 \ldots n^* \quad (3)$$

Calculation of the indicator of the associated ranks assigned by each successive expert, TiT_iTi. If there are identical ranks among them, the formula is the following (4):

$$T_i = \sum_{k=1}^{l} \left(t_k^3 - t_k \right) \quad (4)$$

i = 1, 2, . . ., m

Here, the following pertains:

l—is the number of tied ranks in the group;

t_k—is the number of identical ranks in each group.

Determination of the concordance coefficient, using the formula (5)

$$\acute{\omega} = \frac{\sum_{j=1}^{n^*} d_j^2}{\frac{1}{12} m^{*2} (n^{*3} - n^*) - \frac{1}{12} m^* \sum_{i=1}^{m^*} T_i} \quad (5)$$

In the final survey, only those questions were included that achieved a Kendall/Babington–Smith concordance coefficient of at least 'sufficient' for the range, i.e., $\omega > 0.20\backslash omega > 0.20\omega > 0.20$. In the conducted research, this included 14 questions from the original list (stage B2B).

The first part of the survey was devoted to issues related to the advantages of using e-learning in higher education. The following variables were used in the research:

- Q1—The university supports students in the e-learning process;
- Q2—E-learning is an effective way of learning;
- Q3—E-learning allows one to acquire knowledge;
- Q4—E-learning allows one to verify knowledge;
- Q5—E-learning allows one to easily access academic teachers;
- Q6—E-learning materials are of high quality;

- Q7—The e-learning tools used by the university are accessible;
- Q8—Academic teachers are helpful to students (in the context of e-learning);
- Q9—Academic teachers are competent (in the context of e-learning);
- Q10—Academic teachers care about the security of students' personal data (in the context of e-learning);
- Q11—Academic teachers respond quickly to e-mails;
- Q12—Academic teachers conduct e-learning in a strictly determined time;
- Q13—Using the e-learning platform is convenient;
- Q14—Logging into the e-learning platform is easy.

A five-point Likert scale was used for all questions, allowing students to express their level of agreement or disagreement with each statement. This scale is a widely accepted method in social science research for capturing nuanced attitudes and opinions. It provides a robust measure of the intensity of students' perceptions, facilitating detailed analysis of their responses. The concept of a five-point scale is typical for a SERVPERF methodology [61–63,76].

The remaining variables that were studied do not directly pertain to the quality of e-learning but rather to factors related to the student—their preferences regarding the use of traditional methods and e-learning [82,83], familiarity with information technology, access to the necessary resources for participating in e-learning [26], and the student's overall assessment of the innovativeness of e-learning at the examined university [84].

When examining the factors influencing the advantages and disadvantages of e-learning in universities, the following variables were taken into account in the survey:

- S1—Student's assessment of content acquisition in traditional teaching;
- S2—Student's assessment of content acquisition in e-learning;
- S3—Knowledge of information technology held by the student;
- S4—The student's possession of the resources necessary to participate in e-learning classes;
- S5—Innovation of e-learning solutions used by the university.

In the next stage of the research, pilot studies were conducted with a sample of 100 students using e-learning at universities in Silesia (stage B2C). The pilot study was designed to simulate the conditions of the full-scale survey as closely as possible. The students were asked to complete the questionnaire online, using Google Forms, similar to the method that would be used in the main study. The purpose of this phase was to test the clarity, relevance, and effectiveness of the questionnaire items before distributing the survey to the larger sample of 621 students.

One of the key goals of the pilot study was to identify and address potential issues with the survey questions. This involved assessing whether the questions were clearly understood by the participants and whether they were able to respond without confusion or difficulty. Feedback collected during this phase highlighted several areas for improvement. Based on the insights gained from the pilot study, several adjustments were made to the questionnaire. The modifications included rewording the questions to enhance clarity.

The pilot study provided an opportunity to test the overall flow and structure of the questionnaire. It helped to determine whether the sequence of questions was logical and whether the length of the survey was appropriate for the participants. The feedback indicated whether any questions were redundant or if there were areas where additional questions might be necessary to capture important aspects of the quality of e-learning.

The questionnaire validation was performed using Cronbach's Alpha (α)—a reliability coefficient for the tests (stage B2D). A Cronbach's alpha of 0.87 suggests that the items in your questionnaire are reasonably correlated with each other. This indicates that they are likely measuring the same underlying construct, which in this case is the perceived quality of e-learning. Values between 0.8 and 0.9 are generally considered to reflect good reliability. The result shows that the questions included on the scale have a high degree of internal consistency. This means that respondents who provide high scores for one question are likely to provide high scores for other related questions. For example, if a student feels that

the e-learning materials are of high quality (as measured by one question), they are likely to agree with other statements related to the effectiveness and accessibility of e-learning. The high reliability suggests that the questionnaire can be used effectively in future research or evaluations related to e-learning. This implies that the instrument is suitable for measuring student perceptions and can be used in comparative studies, longitudinal studies, or to assess the impact of changes made in the e-learning environment.

To determine the sample size, the following formula was used:

$$N_{min} = \frac{N_p(\alpha^2 * f(1-f))}{N_p * e^2 + \alpha^2 * f(1-f)} \quad (6)$$

Here, the following pertains:

N_{min}—minimum sample size;

N_p—population size from which the sample is drawn;

α—confidence level for the results, with the value of Z in the normal distribution for the assumed level of significance;

f—fraction size;

e—assumed maximum error.

In the study, the following values were adopted:

α—confidence level 0.05;

N_p—an unknown population;

f—0.5;

e—0.05.

According to the calculations for the minimum research sample, for an unknown population size and the assumed statistical significance α = 0.05/alpha = 0.05α = 0.05, the sample size is 386 students. Our sample (621 students) was larger than the minimum sample size (stage B2E).

STATISCICA-13.3 software was used to analyze the collected data (stage B3A).

Based on an analysis of the literature, we found a gap in the research that refers to the quality of e-learning in higher education. This is also due to the fact that during the literature review, which is presented in the previous section, we did not find any research on the factors that influence variables related to the quality assessment of e-learning.

In our research, we set the following goals:

- G1—Examination of how the quality of e-learning is assessed in Polish universities;
- G2—Examination of the relation between the quality of e-learning in Polish universities and the ease with which the student can acquire content in traditional teaching and e-learning;
- G3—Examination of the relation between the quality of e-learning in Polish universities and the student's knowledge of information technology and their possession of the resources necessary for e-learning;
- G4—Examination of the relation between the quality of e-learning in Polish universities and the student's assessment of the innovation of e-learning solutions used by the university where the student studies;
- G5—Identification factors among quality of e-learning variables.

To realise these goals, we formulated the following scientific hypotheses:

H1a. *The technical aspects of e-learning are evaluated higher than its soft aspects;*

H1b. *The weakness of e-learning is verifying students' knowledge;*

H2. *The student's assessment of the quality of e-learning is positively correlated with the ease of acquiring content in e-learning;*

H3a. *The better students know information technology, the higher they assess the level of quality of classes provided using e-learning;*

H3b. *The higher the level of students' possession of resources to participate in e-learning, the higher they assess the level of quality of classes provided using e-learning;*

H4. *The more often innovative e-learning solutions are used at a university, the higher students assess the level of quality of classes provided using e-learning.*

4. Results

4.1. Examination of the Quality of E-Learning in Polish Universities

In the first stage of the research, the quality level of e-learning classes in the surveyed universities was measured. For all fourteen analyzed variables in Table 2, basic statistical indicators such as mean, median, and standard deviation were presented. The variables were evaluated on a five-point scale from 1 to 5. The following semantic scale was used to interpret the indicator values:

- <4.5–5>—very good;
- (4–4.5)—good;
- <3–4>—average;
- (2–3)—bad;
- <1–2>—very bad.

Table 2. Quality of e-learning in the surveyed universities.

