



DIGITAL TRANSFORMATION IN HIGHER MEDICAL EDUCATION: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

OBJECTIVE: This study explores the effectiveness and adoption of hybrid learning models as part of digital transformation in higher medical education. The focus is on the students of Health Care Management at the Faculty of Public Health, Medical University - Pleven, in the context of the Bulgarian regulatory and technological framework. **METHODS:** The questionnaire contained 17 closed-ended questions assessing satisfaction, preferences, perceived strengths and weaknesses, as well as self-rated outcomes. Data were analyzed using descriptive statistics and chi-square tests. **RESULTS:** 61.9% of students expressed full support for the hybrid model. Key advantages were time flexibility (72.6%) and improved IT skills (66.1%), while key disadvantages were limited communication (58.3%) and poor feedback (50%). **CONCLUSIONS:** Hybrid learning proves to be a suitable and effective approach for postgraduate healthcare education. In the Bulgarian context, its broader application remains limited due to the absence of clear standards for online learning in medical fields and the clinical nature of core specialties. Further regulatory clarity, pedagogical refinement, and investment in digital infrastructure are essential for the responsible and sustainable integration of hybrid models.

Keywords: digital transformation, higher medical education, hybrid learning, student satisfaction, online learning

INTRODUCTION

The digital transformation of higher education is no longer an optional innovation, but a structural imperative - especially in the field of specialized and profiled training in medical and health professions. Driven by rapid technological advances, changing learner expectations and the changes caused by the COVID-19 pandemic, digital education models have accelerated in medical universities around the world. This transformation is redefining how clinical competencies are taught, how students interact with content, and how institutions conceptualize access and flexibility in learning.

As (4) argues, the rapid digitalization of higher education requires a redefinition of pedagogical models across disciplines - including those in health and medicine. His conceptualization of "postpedagogy" emphasizes the learner's ability to participate, curiosity-based learning, and interdisciplinary formats that can be adapted to the training of health professionals to promote reflective, autonomous, and ethically grounded practice. These pedagogical shifts support the development of critical soft skills necessary for contemporary healthcare environments, such as clinical reasoning, empathy, and collaborative problem solving.

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Medical diagnosis has traditionally been based not only on information from patient records, but also on direct contact with the patient. In turn, medical education is based on face-to-face classes - lectures, practical exercises, work with

anatomical preparations, laboratory classes, clinical demonstrations and other forms of practical training that are essential for the acquisition of clinical knowledge and skills. However, recent studies have shown that digitally optimised learning - when well strategically designed - can complement or even surpass traditional methods in certain areas. According to (5), digital platforms "promote higher student engagement and better outcomes, especially when clinical simulations and modular learning are applied." (6) confirm that the combination of multimedia and personalized content improves cognitive retention and procedural understanding among medical students.

Furthermore, the systematic review of (7) found that hybrid models integrating asynchronous digital content with synchronous clinical mentoring resulted in improved learning outcomes and student satisfaction. The emergence of immersive technologies-such as virtual reality (VR), augmented reality (AR), 3D anatomy platforms, and telepresence simulation-provides an opportunity for new ways to acquire skills, particularly in medical disciplines such as surgery, anatomy, evidence-based diagnostic process, and patient communication models in a variety of situations (8).

The transition to digital education is also closely linked to the global strategy for medical and health workforce development. In 2020, the World Health Organization is highlighting the role of digital technologies in scaling up training of health professionals in underserved regions, as well as providing continuing medical education through micro-credentialing and modular certification. This is particularly relevant in Eastern and Southern Europe, where shortages of health care professionals and limited access to specialized and advanced training persist (9).

While global trends offer compelling evidence for the effectiveness of digital tools in medical education, the Bulgarian context presents unique regulatory and infrastructural dynamics that are worth exploring. In the post-pandemic reality, Bulgaria is witnessing a significant acceleration in the integration of distance and hybrid learning models in medical universities. This process is governed by nationally established guidelines that allow up to 85% of

coursework in graduate and postgraduate medical programs to be conducted online, provided that the practical and clinical elements are retained through face-to-face instruction (10). However, the digital transition remains uneven across institutions, with varying levels of implemented technological infrastructure, pedagogical preparedness and academic staff preparedness. These challenges highlight the need for context-specific research on effective digital strategies in medical education.

