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THE ROLE OF DIGITAL TECHNOLOGY IN IMPROVING QUALITY OF EDUCATION

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Purpose: The paper examines the role and importance of digital technologies in ensuring the quality of education in Polish higher education institutions. It aims to identify best practices recognized by the Polish Accreditation Committee through Certificates of Excellence and to determine how the use of information technologies contributes to maintaining and improving educational standards.
Design/methodology/approach: The study is based on an original database of indicators derived from the Polish Accreditation Committee's reports assessing study programs at Polish universities, including the justifications for awarding Certificates of Excellence. Seven stimulant indicators were analyzed: the share of practical and laboratory classes, cooperation with the socio-economic environment, student participation in projects and problem-solving activities, use of innovative IT tools, blended learning and e-learning, use of remote learning platforms, and employment of specialized programs (e.g. Microsoft Teams, Blackboard).
To evaluate and rank the performance of academic fields, the study applies the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method—one of the multivariate statistical techniques within the MADM (Multiple-Attribute Decision-Making) framework.
Findings: The results indicate that the use of digital technologies is a major determinant of educational quality in Polish universities. The top-ranked group includes three programs in the discipline of exact and natural sciences and one program each in engineering and technical sciences, agricultural sciences, and social sciences. These programs are distinguished by extensive use of innovative IT tools and a high share of practical (laboratory) classes. Conversely, the lowest-ranked courses do not employ innovative IT tools, blended learning, or specialized platforms such as Microsoft Teams or Blackboard. The findings confirm that field-specific characteristics, rather than disciplinary classification, significantly influence the effectiveness of digitalization in improving educational quality.
Practical implications: The results provide practical guidance for higher education institutions and policymakers, emphasizing the need for strategic investment in digital infrastructure and technology-enhanced teaching as key drivers of quality and accreditation success.
Originality/value: This paper offers a novel, data-driven perspective on the relationship between digital technologies and educational quality from the accreditation viewpoint. By applying the TOPSIS method, it provides new empirical insights into how technological innovation supports excellence in higher education.

Keywords: quality assurance, teaching, software, education, higher education.
Category of the paper: Research paper.

1. Introduction

The European Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) define the quality of education. It is understood as "primarily a result of the interaction between teachers, students, and the institutional learning environment". Whereas ensuring the quality of education "focuses on “all activities within the continuous improvement cycle of higher education institutions” (Ubachs, Henderikx, 2022). One of the elements that is being paid attention to and has become increasingly important when assessing higher education quality is digital technologies (Van Pham, 2019). It particularly applies to education platforms, distance learning programs, and specialist software used during classes. Possession and use of specialist software during classes is one of the assessment criteria issued by institutions accrediting study programs and universities (Antony, Arumugham, 2004). The article aimed to analyse certificates of excellence issued by the Polish Accreditation Agency till 2022 to demonstrate best practices used at universities in using digital technologies and the impact of these technologies on quality assurance. In particular, the relationship between the discipline and field of study and the use of specialist software during classes and the implementation of IT solutions was sought. As a result, four typological groups were obtained, where the first, best group included fields such as biomedical engineering, food technology and human nutrition, or mathematics, and the weakest group included finance, investment and accounting, artistic education in the field of musical arts. The article consists of five parts: the first section is the introduction, the second contains a literature review, the third presents the methodology, the fourth is a discussion, and the fifth is the conclusion.

2. Literature review

Digital transformation has not only transformed society and the economy, but above all set a new direction for the future of education. It is increasingly affecting everyday life, revealing the urgent need to develop digital competences in education and training systems and institutions that need to keep up with dynamic technological changes. Computers and computer software used for training in manufacturing (computer-aided design, prototyping, and manufacturing) is becoming increasingly popular in educational institutions (Soomro et al., 2021).