Symbol	Variables	Avarage	Median	Standard Deviation
Q1	The university supports students in the e-learning process	3.41	3.00	1.20
Q2	E-learning is an effective way of learning	3.41	4.00	1.35
Q3	E-learning allows one to acquire knowledge	3.78	4.00	1.20
Q4	E-learning allows one to verify knowledge	3.34	3.00	1.34
Q5	E-learning allows one to easily access academic teachers	3.43	3.00	1.26
Q6	E-learning materials are of high quality	3.54	4.00	1.14
Q7	The e-learning tools used by the university are accessible	3.88	4.00	1.04
Q8	Academic teachers are helpful to students (in the context of e-learning)	3.59	4.00	1.14
Q9	Academic teachers are competent (in the context of e-learning)	3.48	4.00	1.13
Q10	Academic teachers care about the security of students' personal data (in the context of e-learning)	3.65	4.00	1.14
Q11	Academic teachers respond quickly to e-mails	3.37	3.00	1.14
Q12	Academic teachers conduct e-learning in a strictly determined time	4.15	4.00	1.01
Q13	Using the e-learning platform is convenient	4.20	5.00	1.12
Q14	Logging in to the e-learning platform is easy	4.38	5.00	0.96

Source: Author's own research.

The conducted research shows that in light of the adopted semantic scale, three variables were assessed at a good level. The variable rated highest was Q14—logging into the e-learning platform—given a score of 4.38, with a relatively low standard deviation and a median of 5.

In second place was the assessment of the ease of using the e-learning platform—Q13. In the case of this variable, the respondents assessed it at the level of 4.20; in its case the median was the same as the previous one, which was 5.

The high evaluation of variables related to the e-learning platform allows us to conclude that universities cope well with the technical side of e-learning solutions. The solutions they implemented (it was usually the Moodle platform in various versions) work well and are well appreciated by students. At this point, it is worth paying attention to the median values—although the average for the examined variables was in the "good" range, the median is "very good". In the case of variables related to the evaluation of the quality of the functioning of the e-learning platform, the rating was very good most of the time, which shows a very high evaluation of this aspect of the functioning of the e-learning in the universities surveyed.

In analyzing the histogram for the variable concerning the convenience of logging into the e-learning platform, 372 respondents (over 50% of all respondents) rated it at level 5—the highest rating. This proves that most students have no problem logging into the e-learning platform. Here, 13 respondents assessed the variable at level 1, and 21 respondents at level 2. In the next part of the publication, the relationships between individual variables and self-assessment by the respondents of information technologies are examined. This allows us to check whether the problems result from low IT competences rather than problems with the e-learning platform.

In the case of the variable concerning the convenience of using the e-learning platform, 340 respondents chose the highest answer—5. This was also more than half of the respondents. However, compared to logging in, a larger number of respondents (although still very small) rated the variable at level 1 or 2—23 and 37 people, respectively. This is most likely due to the fact that the use of an e-learning platform requires greater competence in the field of information technology compared to just logging into the platform, and people with a lower level of it may have more problems using the platform in this case.

The last variables evaluated at a good level were issues related to the conducting of classes by academic teachers within a strictly determined time—Q12. In this case, the average grade was 4.15 with a median of 4. A lower median indicates that most of the students surveyed rated the quality level as average for this variable.

The rest of the variables can be divided into two groups, according to the median. Variables for which the median is 4 show an average grade on the average level, which is from 3 to 4. These are the following variables: Q2—e-learning is an effective way of learning; Q3—e-learning allows one to acquire knowledge; Q6—e-learning materials are of high quality; Q7—the e-learning tools used by the university are accessible; Q8—academic teachers are helpful to students (in the context of e-learning); Q9—academic teachers are competent (in the context of e-learning); Q10—academic teachers care about the security of students' personal data (in the context of e-learning).

At the lowest level, with an average below 4 and median of 3, there are the following variables: Q1—the university supports students in the e-learning process; Q4—e-learning allows one to verify knowledge; Q5—e-learning allows one to easily access academic teachers; Q11—academic teachers respond quickly to e-mails.

Taking into account the entire study population, the table divides the examined variables into four groups: average over 4 and a median 5; average above 4 and median 4; average below 4 and median 4; average below 4 and median 3. Variables for which an average below 4 is accompanied by a median of 3 are areas for improvement in terms of quality level. The results are presented in Table 3.

The analysis of the collected data shows that the use of innovative e-learning teaching methods and the use of open innovation methods in this respect works well from the technical point of view. Most of the variables that are rated well concern various technical aspects—e-learning platform, e-learning tools used, data security, etc.

Variables relating to contacts between university teachers and students are rated worse. Research results support hypothesis H1a, which is as follows: the technical aspects of e-learning are evaluated higher than its soft aspects.

Table 3. The grouping of e-learning quality variables from the point of view of their average and median.

Category	Variables
Average above 4 Median 5	Q13—Using the e-learning platform is convenient Q14—Logging into the e-learning platform is easy
Average above 4 Median 4	Q12—Academic teachers conduct e-learning in a strictly determined time
Average below 4 Median 4	Q2—e-learning is an effective way of learning Q3—e-learning allows one to acquire knowledge Q6—e-learning materials are of high quality Q7—the e-learning tools used by the university are accessible Q8—academic teachers are helpful to students (in the context of e-learning) Q9—academic teachers are competent (in the context of e-learning) Q10—academic teachers care about the security of students' personal data (in the context of e-learning)
Average below 4 Median 3	Q1—the university supports students in the e-learning process, Q4—e-learning allows one to verify knowledge Q5—e-learning allows one to easily access academic teachers Q11—academic teachers respond quickly to e-mails

It is worth paying attention to the issues related to the availability of academic teachers and the speed of responding to emails. Analysis shows that there are problems in this area. Perhaps the low rating regarding the speed of response to e-mails is due to the fact that students, as people of the younger generation, are used to very fast contact via the internet. In this case, it can be recommended that university authorities pay attention to this aspect and convince academic teachers of the need to react faster to students' messages. Accessibility problems may also result from the insufficient use of electronic communication tools in the field of lecturers' consultations, leading students to believe that there are problems with access to academic teachers in the case of the extensive use of e-learning.

The variable of e-learning quality that was rated the worst was the variable concerning knowledge verification in e-learning—the score was 3.34. Students believe that while e-learning works well in the case of knowledge transfer, knowledge testing using e-learning is problematic. The results of the research support hypothesis H1b, which is as follows: the weakness of e-learning is verifying students' knowledge.

During the COVID-19 pandemic, due to epidemiological restrictions, universities conducted classes entirely via e-learning, and both classes and knowledge verification were conducted online. Based on the results, at present, when e-learning is used but it no longer results from epidemiological restrictions and more often has the nature of hybrid teaching, it is recommended to use e-learning for teaching and learning; however, at the same time it is recommended to verify knowledge in the traditional form.

4.2. Relation Between the Quality of E-Learning and the Ease of Acquiring Content in Traditional Teaching and E-Learning

In the next stage of the research, an analysis of the correlation was made between the examined variables regarding the quality of e-learning in the surveyed universities and the evaluation, provided by the students, in terms of the ease of acquiring content in traditional learning and in e-learning. Variables were also rated on a five-point scale from 1 to 5. Since all variables are discrete variables, Spearman's rank correlation coefficient was used. The appropriate values of the coefficients are listed in Table 4. Correlations that are statistically significant at the level of statistical significance $\alpha = 0.05$ are in bold.

Table 4. Spearman correlations between the quality of e-learning in higher education institutions and the ease of learning content for students in traditional learning and e-learning.