Under national regulations, up to 85% of coursework in undergraduate and postgraduate medical programmes can be conducted online - provided that the core clinical and practical components are delivered through face-to-face teaching (10).

In the work presented, we adopt the distinctions proposed by (11) and (12), distinguishing between **e-learning** (asynchronous, multimedia-enriched modules), **online learning** (synchronous, instructor-led virtual sessions) and **hybrid learning** (deliberate and pedagogically directed integration of the two formats).

This study explores the adoption and effectiveness of hybrid learning as part of the broader digital transformation in Bulgarian higher medical education. Specifically, it analyses the results of a pilot study conducted among students enrolled in the part-time Health Care Management programme at the Medical University - Pleven.

Digital Transformation in Higher Medical Education in Bulgaria

In response to broader trends in digitalization, medical universities in Bulgaria are increasingly adopting distance and hybrid learning models, especially in graduate and postgraduate programs. These initiatives are in line with national regulations that allow up to 85% of teaching time in such programmes to be conducted online, while requiring at least 15% of coursework - particularly the clinical and practical components - to be conducted in person. This regulatory framework provides flexibility for universities to modernize their curricula while maintaining core practical training for future health professionals.

- **Medical University - Varna:** Offers distance learning for highly specialized

activities in medicine, which is conducted individually at university multidisciplinary hospitals. The training is provided through an Internet-based system that contains an integrated database with personal data, curricula, virtual study materials, assignments and tests.

- **Medical University - Plovdiv:** has a Center for Electronic and Distance Education (CEDE), which provides technological conditions for conducting courses, qualification programs for acquiring health qualifications and conducting examinations. CEOO develops technical and methodological guidelines for conducting continuing education courses and programs, public lectures, seminars and programs, e-distance learning and certification examinations in the field of medicine, dentistry and pharmacy.

- **Medical University - Pleven:** It has a Distance Learning Center, which provides technological conditions for conducting courses and qualification programs for acquiring health qualifications and conducting examinations. The Centre develops technical and methodological guidelines for conducting continuing education courses and programmes, public lectures, seminars and programmes, e-distance learning and certification examinations in the field of medicine, dentistry and pharmacy.

Medical University - Pleven: presentation of its experience with digital innovations in medical education

Medical University - Pleven is recognized as a national leader in the digital transformation of medical education in Bulgaria. Since gaining university status in 2004, the institution has consistently invested in technological infrastructure and innovation in education.

Key achievements include the establishment of the Centre for Tele-Communication Endoscopy (2007), the introduction of robotic surgery through the Da Vinci system (2008) and the opening of a centre for non-invasive treatment of tumours with high-intensity focused ultrasound - HIFU (2012). In recent years, the university has integrated advanced educational technologies such as the Lectorio platform, 3D virtual dissection tables, augmented and virtual reality studios, telepathology systems and 3D bioprinting.

This infrastructure set the stage for implementing a hybrid model in the extramural health care management program during the COVID-19 pandemic. The model alternates two weeks of synchronous online learning with one week of face-to-face practical sessions. It provides flexibility for working professionals and leads to dual qualifications - in health management and teaching - with opportunities for progression in both clinical and academic areas.

MATERIALS AND METHODS

In order to assess the effectiveness and acceptance of this hybrid model in the Health Management program at Medical University - Pleven, a structured study was conducted combining a SWOT analysis with a survey of part-time students.

The SWOT analysis was conducted to systematically assess the internal and external factors influencing the hybrid educational model. This included a review of:

- Available technical infrastructure and digital platforms;
- Faculty readiness and teaching capacity;
- Institutional and regulatory constraints;
- Opportunities for innovation, including international cooperation and the use of immersive technologies;
- Risks related to quality assurance, learner engagement and technology accessibility.

The analytical framework builds on the differentiation proposed by (11) and (12) by distinguishing:

- E-learning - asynchronous, multimedia-based modules and self-paced content;
- Online learning - synchronous instructor-led sessions via virtual classrooms;
- Hybrid learning - a pedagogically structured combination of the two.