The COVID-19 pandemic has become a catalyst for the transition to online and hybrid learning. The experience gained during this time has shown that the future of education lies in flexible, innovative forms of teaching that enable more personalised and engaging interaction between teacher and student in a digital environment. Florjančič and Wiechetek (2022) compared two platforms used in education, Moodle and Teams, based on the experience of two universities from Polish and Slovenia. The comparison showed that Moodle is a great, but complicated platform, while MS Teams is more modern and relatively simple tool that enables real-time communication and integration with Office 365. MS Teams works well in various types of communication (lectures, video conferencing, chat) and is more useful in general content creation, while the Moodle platform performs better in traditional learning tasks (assessments, peer-to-peer assessment, quizzes, categorization) (Krašna, Pesek, 2020). The Moodle platform also works well for the implementation of Team-Based Learning (TBL), as demonstrated in the Proctor and Hayslett (2024) study conducted in two groups of pharmacy students. Florjančič and Wiechetek (2022) noted that in the education process, Moodle and MS Teams platforms can be integrated to obtain a structured and administered course (Moodle) with the possibility of collaboration and communication (MS Teams). A comparison of the usability of the Moodle and Teams platforms among accounting students at the University of Gdańsk was conducted by Kujawski and Szadziewska (2024). Respondents indicated MS Teams as a more useful tool for university-level education.

The usability of the Moodle and Teams platforms was also studied in the context of education in individual scientific fields. Astafieva et al. (2023) investigated and confirmed the possibility of using the Moodle platform to implement an inquiry-based learning in mathematics (IBLM) approach to teaching mathematics based on student questions and active engagement. Anđelković et al. (2024) diagnosed the Moodle and MS Teams platforms in the context of English for Special Purposes (ESP) teaching at the University of Belgrade. Research shows that both platforms have similar functionalities in terms of delivering and managing educational content. For testing and evaluating and analysing students' learning progress and improving the learning process, Moodle has proven to be more useful.

The development of information technology has allowed the introduction of blended learning and e-learning. Kumar et al. (2021) and Müller and Mildenberger (2021) have shown in independent research that modern teaching methods are not more artificial than traditional ones, and Kirillova et al. (2019) have proven on the basis of their research that blended learning using project-based learning (PBL) is more effective compared to other teaching models for foreign language-based communication problems in learning. It allows students to engage in those activities that are more interesting to them and thus individualize their learning and career path. In addition, Schefer-Wenzl et. al. (2019) proved that blended learning can be integrated into mobile platforms for engineering and medical disciplines.

A relatively new direction of scientific research, but dynamically developing, is the use of AI in education. Based on previous studies, it has been shown that AI plays a key role in motivating students (Lin et al., 2021; Xia et al., 2022) and increasing the level of their engagement in learning (Huang et al., 2023a; Nazari et al., 2021). Adiguzel et al. (2023) presented the benefits of using AI not only for students but also for teachers.

Research conducted by Owan et al. (2023) focused on the role of teachers in the AI-based education system and showed that the use of AI will not replace the teacher in the role of a person adjusting the assessment to the individual abilities and capabilities of the student, interpreting the results of his or her work and individualizing the path of development and acquiring skills, providing and giving context to the information and content provided, and supporting critical thinking. The cited studies are in part a response to the concerns of teachers about whether the development of AI will reduce the demand for their work, especially in the context of learning foreign languages (Tseng, Warschauer, 2023).

Artificial intelligence-based tools are certainly useful in the process of acquiring knowledge, but they must be used wisely and not as a substitute for conventional approaches to learning (Genelza, 2024).

To the best of the authors' knowledge, there are no studies that are devoted to the use of IT techniques in relation to individual fields of study, and our study fills this gap.

3. Methodology

The basis for the empirical research, the results of which are presented in this paper, is a database of indicators created on the basis of reports of the Polish Accreditation Committee containing an assessment of study programs implemented at Polish universities, including justification for granting certificates in the field of ensuring the quality of education.

The following indicators were used in the study:

1) large/increasing share of practical classes (laboratory, laboratory),
2) cooperation with the socio-economic environment,
3) student participation in projects/focus on creative problem solving,
4) use of innovative IT tools that support the process,
5) blended learning/e-learning,
6) use of remote learning platforms,
7) using specialized programs (e.g. Microsoft Teams, Remote Education Platform, Blackboard platform).

The indicators presented above are stimulant, which means that with the increase in the value of this indicator, an improvement in the situation in the analysed area is observed.