Variables	Ease with Which the Student Can Acquire Content in Traditional Learning	Ease with Which the Student Can Acquire Content in E-Learning
The university supports students in the e-learning process	0.01	**0.27**
E-learning is an effective way of learning	**−0.39**	**0.70**
E-learning allows one to acquire knowledge	**−0.33**	**0.68**
E-learning allows one to verify knowledge	**−0.31**	**0.60**
E-learning allows one to easily access academic teachers	**−0.27**	**0.50**
E-learning materials are of high quality	**−0.24**	**0.52**
The e-learning tools used by the university are accessible	**−0.11**	**0.39**
Academic teachers are helpful to students (in the context of e-learning)	**−0.13**	**0.38**
Academic teachers are competent (in the context of e-learning)	**−0.10**	**0.35**
Academic teachers care about the security of students' personal data (in the context of e-learning)	**−0.10**	**0.29**
Academic teachers respond quickly to e-mails	**−0.05**	**0.30**
Academic teachers conduct e-learning in a strictly determined time	**−0.08**	**0.28**
Using the e-learning platform is convenient	**−0.29**	**0.45**
Logging in to the e-learning platform is easy	**−0.16**	**0.34**

Source: Author's own research.

The analysis shows that the students' assessment of the quality of e-learning depends on whether they prefer traditional learning or e-learning. In the case of students who prefer traditional learning, all variables except Q1 are negatively correlated with the evaluation of the e-learning quality, and in the case of 11 variables, the correlation coefficient is statistically significant. The values of the correlation coefficients are not high for many variables, which means that there is a weak negative relationship (correlation coefficients in the range of 0.2–0.4). Research has shown that students who prefer traditional teaching do not rate the quality of e-learning highly, which is largely due to their habits and the fact that it is easier for them to acquire knowledge in the traditional form.

In the case of the correlation between the ease of acquiring content in e-learning and the examined variables of e-learning quality, there is a positive correlation—the easier a given student considers it to be to use e-learning tools, the higher they assess its quality. Statistically significant correlations occur for all variables studied. The strongest correlations are in variables Q2 (e-learning is an effective way of learning (correlation coefficient 0.7)), Q3 (e-learning allows one to acquire knowledge (correlation coefficient 0.68)) and Q4 (e-learning allows one to verify knowledge (correlation coefficient 0.6)). The results of the conducted analysis support the H2 hypothesis, which is that the student's assessment of the quality of e-learning is positively correlated with the ease of acquiring content in e-learning.

To perform a more detailed analysis, Table 5 presents the average values of the variables depending on the ease with which students acquire e-learning content. The data show that in the case of all the variables studied, the following relation can be observed: the greater the ease of acquiring e-learning content, the higher the assessment of individual variables of the quality of teaching with the use of e-learning. In the case of students who assess the ease of e-learning very highly, almost all variables are rated as good (above 4). Some of the variables (Q3, Q13; Q15) are assessed at a very good level.

Table 5. The quality of e-learning in the surveyed universities in relation to the assessment of acquiring e-learning content.

Variables	Ease with Which the Student Can Acquire Content in E-Learning				
	1	**2**	**3**	**4**	**5**
The university supports students in the e-learning process	2.79	2.93	3.33	3.54	3.77
E-learning is an effective way of learning	1.50	2.02	3.12	3.96	4.42
E-learning allows one to acquire knowledge	1.97	2.65	3.58	4.21	4.65
E-learning allows one to verify knowledge	1.74	2.14	3.14	3.67	4.28
E-learning allows one to easily access academic teachers	2.26	2.58	3.11	3.82	4.13
E-learning materials are of high quality	2.00	2.88	3.32	3.83	4.21
The e-learning tools used by the university are accessible	2.87	3.43	3.68	4.10	4.33
Academic teachers are helpful to students (in the context of e-learning)	2.55	3.14	3.35	3.78	4.13
Academic teachers are competent (in the context of e-learning)	2.66	3.01	3.29	3.62	3.97
Academic teachers care about the security of students' personal data (in the context of e-learning)	2.89	3.28	3.53	3.77	4.04
Academic teachers respond quickly to e-mails	2.84	2.92	3.19	3.51	3.78
Academic teachers conduct e-learning in a strictly determined time	3.63	3.76	4.02	4.29	4.47
Using the e-learning platform is convenient	2.78	3.50	4.22	4.48	4.63
Logging in to the e-learning platform is easy	3.27	4.04	4.36	4.58	4.65

It is worth paying attention to variable Q4 concerning the verification of knowledge using e-learning. It was the variable that was the lowest rated for the studied population. When we analyze individual groups of students from the point of view of their ease of acquiring e-learning content, we can see great differences. Students who evaluated their ease of acquiring e-learning at 5 assessed the verification of knowledge derived via e-learning as 4.28, which is good. On the other hand, students who evaluated the ease of acquiring e-learning content as 1 assessed the possibility of using this method to verify knowledge as 1.74.

4.3. Quality of E-Learning and Its Relation to Information Technology, Resources, and Innovation

In the last stage of the conducted research, it was decided to examinate the relation between the quality of e-learning in Polish universities and the following elements: student's knowledge of information technology, their possession of the resources necessary for e-learning, and their assessment of the innovation of e-learning solutions used by the university where the student studies. Spearman's rank correlation coefficient was also used for the analysis. The results are presented in Table 6.

For all the examined variables concerning the quality of e-learning provided by Polish universities, all the correlation coefficients contained in Table 6 are statistically significant at the statistical significance level of $\alpha = 0.05$.

Based on the research, the following dependencies were found:

- The greater the students' knowledge of information technology, the better they assess the quality of individual aspects of e-learning implementation. The correlations are not high, but they are statistically significant;
- The better the resources the student has to participate in e-learning, the better they assess the quality of classes carried out using this method. In this case, the correlations are at a higher level. In particular, the highest correlation coefficients occur for the following variables—Q7 (the e-learning tools used by the university are accessible (correlation coefficient 0.52)); Q6 (e-learning materials are of high quality (correlation

coefficient 0.49)); Q8 (academic teachers are helpful to students (in the context of e-learning (correlation coefficient 0.48));

- The higher the student evaluates the innovativeness of the e-learning solutions used by the university, the higher they evaluate all the examined variables concerning the quality of the e-learning classes conducted at the university.

Table 6. Spearman's ranks between the quality of e-learning in Polish universities and student's knowledge of information technology, their possession of the resources necessary for e-learning, and their assessment of the innovation of e-learning solutions used by the university where the student studies.

Variables	Student's Knowledge of Information Technology	Student's Possession of the Resources Necessary for E-Learning,	Innovation of E-Learning Solutions Used by the University Where the Student Studies
The university supports students in the e-learning process	0.14	0.46	0.24
E-learning is an effective way of learning	0.30	0.36	0.41
E-learning allows one to acquire knowledge	0.34	0.37	0.47
E-learning allows one to verify knowledge	0.24	0.35	0.36
E-learning allows one to easily access academic teachers	0.23	0.36	0.32
E-learning materials are of high quality	0.21	0.49	0.34
The e-learning tools used by the university are accessible	0.17	0.52	0.32
Academic teachers are helpful to students (in the context of e-learning)	0.13	0.48	0.30
Academic teachers are competent (in the context of e-learning)	0.10	0.46	0.22
Academic teachers care about the security of students' personal data (in the context of e-learning)	0.10	0.32	0.20
Academic teachers respond quickly to e-mails	0.13	0.30	0.23
Academic teachers conduct e-learning in a strictly determined time	0.18	0.32	0.29
Using the e-learning platform is convenient	0.21	0.38	0.35
Logging in to the e-learning platform is easy	0.22	0.36	0.32

Source: Author's own research.

The obtained results confirm the hypotheses H3a, H3b, and H4, which are as follows: H3a—the better students know information technology, the higher they assess the level of quality of classes provided using e-learning; H3b—the higher the level of students' possession of resources to participate in e-learning, the higher they assess the level of quality of classes provided using e-learning; H4—the more often innovative e-learning solutions are used in a university, the higher students assess the level of quality of classes provided using e-learning.

The following Tables 7–9 present the average values for every variable of e-learning quality in the context of the following (respectively):

- students' knowledge of information technology;
- students' possession of the resources necessary for e-learning;
- students' assessment of the innovation of e-learning solutions used by the university where the student studies.

Table 7. Quality of e-learning (averages) and student's knowledge of information technology (according to a scale from 1 to 5).