The structured questionnaire survey was conducted among 63 part-time students. The instrument contained 17 closed-ended questions designed to assess:

- Learner satisfaction with the hybrid format;
- Perceived advantages and disadvantages of online versus in-person methods;
- Preferences for content delivery methods;
- Self-assessed outcomes related to time management, digital skills and professional development.

The sample includes professionals with different backgrounds - mainly nurses, medical laboratory technicians, midwives and radiographers - representing a wide range of health workers in Bulgaria. Respondents also varied in geographic background and years of experience, allowing us to understand how hybrid education meets the needs of working professionals at different life and career stages.

Quantitative data were processed using descriptive statistics and chi-square analysis, which allowed the identification of statistically significant patterns in students' responses. The

survey results are presented along with the SWOT analysis to offer an overall interpretation of the hybrid model's effectiveness and areas for improvement.

RESULTS AND DISCUSSION

Profile and background of the students

The sample of the study consisted of 63 part-time students from the specialty "Health Care Management" at Medical University - Pleven. All participants were licensed health care professionals.

Table 1. Distribution of respondents according to their basic specialty (%)

	N=63	Chi-Square	df	p
• o	32 (50.8%) 11 (17.5%) 6 (9.5%) 14 (22.2%)	24.429	3	< 0.001
.	25 (39.7%) 14 (22.2%) 24 (38.1%)	3.524	2	0.172
	33 (52.4%) 5 (7.9%) 3 (4.8%) 2 (3.2%)	60.545	4	< 0.001

The majority of students were based in Pleven (52.4%), while others travelled from surrounding towns such as Veliko Tarnovo, Ruse, Lovech and several more remote locations, demonstrating the geographical reach and accessibility of the hybrid format.

The hybrid training of the students of the Healthcare Management program consists of organizing the attendance sessions as follows: for 2 (two) weeks they are held in a virtual online classroom (BigBlueButton), and for 1 (one) week they are attended on campus (mainly practical sessions).

Student satisfaction with the hybrid model

The hybrid training format alternates two weeks of online training via BigBlueButton with one week of in-person sessions focused on case-based learning, project development, and pedagogical skills (**Figure 1**).

Student attitudes towards this model were mostly positive:

- **61.9%** fully approve of the structure;
- **25.4%** partially approved;
- Only a small minority expressed neutral or negative views.

A chi-square test confirmed the statistical significance of this endorsement ($\chi^2 = 80.095$, $df = 4$, $p < 0.001$), indicating a strong consensus among respondents that the hybrid format met their needs.