In the paper, one of the methods of multivariate statistical analysis – the TOPSIS method (Technique for Order of Preference by Similarity to Ideal Solution) – was used for linear ordering of fields of study at Polish universities. This method has been developed as a tool to support the decision-making process in complex situations where many different criteria need to be taken into account. Therefore, it is included in the group of multi-criteria decision-making methods, referred to in the literature as MADM (multiple-attribute decision making) (Ghose, 2021; Parida, Sahoo, 2013; Proctor, Hayslett, 2024; Ghose, 2021; Roszkowska, 2019; Yoon, Kim, 2017; Zulqarnain et al., 2020). The TOPSIS procedure used for the linear ordering of multidimensional objects takes place in eight steps.

Step 1. The starting point is to define the matrix:

$$X = [x_{ij}] \tag{1}$$

where:
i – object number (i = 1, 2, ..., n),
j – diagnostic feature number (j = 1, 2, ..., m),
x_{ij} – the value of j-th feature for i-th object.

Step 2. In order to ensure the comparability of variables, the initial values of diagnostic features are normalized based on the formula:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}} \tag{2}$$

where: z_{ij} – the value of j-th standardized diagnostic feature for the i-th object.

Step 3. Values of normalized diagnostic features are weighted, which results in the matrix:

$$V = [v_{ij}] = [w_j z_{ij}] \tag{3}$$

for:

$$\sum_{j=1}^{m} w_j = 1 \tag{4}$$

where: w_j – weight of j-th diagnostic feature.

Step 4. For each normalized weighted diagnostic feature from the matrix (3), two reference points are determined, which are determined by the Positive Ideal Solution and Negative Ideal Solution coordinates, respectively:

$$v_j^+ = \begin{cases} \max\limits_i v_{ij} & \text{for stimulant} \\ \min\limits_i v_{ij} & \text{for destimulant} \end{cases} \tag{5}$$

$$v_j^- = \begin{cases} \min\limits_i v_{ij} & \text{for stimulant} \\ \max\limits_i v_{ij} & \text{for destimulant} \end{cases} \tag{6}$$

where:
v_j^+ – j-th coordinate of Positive Ideal Solution,
v_j^- – j-th coordinate of Negative Ideal Solution.

Step 5. For all objects, their Euclidean distances from the positive and negative ideal value are calculated, respectively:

$$d_i^+ = \sqrt{\sum_{j=1}^{m}\left(v_{ij} - v_j^+\right)^2} \quad (7)$$

$$d_i^- = \sqrt{\sum_{j=1}^{m}\left(v_{ij} - v_j^-\right)^2} \quad (8)$$

where:
d_i^+ – Euclidean distance of the i-th object from Positive Ideal Solution,
d_i^- – Euclidean distance of the i-th object from Negative Ideal Solution.

Step 6. The value of the aggregate variable denoting the relative proximity of the i-th object to the Positive Ideal Solution is determined as the quotient:

$$R_i = \frac{d_i^-}{d_i^- + d_i^+} \quad (9)$$

where: $0 \leq R_i \leq 1$.

The preferred object has the shortest distance from the positive ideal value and, at the same time, the most significant distance from the negative ideal value, i.e., it has the highest value of the coefficient R_i.

Step 7. Linear ordering of objects is performed due to the aggregate variable's non-increasing value (9).

Step 8. Using the three-median method to divide objects into typological groups with a similar level of the studied phenomenon according to formulas (Młodak, 2006):

Group I: $\mu_i > \text{med}_1(\boldsymbol{\mu})$ – very low risk of occurrence.

Group II: $\text{med}(\boldsymbol{\mu}) < \mu_i \leq \text{med}_1(\boldsymbol{\mu})$ – average threat of occurrence.

Group III: $\text{med}_2(\boldsymbol{\mu}) < \mu_i \leq \text{med}(\boldsymbol{\mu})$ – high risk of occurrence.

Group IV: $\mu_i \leq \text{med}_2(\boldsymbol{\mu})$ – very high risk of occurrence.