Variables	Student's Knowledge of Information Technology				
	1	**2**	**3**	**4**	**5**
The university supports students in the e-learning process	3.67	2.88	3.26	3.41	3.58
E-learning is an effective way of learning	2.33	2.38	3.10	3.33	3.90
E-learning allows one to acquire knowledge	2.67	2.68	3.50	3.70	4.26
E-learning allows one to verify knowledge	2.00	2.56	3.04	3.30	3.72
E-learning allows one to easily access academic teachers	2.67	2.79	3.23	3.32	3.82
E-learning materials are of high quality	3.00	2.91	3.33	3.53	3.81
The e-learning tools used by the university are accessible	4.00	3.26	3.71	3.90	4.04
Academic teachers are helpful to students (in the context of e-learning)	3.67	3.15	3.45	3.58	3.77
Academic teachers are competent (in the context of e-learning)	3.67	3.29	3.36	3.45	3.63
Academic teachers care about the security of students' personal data (in the context of e-learning)	4.00	3.29	3.53	3.67	3.75
Academic teachers respond quickly to e-mails	3.33	3.21	3.29	3.26	3.59
Academic teachers conduct e-learning in a strictly determined time	3.33	3.76	3.98	4.12	4.35
Using the e-learning platform is convenient	3.00	3.36	4.15	4.16	4.44
Logging in to the e-learning platform is easy	3.67	3.70	4.25	4.37	4.60

Table 8. Quality of e-learning (averages) and student's possession of the resources necessary for e-learning (according to a scale from 1 to 5).

Variables	Student's Possession of the Resources Necessary for E-Learning				
	1	**2**	**3**	**4**	**5**
The university supports students in the e-learning process	2.80	2.39	3.11	3.42	3.67
E-learning is an effective way of learning	2.00	2.00	2.86	3.30	4.00
E-learning allows one to acquire knowledge	2.00	2.32	3.22	3.70	4.36
E-learning allows one to verify knowledge	2.00	2.04	2.91	3.23	3.85
E-learning allows one to easily access academic teachers	2.00	2.36	3.11	3.30	3.87
E-learning materials are of high quality	3.00	2.46	3.17	3.46	3.96
The e-learning tools used by the university are accessible	3.60	2.93	3.47	3.89	4.18
Academic teachers are helpful to students (in the context of e-learning)	3.00	2.57	3.18	3.59	3.94
Academic teachers are competent (in the context of e-learning)	2.80	2.68	3.17	3.52	3.71
Academic teachers care about the security of students' personal data (in the context of e-learning)	3.40	2.86	3.44	3.62	3.89
Academic teachers respond quickly to e-mails	2.80	2.79	3.18	3.25	3.66
Academic teachers conduct e-learning in a strictly determined time	3.60	3.39	3.86	4.10	4.43
Using the e-learning platform is convenient	2.40	3.14	3.85	4.22	4.52
Logging in to the e-learning platform is easy	3.40	3.71	4.06	4.39	4.63

Table 9. Quality of e-learning (averages); student's assessment of the innovation of e-learning solutions used by the university where the student studies (according to the scale from 1 to 5).

Variables	Student's Assessment of the Innovation of E-Learning Solutions Used by the University Where the Student Studies				
	1	**2**	**3**	**4**	**5**
The university supports students in the e-learning process	1.60	2.38	3.12	3.64	4.10
E-learning is an effective way of learning	1.70	2.72	3.10	3.58	4.08
E-learning allows one to acquire knowledge	1.90	3.14	3.50	3.96	4.39
E-learning allows one to verify knowledge	1.60	2.63	3.08	3.44	4.07
E-learning allows one to easily access academic teachers	2.00	2.88	3.12	3.52	4.14
E-learning materials are of high quality	1.80	2.72	3.18	3.71	4.35
The e-learning tools used by the university are accessible	2.10	2.97	3.53	4.14	4.55
Academic teachers are helpful to students (in the context of e-learning)	1.40	2.85	3.22	3.78	4.39
Academic teachers are competent (in the context of e-learning)	1.30	2.78	3.14	3.65	4.23
Academic teachers care about the security of students' personal data (in the context of e-learning)	2.00	3.34	3.36	3.74	4.22
Academic teachers respond quickly to e-mails	2.40	2.98	3.08	3.50	3.86
Academic teachers conduct e-learning in a strictly determined time	2.60	3.68	3.96	4.27	4.58
Using the e-learning platform is convenient	2.60	3.66	3.84	4.42	4.76
Logging in to the e-learning platform is easy	2.70	3.74	4.19	4.57	4.79

In the case of knowledge of information technology (Table 7), data analysis allows us to conclude that:

- Students with a very good knowledge of information technology rate the e-learning tools as accessible (4.04 compared to 3.88 in the general population);
- Students who know information technology very well believe that the e-learning implemented at their university allows them to acquire knowledge (score 4.26 compared to 3.78 in the entire population);
- Students with very good knowledge of information technology assessed only one variable (Q10—timeliness of classes) at a level below 3.5;
- Students with very little knowledge of information technology did not assess any of the variables at a level greater than 4;
- The less familiar a given student is with information technology, the less they assess e-learning as a good form of knowledge verification—a rating of 3.72 among people who know information technology very well, and 2.00 among people who know information technology very poorly;
- We can encounter an interesting phenomenon in the case of variable Q10—academic teachers care about the security of students' personal data. In this case, it is best assessed by students who do not know information technology. They are unaware of the risks that may occur and, therefore, will not be aware of security problems.

In the case of issues related to the resources that a student must have to participate in e-learning (Table 8), the data analysis allows us to conclude that:

- People with good or very good resources to participate in e-learning rate the class quality level above 3 for all variables;
- In the group of students with very good resources to participate in e-learning, six variables are rated above 4, and one of them above 4.5—the convenience of using the e-learning platform;

- People who rate their resources for participating in e-learning as very low also rate the quality of this type of classes as low. For this group, only three variables are rated at a level above 3. These variables refer to those aspects of e-learning that are not affected by the equipment, e.g., punctuality of academic teachers or accessibility of e-learning tools used by the university;
- Furthermore, in the case of the students' hardware resources, they strongly influence whether they perceive e-learning as a good way to verify knowledge. People with very poor hardware resources rate this variable as 2, while people with very good access to this type of hardware resource evaluate it as 3.85.

In order to assess the innovativeness of e-learning solutions used by the university (Table 9), the following conclusions can be drawn:

- If the student evaluates the e-learning solutions used as innovative, he or she also evaluates their quality highly—only one variable in this group (Q11—academic teachers respond quickly to e-mails) is rated below 4. However, this variable is not related to IT matters, but it concerns the "soft" aspects of the learning process. Four variables are evaluated at a very good level, above 4.5. These are variables related to the IT tools used—the use of the e-learning platform or the accessibility of the e-learning tools used by universities;
- For students who assess the e-learning solutions used by the university as not very innovative, none of the e-learning quality variables surveyed are rated above 3, and seven of them are rated below 2;
- Variables generally rated high, such as the use of an e-learning platform, are rated at 2.7 in a situation where universities use not very innovative e-learning solutions;
- The innovation of the solutions used has a strong influence on verifying knowledge with the use of e-learning. When the IT solutions used by the university are not very innovative, the effectiveness of this knowledge testing is 1.6. When the solutions are highly innovative, it increases the quality to 4.07.

4.4. Identification Factors Among Quality of E-Learning Variables

In the next stage, a multiple regression analysis was conducted for the examined variables. The models should include variables that are strongly correlated with the dependent variable and as weakly correlated with each other as possible. Using the backward stepwise multiple regression method, regression models were identified. These regression models are used to analyze the relationships between multiple independent (explanatory) variables and the dependent (explained) variable. Multiple regression analysis allows for the prediction of the dependent variable based on the knowledge of the independent variables. Table 10 presents those variables for which the significance level is $\alpha = 0.01$. Empty fields in the table indicate that the variable did not qualify for the model. Table 10 also provide the constant (intercept) of the equation, the R value (which indicates the fit of the model to the empirical variables), as well as R^2, adjusted R^2, and the standard error of estimation for the given variable. The table contains the results of the multiple regression analysis for the relationship between the quality of e-learning (Q1–Q14) and students' perceptions of e-learning as a teaching method (S1–S5).