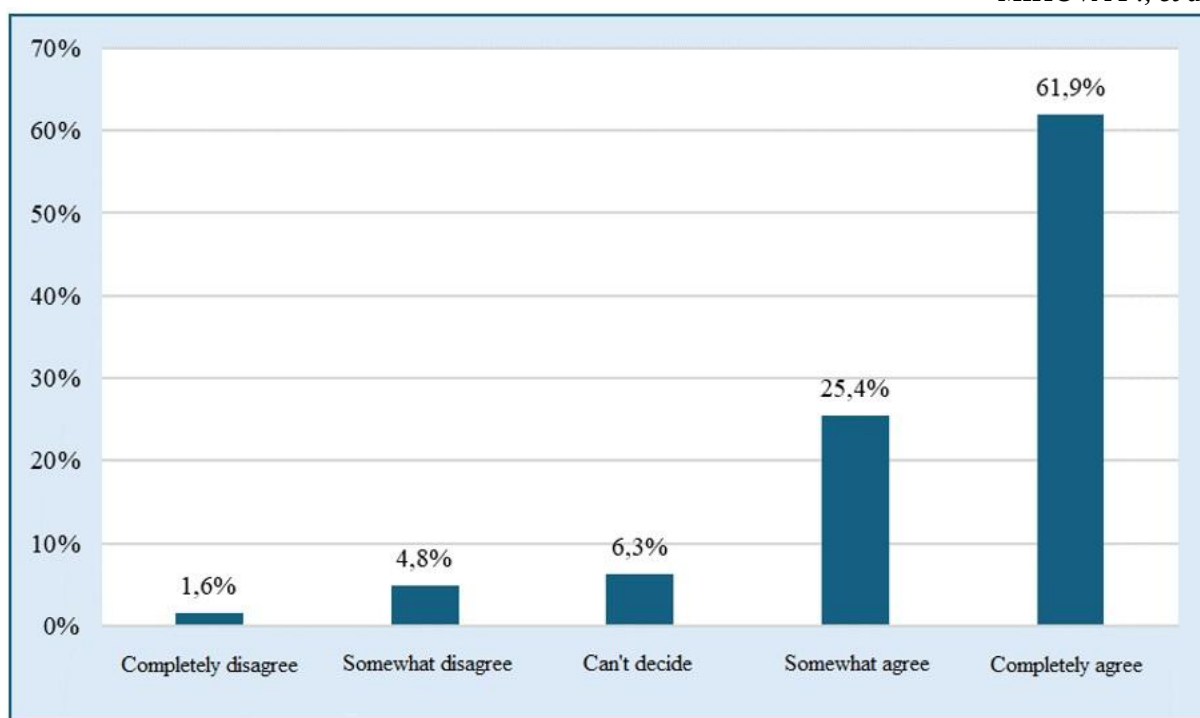


Figure 1. Do you approve of the organization of the Health Care Management course in a hybrid format (n=63)($\chi^2 = 80.095$, df = 4, $p < 0.001$)?

In the attendance classes, students discussed and debated various issues of management and pedagogy and analyzed case studies from practice. Particularly useful for them are the classes during which they learn the methodology for writing the "Health Care Management Project". Exercises related to the pedagogical qualification of students are also

very useful when conducted in person. Students learn the methodology of conducting teaching exercises with students, learning to plan, prepare and implement a session on a given topic. Attending practical training sessions also provides an opportunity to improve the communication and presentation skills of the learners.

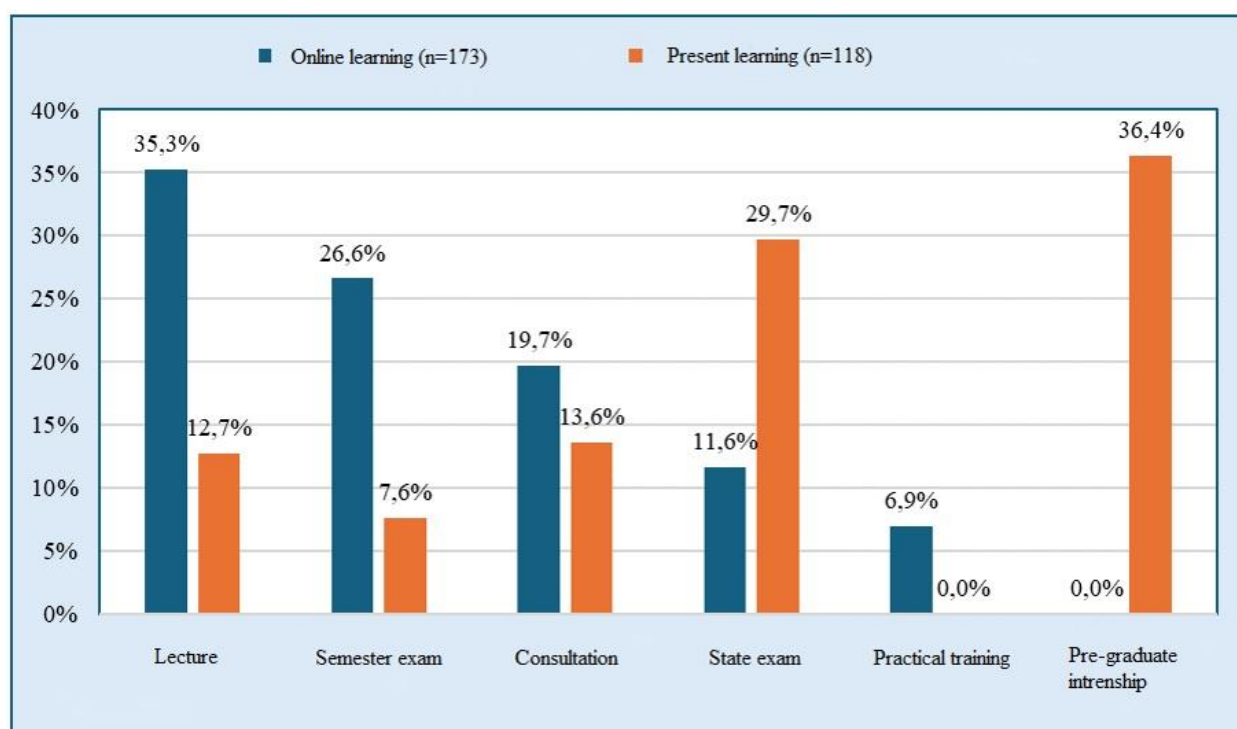


Figure 2. Which form of learning is appropriate for online/present learning ($\chi^2 = 176.458$, df = 49, $p < 0.001$)