To summarize, the adopted methodological approach is based on a structured set of seven stimulant indicators reflecting key dimensions of educational quality related to the use of digital technologies. The application of the TOPSIS method enabled the transformation of multidimensional data into a synthetic measure, allowing for the linear ordering of the analyzed objects. The procedure ensures comparability of variables through normalization and incorporates equal weighting of criteria, thereby avoiding preferential bias in the evaluation process. As a result, the proposed approach provides a consistent and transparent framework for assessing and comparing the relative position of the examined objects within the analyzed dataset.

4. Results

The values of the seven indicators defined in the methodology were used in the TOPSIS method (i = 1, 2, …, 28; j = 1, 2, …, 7). According to the procedure of this method, they were normalized in the first step. The same weights were used in the weighting for all normalized values, which amounted to $w_j = \frac{1}{7}$, which results from the equal treatment of all characteristics.

Table 1.
Values of the aggregate variable, ranks, and typological groups of specialization

Discipline	Specialization	Measure	Group
Engineering and technical sciences	Biomedical Engineering	1.0000	I
Agricultural Sciences	Food Technology and Human Nutrition	1.0000	
Exact and natural sciences	mathematics	1.0000	
Social sciences	spatial management	0.7101	
Exact and natural sciences	chemistry	0.7101	
Exact and natural sciences	**computer science**	**0.7101**	
Engineering and technical sciences	Chemical and Process Engineering	0.6126	II
Social sciences	Internal security	0.6126	
Social sciences	Sociology	0.6126	
Engineering and technical sciences	Architecture	0.5359	
Social sciences	International Economic Relations	0.5359	
Social sciences	Law	0.5359	
Exact and natural sciences	Quantitative methods in economics and information systems	0.5359	
Arts Sciences	Organization of film and television production	0.5359	
Humanities	Ethnology	0.4641	III
Social sciences	Management and command	0.4641	
Exact and natural sciences	Hippology and horsemanship	0.4641	
Exact and natural sciences	cryptology and cybersecurity	0.4641	
Veterinary Sciences	veterinary medicine	0.4641	
Arts Sciences	composition and music theory	0.4641	
Arts Sciences	Direction	0.4641	
Engineering and technical sciences	Construction	0.3874	IV
Exact and natural sciences	Astronomy	0.3874	
Exact and natural sciences	Physics	0.3874	
Exact and natural sciences	Geography	0.3874	
Arts Sciences	Design	0.3874	
Social sciences	Finance, investment and accounting	0.2899	
Arts Sciences	Artistic education in the field of musical arts	0.2899	

Source: own elaboration.

The analysis of the information in Table 1 shows that the best first group includes three courses belonging to the discipline of exact and natural sciences and one course each from the disciplines of engineering and technical sciences, agricultural sciences and social sciences. These courses are characterized primarily by the use of innovative IT tools that support the teaching process. In addition, they have a large/increasing share of practical classes (laboratory). Courses belonging to group IV do not use innovative IT tools that support the teaching process, do not use blended learning/e-learning and do not use specialized programs (e.g. Microsoft Teams, Remote Education Platform, Blackboard platform.

5. Discussion

According to the current state of knowledge of the authors, there have been no similar studies in the literature, the results of which could serve as a direct point of reference for comparing the obtained results. However, there are scientific studies devoted to the analysis of the quality of education at the academic level, in which, like in this study, the TOPSIS method was used. The choice of this method results from its ability to simultaneously take into account many different evaluation criteria and, if necessary, assign them appropriate weights, which allows for a comprehensive analysis of the effects resulting from their cooperation. An additional advantage of the TOPSIS method is the elimination of the subjectivity of input data, the lack of the need to define the objective function and the lack of the requirement to meet restrictive test assumptions, which makes it a research tool with a high degree of universality and flexibility.

Wang et al. (2022b) conducted an analysis of the efficiency of higher education in the private university sector in Vietnam. The study took into account the following criteria: the number of students, the number of curricula, the number of lecturers, the quality of teaching infrastructure, the size of the budget and the employment rates of graduates. The highest rated universities were characterized by high efficiency in terms of employing graduates and significant investments in the development of educational infrastructure. The analysis revealed significant disparities between universities in terms of the efficiency and quality of educational services provided.