In the regression models, variables that were strongly correlated with the dependent variable (students' perceptions) and weakly correlated with each other were selected. The backward stepwise regression method was employed to determine the most suitable models. This method gradually eliminates the least significant predictors, refining the model to include only those variables that have a substantial impact on the dependent variable. The purpose of these regression models is to analyze the relationships between multiple independent variables (e-learning quality factors) and the dependent variable (students' perceptions), ultimately allowing predictions of students' perceptions based on the independent variables.

Table 10. The multidimensional model of relationships between e-learning quality variables and students' e-learning assessment.

E-Learning Quality Variables	Students' E-Learning Assessment				
	S1 Student's Assessment of Content Acquisition in Traditional Teaching	**S2 Student's Assessment of Content Acquisition in E-Learning**	**S3 Knowledge of Information Technology by the Student**	**S4 the Student's Possession of the Resources Necessary to Participate in E-Learning Classes**	**S5 Innovation of E-Learning Solutions Used by the University**
Q1 The university supports students in the e-learning process	0.156				0.153
Q2 E-learning is an effective way of learning	−0.262	0.363	0.214	0.061	
Q3 E-learning allows one to acquire knowledge		0.237			
Q4 E-learning allows one to verify knowledge				0.316	
Q5 E-learning allows one to easily access academic teachers	−0.084		0.124		
Q6 E-learning materials are of high quality					0.0879
Q7 The e-learning tools used by the university are accessible					0.208
Q8 Academic teachers are helpful to students (in the context of e-learning)					0.14
Q9 Academic teachers are competent (in the context of e-learning)				0.103	
Q10 Academic teachers care about the security of students' personal data (in the context of e-learning)				−0.100	
Q11 Academic teachers respond quickly to e-mails					
Q12 Academic teachers conduct e-learning in a strictly determined time					
Q13 Using the e-learning platform is convenient	0.059			0.087	
Q14 Logging in to the e-learning platform is easy					
Intercept	4.55	1.001	1.629	2.294	1.373
R	0.467	0.727	0.454	0.497	0.591
R^2	0.218	0.528	0.203	0.247	0.350
Adjusted R^2	0.199	0.517	0.186	0.228	0.334
Standard error of estimation	0.9439	0.858	1.011	0.809	0.801

The table presents the results of the multiple regression analysis, indicating the relationship between various e-learning quality factors and each aspect of students' perceptions (S1–S5). For each regression model, the table lists the coefficients (indicating the strength and direction of the relationship between each independent variable and the dependent variable), the constant (intercept), the R value (representing the correlation between observed and predicted values of the dependent variable), the R-squared value (indicating the proportion of variance in the dependent variable explained by the independent variables), the adjusted R-squared value (a more accurate estimate of the R-squared value that accounts for the number of predictors), and the standard error of estimation (reflecting the average distance that the observed values fall from the regression line).

Starting with S1, which represents students' assessment of content acquisition in traditional teaching, it is shown that Q2 (e-learning is an effective way of learning) has a negative coefficient of −0.262, suggesting that students who view e-learning as effective may rate traditional teaching less favorably. Q1 (the university supports students in the e-learning process) has a positive coefficient of 0.156, indicating that better university support in e-learning correlates with more positive assessments of content acquisition in traditional teaching. The model has an R value of 0.467, meaning there is a moderate correlation between the predictors and the dependent variable. The R-squared value is 0.218, meaning 21.8% of the variance in S1 can be explained by the independent variables in the model.

For S2, representing students' assessment of content acquisition in e-learning, Q2 is the most significant predictor, with a coefficient of 0.363, suggesting a strong positive relationship between students' perception of e-learning's effectiveness and their assessment of content acquisition in e-learning. The model for S2 has an R value of 0.727, indicating a strong correlation, with an R-squared value of 0.528, meaning that 52.8% of the variance in S2 is explained by the model.

Moving to S3, knowledge of information technology held by the student, Q2 again appears as a significant predictor with a positive coefficient of 0.214. The model's R value is 0.454, indicating a moderate correlation, and the R-squared value is 0.203, indicating that 20.3% of the variance in S3 can be explained by the predictors.

In the model for S4, which represents the student's possession of the necessary resources to participate in e-learning, Q4 (e-learning allows for verifying knowledge) is a significant predictor with a coefficient of 0.316. This model has an R value of 0.497 and an R-squared value of 0.247, meaning 24.7% of the variance in S4 is explained by the model.

Lastly, for S5, the innovation of e-learning solutions used by the university, Q2 and Q7 (accessibility of e-learning tools) are significant predictors with coefficients of 0.061 and 0.208, respectively. The model for S5 has an R value of 0.591 and an R-squared value of 0.350, meaning that 35% of the variance in S5 is explained by the independent variables.

The multiple regression analysis reveals several important insights into how students' perceptions of e-learning are shaped by various quality factors. The results suggest that perceived effectiveness of e-learning (Q2) consistently plays a pivotal role across multiple dimensions of students' assessments, including content acquisition in both traditional and e-learning formats, technological proficiency, resource availability, and innovation. Additionally, other factors such as university support (Q1), knowledge verification (Q4), and tool accessibility (Q7) contribute to shaping specific aspects of students' perceptions, highlighting the multifaceted nature of e-learning experiences.

These findings have significant implications for educational institutions aiming to enhance e-learning experiences. By focusing on improving the perceived effectiveness of e-learning and ensuring accessibility and support, universities can positively influence students' overall perceptions and satisfaction with e-learning as a teaching method. The analysis also suggests that enhancing the quality of specific e-learning components, such as knowledge verification and tool accessibility, can further strengthen students' engagement with and positive evaluations of e-learning environments.

The factor analysis method was used to group the factors into variables. The normalized Varimax rotation was applied. The Kaiser–Meyer–Olkin test for the adequacy of the correlation matrix is 0.75, which justifies the use of factor analysis in this case. According to the Kaiser criterion, two factors with eigenvalues greater than 1 should be retained. When applying Cattell's scree plot criterion, it also suggests retaining two factors.

The factor analysis results provide a clear understanding of how the various aspects of e-learning quality (Q1–Q14) cluster into two distinct factors, which together explain 64% of the variance in the data. Each factor represents a different dimension of e-learning quality, as indicated by the factor loadings presented in Table 11. The factors were identified using normalized Varimax rotation, which maximizes the variance explained by each factor while

maintaining orthogonality, ensuring that the factors remain uncorrelated. Overall, the identified factors explain 64% of the variance.

Table 11. The loadings of factors.

	Variables	Factor 1	Factor 2
1.	Q1 The university supports students in the e-learning process	0.663	0.180
2.	Q2 E-learning is an effective way of learning	0.203	0.895
3.	Q3 E-learning allows one to acquire knowledge	0.236	0.890
4.	Q4 E-learning allows one to verify knowledge	0.235	0.842
5.	Q5 E-learning allows one to easily access academic teachers	0.409	0.660
6.	Q6 E-learning materials are of high quality	0.580	0.611
7.	Q7 The e-learning tools used by the university are accessible	0.658	0.422
8.	Q8 Academic teachers are helpful to students (in the context of e-learning)	0.795	0.323
9.	Q9 Academic teachers are competent (in the context of e-learning)	0.814	0.293
10.	Q10 Academic teachers care about the security of students' personal data (in the context of e-learning)	0.746	0.197
11.	Q11 Academic teachers respond quickly to e-mails	0.695	0.214
12.	Q12 Academic teachers conduct e-learning in a strictly determined time	0.648	0.262
13.	Q13 Using the e-learning platform is convenient	0.402	0.626
14.	Q14 Logging in to the e-learning platform is easy	0.512	0.455
	Explained value	4.71	4.26

Factor 1 is primarily associated with aspects related to the role and quality of academic teachers in the e-learning process. This factor shows high loadings for variables such as "Academic teachers are competent" (0.814), "Academic teachers are helpful to students" (0.795), and "Academic teachers care about the security of students' personal data" (0.746). Additionally, "Academic teachers respond quickly to e-mails" (0.695) and "Academic teachers conduct e-learning in a strictly determined time" (0.648) also load significantly onto this factor. These loadings suggest that Factor 1 can be interpreted as "Teacher engagement and competence in e-learning", reflecting the importance of the teacher's role in facilitating and supporting the e-learning experience.