Wang et al. (2022a) evaluated the higher education systems in China, the US, and Germany. The study used a combination of the AHP (criteria hierarchy) and TOPSIS methods. This approach allowed for the creation of university rankings and the assessment of their performance. The results of the study indicated that universities with strong connections with industry and high levels of innovation performed better in the rankings.

A comparative assessment of the higher education systems in the United States, China, Japan, and Vietnam was conducted by Zhang (2021). The analysis took into account the following criteria: the number of institutions and students, the student-teacher ratio, the number of academic teachers, the employment rate of graduates, and the share of government spending on education in total public spending. The results of the study showed that the United States took the highest position in the ranking, followed by China, Japan, and Vietnam.

Cai et al. (2022), using the improved entropy-weighted TOPSIS method, assessed the level of entrepreneurship education at the higher education level based on 35 indicators grouped into five areas: curriculum systems, teaching staff development, organizational leadership, teaching process management, and institutional mechanisms. The study results suggest that Chinese universities should strengthen the practical component of education, and the teaching process should combine specialization with innovation. It also emphasized the need for continuous development of academic staff competences and intensification of research activities, especially interdisciplinary and international ones.

Ersoy (2021) assessed the effectiveness of distance education in 56 public universities in Turkey. He used data envelopment analysis (DEA) and the TOPSIS method in his study. The results obtained varied depending on the method used: according to the DEA analysis, Anadolu University was the best in distance learning, while according to the TOPSIS method, Sakarya University was the best.

Kang (2025) assessed the degree of integration of education with industry at applied undergraduate universities using an advanced version of the TOPSIS method. The assessment of the quality of cooperation between universities and the industry sector was considered an important indicator of the effectiveness in terms of talent development, technological innovation and research cooperation. The study results can serve as a basis for formulating recommendations aimed at improving the quality of education and increasing the employment rate of graduates.

6. Summary

The article analyses the importance and role of digital technologies in ensuring quality in higher education institutions. In particular, best practices that contributed to this quality were identified, such as an increased share of laboratory classes in study programs, remote learning platforms, and specialist software. As a result, it was shown that universities educating in biomedical engineering, food technology and human nutrition, mathematics, spatial management, chemistry, and computer science mainly build their advantage in ensuring quality through digital technologies. The weakest in this respect are the fields of finance, investment, and accounting, as well as artistic education in musical arts. The specificity of the field has a significant impact on this. Still, the scientific discipline to which the field is assigned is unimportant because, for example, there were fields of study rated the best and the worst in the discipline of engineering and technical sciences. The study has its limitations. First, the analysis is based on a dataset restricted to accredited study programs evaluated by the Polish Accreditation Committee, which may limit the generalizability of the findings. Second, the temporal scope is constrained to certificates awarded in recent years, due to data availability. In addition to these data-related limitations, certain methodological assumptions inherent in the TOPSIS approach should be acknowledged. In particular, the method assumes the independence of evaluation criteria and may be sensitive to the choice of normalization procedure and weighting scheme. Although equal weights were adopted to ensure neutrality in the assessment, alternative specifications could lead to variations in the resulting rankings. Therefore, the findings should be interpreted with due consideration of these assumptions, which are characteristic of multi-criteria decision-making methods. Future work plans an in-depth analysis in terms of taking into account the international perspective and comparing best practices assessments expressed by certificates in Poland and other European countries. It is also planned to expand the time perspective of the study.

The obtained results may serve as a useful source of information for higher education institutions as well as policymakers responsible for shaping educational policy. At the same time, they point to the need for a more structured and strategic approach to the integration of digital technologies in the educational process. In particular, universities may consider implementing targeted initiatives aimed at developing the digital competences of academic staff, including both systematic training and continuous professional development in the use of tools supporting the teaching process. Furthermore, it appears justified to develop and institutionalize standards for blended and online learning that address both pedagogical and technological aspects, which may contribute to enhancing the consistency and effectiveness of the educational process. Finally, a stronger focus on the integration of specialized software and digital platforms within curricula, tailored to the specific characteristics of individual fields of study, may support improvements in educational quality and better alignment with accreditation criteria.

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