Factor 2, on the other hand, is more closely related to the effectiveness and accessibility of the e-learning system itself. High loadings are observed for variables such as "e-learning is an effective way of learning" (0.895), "e-learning allows one to acquire knowledge" (0.890), and "e-learning allows one to verify knowledge" (0.842). These loadings indicate that this factor represents "e-learning effectiveness and accessibility", emphasizing how the system's efficiency in delivering content and supporting student learning is crucial to the overall e-learning experience. Other significant loadings in this factor include "e-learning allows easy access to academic teachers" (0.660) and "using the e-learning platform is convenient" (0.626), further reinforcing the idea that this factor relates to the system's user-friendliness and functionality.

The explained values of 4.71 for Factor 1 and 4.26 for Factor 2 indicate the amount of variance each factor accounts for in the data. These values reflect the importance of both teacher-related factors and system-related factors in shaping the quality of the e-learning experience. Naming the factors as "teacher engagement and competence in e-learning" for Factor 1 and "e-learning effectiveness and accessibility" for Factor 2 provides a clear and intuitive understanding of the dimensions captured by the analysis. These two factors collectively provide a comprehensive view of what drives students' perceptions of e-learning

quality, highlighting the critical roles of both instructional support and technological infrastructure in successful e-learning environments.

5. Discussion

In the literature, there is some research on the topic that we presented in this paper. In the following, we discuss these findings and compare them to ours. Some of them differ in methodology and approach, and others in results.

Puriwat and Tripopsakul [43] in their research revealed that the quality of e-learning consisted of three elements: course content and design, administrative and technical support, and instructor and learner characteristics. Comparing their research with ours, it turns out that they approached the quality of e-learning in a different way. Namely, in our research, we identified 14 characteristics that affect the quality of e-learning, while these authors addressed three main segments. According to the results of their research, the content and design of the course were the most important dimensions of overall e-learning quality. Furthermore, further analysis indicated that student satisfaction partially mediated the relationship between the quality of e-learning and intentions of continued use. In turn, in our research, we examined the correlation between the resources to participate in e-learning and the evaluation of the quality of e-learning. It turned out that students who rate their resources for participating in e-learning as very low rate the quality of this type of class as low. A similar situation occurred with regard to the good assessment of resources—students rated the quality of learning highly. Therefore, the assessment of the quality of e-learning is also influenced by the resources possessed by students (the student's technical infrastructure), which the authors of the publication that was mentioned did not take into account. In another study [85], Elumalai et al. determined a different group of the key determinants of the quality of e-learning. These factors included administrative support, course content, course design, social support, technical support, instructor characteristics, and learner characteristics.

Referring to the research method, in our paper we developed a survey, using a Google questionnaire, while Alkinani [44] used structured interviews. Several (fifteen) participated in the examination. In conclusion, this method allowed the author to gather more detailed data on the quality of e-learning by focusing on individual experiences. However, a limitation of this approach was the significantly smaller research sample size compared to our study, which included 621 students. In the paper, both positive and negative perceptions of online learning were identified, along with the factors influencing these perceptions. Positive aspects included flexibility, cost-effectiveness, access to electronic research databases, and well-designed online classroom interfaces. On the contrary, negative perceptions were attributed to delayed feedback from lecturers, lack of technical support, low self-esteem and motivation, feelings of isolation, one-way teaching methods, and poorly designed course materials. Our research found that three variables were assessed positively: logging into the e-learning platform (score of 4.38), ease of use (score of 4.20), and adherence to the scheduled class times by academic teachers (score of 4.15). Jaoua et al. [86] focus their research on an e-learning success model in the context of the COVID-19 pandemic. They assess the effectiveness of e-learning and investigate the key antecedents of e-learning effectiveness. A structured survey (a sample of 1202 students) was used among students from Imam Mohammad Ibn Saud Islamic University to examine the linkages among the proposed models. The research findings of the authors indicate that effective e-learning is supported by the interactions between the following four factors: the e-learning system, readiness for e-learning, interactivity, and resistance to change. To some extent, the authors' research is similar to ours because the issue of e-learning quality is related to e-learning effectiveness. On the other hand, we separately examined the subjective feeling of e-learning effectiveness, finding that it was variable Q2. Regarding the study by the authors of the e-learning system, we studied individual elements of the system, for example, we examined whether the e-learning tools used by the university are accessible (Q7; average below 4.0, median 4.0), if academic teachers care about the security of students'

personal data (Q10; average below 4.0, median 4.0), if academic teachers conduct e-learning in a strictly determined time (Q12; average above 4.0, median 4.0), if using the e-learning platform is convenient (Q13; average above 4.0, median 5.0—very good evaluation), and if logging into the e-learning platform is easy (Q14; average above 4.0, median 5.0—very good evaluation). In the field of e-learning readiness, we only studied if academic teachers are competent (Q9; average below 4.0, median 4.0). The issue of interactivity was also very important to us and to the authors, as we examined whether e-learning allows one to easily reach the academic teachers (Q5; average below 4.0, median 3.0—quite low rating), whether academic teachers are helpful to students (Q8; average below 4.0, median 4.0), and whether academic teachers respond quickly to e-mails (Q11; average below 4.0, median 3.0—quite low rating). However, we did not study resistance to change, which is in fact an important issue in this topic. According to another study (Timbi-Sisalima et al.) [87], the e-learning evaluation model should consist of four main elements: organization, student body, teaching, and infrastructure. This is to some extent consistent with our research, but we evaluated certain aspects in detail and not in the main categories.

When it comes to e-learning in European Union countries, there are several studies with similar, as well as different, results to ours. The study in Germany [24] revealed that teachers showed a strong interest in e-learning tools during the pandemic, while students showed mixed feelings. The results, connected to the evaluation performed by the students, can be perceived as quite different from ours. In ours, the results were more positive. In another research [25] in Germany, the analysis showed that the pressure of the pandemic and the increased commitment of teachers might positively influence digital innovations in university teaching. In our research, innovative aspects were also shown to be positively assessed, recalling that the use of innovative e-learning teaching methods and the use of open innovation methods works well from a technical point of view. Most of the variables examined that are rated well concern various technical aspects—e-learning platforms, e-learning tools used, data security, etc. A different method from the one we used in our research on the similar topic of e-learning assessment was presented by authors from Spain [28]. While we used surveys, they used interviews. They focused mainly on identifying the main themes related to the challenges and impacts of this sudden shift to e-learning. The interviews were also used in a study in the Czech Republic [38]. While surveying is a closed and constructed method of research, interviews are an open-ended form of research, which allows the interviewer to provide information that goes beyond the pre-defined survey questions. This allows interviews to provide more new insights and information, including those hidden "between the lines." They allow for spontaneous answers that can lead to interesting conclusions. Therefore, in the future, it is worth considering expanding our research to include interviews, which will certainly deepen and complement the results obtained from the surveys, providing a more comprehensive picture of the issues being studied. A study in Spain [29] revealed that keeping students attention during e-leaning was a great challenge. Students preferred prerecorded sessions over online lessons. In the context of our research, this finding presents an interesting avenue for further exploration: comparing students' preferences and learning outcomes between live online lessons and asynchronous learning through prerecorded sessions. This comparison could provide deeper insight into optimizing e-learning formats to better meet student needs and enhance engagement. Similar research to ours was conducted by Veeramanickam and Ramesh [88]. Their research method was also a survey questionnaire. To analyze the quality of learning in an e-learning platform, they took into consideration the following elements (categories): degree of flexibility and adaptability (for example, learner control, learner activity, motivation and feedback), degree of supportability (for example, technical skills, cost and technical crisis and internet access), staff qualification and experience (awareness of new technology), performance assessment (the impact of a performance evaluation using Artificial Intelligence methods), and learner's interest (course materials, gaming, and learners' self-interests). What is more, the authors studied the issue of predicting the impact of the e-learning quality. In our article, we did not make

an unambiguous prediction of the quality assessment performed by the students, but we examined some correlations. These allow us to draw conclusions about how some students will evaluate given elements of e-learning. First, the greater the students' knowledge of information technology, the better they assess the quality of individual aspects of e-learning implementation. Another finding is that the better resources the student has to participate in e-learning, the better they assess the quality of classes carried out using this method. Hence, the technical infrastructure influences the perception of the quality of e-learning. Correlations are also observed in terms of good knowledge of IT. Students with a very good knowledge of information technology rate the e-learning tools as accessible, and also believe that the e-learning implemented at their university allows them to acquire knowledge. Another correlation is between innovation and the quality of e-learning. If students evaluate e-learning solutions as innovative, they also evaluate their quality as high.

The results of this paper provide valuable insights that can be practically applied within higher education institutions to enhance the quality and effectiveness of e-learning. By translating the findings into actionable strategies, educators and administrators can create a more engaging and supportive online learning environment for students.

The identification of the significance of "teacher engagement and competence in e-learning" underscores the necessity for institutions to invest in comprehensive training and professional development programs for faculty. Practically, this could involve establishing workshops and training sessions that focus on best practices for online teaching, including the effective use of digital tools, techniques for fostering student interaction, and strategies for maintaining student motivation. By equipping educators with the skills necessary to engage learners in the digital space, institutions can improve the overall quality of the online learning experience. Furthermore, the results suggest that ongoing mentorship and support for faculty can facilitate the continuous refinement of their e-learning practices, ultimately leading to better student outcomes.

Also, the results pertaining to "e-learning effectiveness and accessibility" highlight the need for a thorough assessment of existing e-learning platforms and resources. Educational institutions can leverage these findings to conduct comprehensive evaluations of their current technologies and instructional materials, identifying areas that require enhancement or modification. For example, institutions might prioritize the development of user-friendly interfaces and ensure that all students have equitable access to the necessary technological resources. This could involve providing additional support for students who may struggle with digital literacy, offering resources like tutorials or workshops that help them navigate online learning platforms more effectively.

The study emphasizes the importance of gathering and responding to student feedback regarding their e-learning experiences. In practice, institutions can implement regular surveys or focus groups to solicit input from students about their perceptions of course quality, accessibility, and engagement. These data can inform continuous improvement efforts, allowing educators and administrators to make informed decisions regarding course design and instructional methods that are responsive to students' needs. By actively involving students in the evaluation process, institutions not only enhance the learning experience but also foster a sense of community and collaboration that can mitigate feelings of isolation often associated with online learning.

The findings may also inspire the development of institutional policies aimed at promoting inclusivity and accessibility in e-learning. For instance, institutions may adopt guidelines that require all online courses to adhere to certain standards of accessibility, ensuring that materials are available to all students, including those with disabilities. This proactive approach to inclusivity will not only enhance the overall quality of e-learning, but also align with broader educational goals of equity and diversity.

Based on the study's findings, several guidelines can be adopted to improve the effectiveness of e-learning within higher education institutions. These guidelines are designed to address the identified factors that contribute to successful online learning environments and to promote best practices among educators and administrators.

- Institutions should prioritize the training and professional development of faculty members involved in e-learning. This can be achieved by implementing structured programs that focus on the development of digital teaching competencies. Such programs might include workshops that cover the effective use of e-learning tools, pedagogical approaches tailored for online instruction, and strategies for engaging students in virtual settings. By equipping educators with the skills and knowledge necessary to navigate the complexities of online teaching, institutions can foster an environment where effective e-learning thrives.
- The creation of a supportive and collaborative community for educators is essential. Institutions can establish mentorship programs that pair experienced online instructors with those new to e-learning. This mentorship can facilitate the exchange of best practices, resources, and insights, ultimately enriching the teaching and learning experience. Additionally, regular faculty meetings and forums focused on e-learning challenges and successes can encourage the exchange of ideas and foster a culture of collaboration.
- It is crucial to adopt a student-centered approach in the design and delivery of e-learning courses. Institutions should actively solicit and incorporate student feedback in course development and instructional methods. Regular surveys, focus groups, and informal check-ins can provide valuable insights into students' experiences, preferences, and challenges in the online learning environment. This feedback should inform continuous improvement efforts, ensuring that courses remain relevant, engaging, and accessible to all students.
- In terms of technology, institutions should invest in the evaluation and enhancement of their e-learning platforms. Ensuring that online learning systems are user-friendly, accessible, and equipped with the necessary features to support diverse learning needs is paramount. Institutions should conduct regular evaluations of their e-learning technologies and seek student input to identify areas for improvement. In addition, institutions can develop resources to support students in navigating online platforms, such as tutorials, help centers, or peer support programs.
- Accessibility should also be a guiding principle in the development of e-learning courses. Institutions must adopt policies that mandate adherence to accessibility standards in all online materials and resources. This includes ensuring that all content is compatible with assistive technologies and that course materials are designed to be inclusive for students with varying abilities and backgrounds. Institutions can provide training for faculty on best practices for creating accessible content, such as captioning videos and providing alternative formats for reading.
- Institutions should establish clear guidelines for the evaluation and assessment of online courses. This may involve developing standardized rubrics that focus on key elements of effective e-learning, such as engagement, interactivity, and accessibility. Regular evaluations of online courses based on these rubrics can help maintain high standards of quality and provide insights for continuous improvement.

The relevance of the data from 2021 in a 2024 context remains significant despite the substantial changes in educational and social environments after the end of the COVID-19 pandemic. Data collected in 2021 offer a crucial baseline to understand the immediate impacts of the pandemic on e-learning and the rapid shift towards digital education, providing information on how students and institutions initially adapted to this unexpected change. This period was marked by a forced and accelerated adoption of e-learning platforms and methods, which shaped perceptions, challenges, and opportunities associated with digital education in ways that could continue to influence practices even as the pandemic subsides.

In 2024, since institutions have had time to refine and improve their e-learning offerings, the data from 2021 serve as a valuable reference point to evaluate the progression and effectiveness of these changes. This allows researchers and educators to compare and contrast the early responses to e-learning with the more mature, developed practices that have emerged in the post-pandemic era. Understanding where students and educators

started in 2021 provides context to evaluate the long-term impacts of the pandemic on the adoption of educational technology, pedagogical strategies, and student engagement.

6. Conclusions

The research allows us to conclude that a student's perception of e-learning is affected by factors connected with the university and with the student. For the quality of e-learning to be high, the university must try to improve the innovation of the methods used by it and by academic teachers, both in terms of technology and teaching methods. In particular, there are problems with the "soft" aspects of e-learning and the use of new technologies in the way expected by students—e.g., availability of lecturers for e-consultations or quick response to messages from students.

The realization of hypothesis H1a, which posits that the technical aspects of e-learning are evaluated more than its soft aspects, can be observed through a comprehensive analysis of the data collected from the study. The findings indicate a clear preference among the respondents for the technical components, such as the functionality of learning management systems, ease of navigation, and the availability of multimedia resources, which were rated significantly higher compared to the soft aspects, which include factors like interpersonal communication, emotional support, and collaborative learning experiences. This disparity suggests that participants place greater value on the tangible and measurable elements of e-learning that facilitate access to content and enhance user experience, rather than on the more nuanced and qualitative aspects related to social interaction and emotional engagement. Furthermore, this trend highlights a potential gap in the perception of the quality of e-learning, where the emphasis on technical efficiency may overshadow the importance of soft skills and interpersonal dynamics, which are crucial for a holistic learning experience. The implications of these findings call for a balanced approach to e-learning evaluation, ensuring that both technical and soft aspects are addressed to create a more comprehensive and effective online learning environment. Participants consistently expressed concerns about the effectiveness of traditional assessment methods within the e-learning framework, indicating a perception that these methods do not adequately measure the true understanding and mastery of the material. The data reveal that the respondents felt that online assessments, such as quizzes and timed exams, often fail to capture the depth of students' knowledge and skills, leading to questions about their validity and reliability. Furthermore, the lack of direct interaction with instructors during assessments was identified as a significant barrier to effective knowledge verification, as it diminishes opportunities for immediate feedback and the clarification of misunderstandings. This perspective highlights a critical gap in the e-learning experience, suggesting that reliance on automated assessments may not only undermine the learning process, but may also contribute to a superficial grasp of the subject matter. Consequently, the findings indicate a pressing need for innovative and robust assessment strategies that can better evaluate students' knowledge and learning outcomes in online environments, thus addressing the inherent weaknesses identified in the H1b hypothesis.

In the case of hypothesis H2, the analysis revealed a significant relationship between students' perceptions of content accessibility and their overall satisfaction with the e-learning experience. Participants reported that when the learning materials were organized intuitively and presented in a user-friendly manner, they experienced a smoother and more efficient learning process. This ease of access not only facilitated the comprehension of complex topics, but also created a more engaging and motivating learning environment. Furthermore, the students expressed that the availability of various multimedia resources, such as videos, interactive quizzes, and discussion forums, contributed to their positive evaluation of the quality of e-learning, as these resources improved their understanding and retention of the material. In contrast, when students encountered difficulties in navigating the platform or accessing course materials, their assessment of the quality of the e-learning significantly declined, indicating that a user-centric and seamless design is crucial for fostering a favorable learning experience. Ultimately, the findings underscore the

importance of content accessibility in shaping students' perceptions of e-learning quality, suggesting that educational institutions should prioritize user-friendly design and resource availability to enhance overall learning outcomes.

The analysis of hypothesis H3a indicated a clear positive correlation between the self-reported levels of technological competence of the students and their evaluations of the quality of e-learning courses. Participants who demonstrated greater familiarity with various digital tools and platforms expressed greater confidence and comfort in engaging with e-learning materials, which, in turn, influenced their general perception of the instructional quality. Those adept at information technology not only reported a more positive experience regarding the functionality and interactivity of the e-learning environment, but also articulated that their skills allowed them to utilize the available resources more effectively, facilitating deeper learning. Furthermore, the data suggest that technologically savvy students were more likely to appreciate the innovative aspects of e-learning, such as interactive elements and multimedia content, since they could use these tools to enhance their educational experience. In contrast, students with lower technological proficiency often faced challenges that led to frustration, resulting in more critical assessments of e-learning quality. Therefore, the findings reinforce the idea that enhancing students' information technology skills could play a significant role in improving their perceptions of the quality of e-learning and, ultimately, their learning outcomes.

The realization of hypothesis H3b, which posits that students who have more resources for participating in e-learning will evaluate the quality of these classes more positively, was supported by the findings of the study. Data analysis revealed a significant positive correlation between the availability of essential resources—such as reliable internet access, appropriate technological devices, and a conducive learning environment—and the students' assessments of e-learning quality. Students who reported having consistent and high-quality internet connections, as well as access to laptops or tablets, expressed greater satisfaction with the e-learning courses, highlighting their ability to engage with the content without interruptions or technical difficulties. This suggests that the presence of adequate resources not only enhances the technical aspects of e-learning, but also fosters a more immersive and productive educational experience. Consequently, the results indicate that institutions should prioritize ensuring that all students have access to the necessary resources to optimize their learning experiences, as such access is directly linked to their perceptions of quality in e-learning offerings.

In the case of H4,the analysis indicated a clear positive relationship between the integration of cutting-edge educational technologies and pedagogical approaches—such as interactive multimedia, gamification, and personalized learning platforms—and students' evaluations of course quality. Participants who reported experiencing a variety of innovative e-learning tools expressed significantly higher satisfaction levels, attributing their positive assessments to the engaging nature of these solutions and their effectiveness in facilitating a deeper understanding of the course material. Moreover, students highlighted the impact of innovative features, such as virtual simulations and collaborative online projects, which not only enhanced their learning experiences but also contributed to a sense of community and interactivity that is often lacking in traditional e-learning formats. This evidence underscores the importance of continuously adopting and implementing innovative e-learning strategies in higher education settings, as such practices not only improve student engagement, but also elevate the perceived quality of educational offerings, ultimately leading to more favorable outcomes in student learning and satisfaction.

However, some of the problems are not on the side of the university. If a student does not have sufficient resources to enable him/her to use e-learning comfortably and does not have knowledge about the use of new technologies, he/she will not rate the quality of e-learning highly, even if the university uses the latest, innovative solutions. For this reason, it seems that e-learning should not be a basic teaching method, but a voluntary option, the use of which is effective when students have sufficient resources and knowledge of technology combined with the desire to acquire knowledge in this way.

Based on the research, it is possible to recommend the following to universities:

- Paying attention to the innovativeness of the e-learning methods used, both in terms of the technology used and—in the even greater scope—of teaching methods and the involvement of academic teachers;
- The use of hybrid teaching, where, in particular, exams are carried out in the traditional form;
- The use of full e-learning only for students who prefer this form of class, and wo have the appropriate resources and competences for it.

The primary scientific value of this paper lies in its comprehensive investigation into the factors influencing students' perceptions of e-learning quality within higher education. By analyzing a robust dataset that comprises responses from a significant sample of 621 students, the study elucidates the intricate relationships between various dimensions of e-learning, including technological proficiency, resource availability, and perceived innovativeness of e-learning solutions.

The paper contributes to the existing body of literature by employing a multifaceted approach, utilizing both multiple regression analysis and factor analysis to uncover the nuanced interplay between students' knowledge of information technology and their assessments of e-learning quality. This dual methodology not only enriches the analytical framework but also facilitates a deeper understanding of the dynamics at play in the e-learning environment. Also, the identification of two distinct factors—"teacher engagement and competence in e-learning" and "e-learning effectiveness and accessibility"—provides a structured perspective on how various elements interact to shape students' experiences and evaluations. This distinction highlights the importance of both instructional support and technological infrastructure in fostering positive learning outcomes, which is essential for educators and administrators seeking to enhance the quality of e-learning offerings.

The paper's findings underscore the critical role of student resources and technological familiarity in shaping perceptions of e-learning. This insight emphasizes the need for educational institutions to consider students' varying levels of technological competence and access to resources when implementing e-learning solutions, thereby advocating for a more personalized approach to e-learning that accommodates diverse learner needs.

The novelty of this paper is rooted in its unique approach to investigating the dimensions that influence students' perceptions of e-learning quality in the context of higher education. While previous studies have often focused on isolated aspects of e-learning, this paper distinguishes itself by adopting a holistic perspective that encompasses various interrelated factors, including technological competence, resource availability, and instructional support.

Due to the unexplored nature of the topic, it can be concluded that there is a very broad research perspective for the future. First, the research focused only on students' assessment of the quality of e-learning. Therefore, it is worth examining how lecturers assess the quality of e-learning. Next, it would be important to compare the assessments of e-learning quality by students and lecturers. When it comes to the quality assessment performed by lecturers, a number of factors should be taken into account in this assessment, such as the IT skills of those who conduct e-learning, competences for online teaching, and completed trainings that prepare one to conduct classes remotely. On the other hand, the quality of e-learning can also be assessed by verifying learning outcomes. Therefore, another area of research in the future may be in teaching subjects in a traditional and remote way, and comparing learning outcomes in both of ways.

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