Perceived strengths of hybrid learning

Respondents identified several strengths of the hybrid model (Figure 3a):

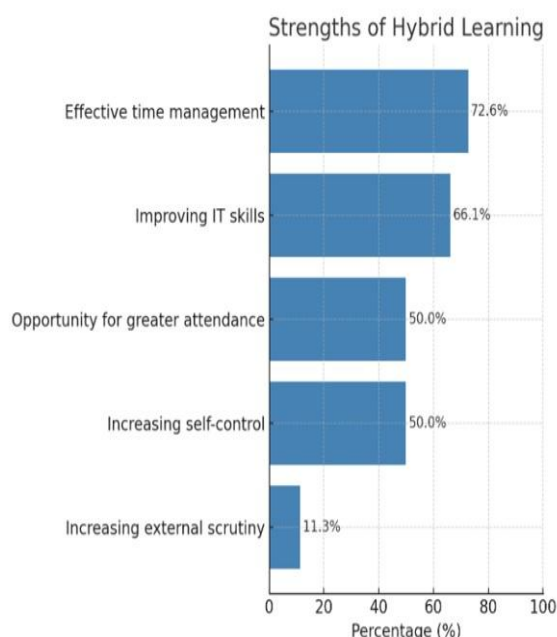


Figure 3. a) Strengths of hybrid learning,

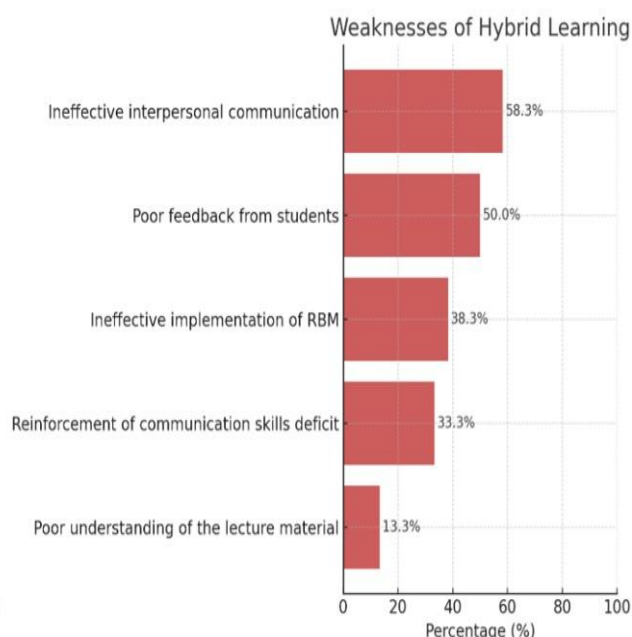
1. Effective time management (72.6%) - the most cited benefit, reflecting the ability to balance work, study and family life.
2. Improved digital skills (66.1%) - improved competence with online tools and platforms.
3. Increased class attendance (50%) - facilitated by flexible online format.
4. Increased self-discipline and autonomy (50%) - reflecting the potential of the model to promote independent learning.

These findings confirm that the hybrid model is particularly suitable for adult learners in professional settings for whom time, access and flexibility are essential.

Perceived weaknesses of hybrid training

Challenges identified by students (Figure 3b) include:

1. Limited interpersonal communication (58.3%) - reflecting the difficulty of building rapport in virtual spaces.
2. Insufficient feedback from students (50%) - related to reduced real-time interaction and delayed clarification.
3. Ineffective implementation of results-based management concepts (38.3%) - possibly due to abstract content provided online.
4. Deficits in communication skills development (33.3%) - limited opportunities to practice soft skills.



b) Weaknesses of hybrid learning

5. Poor understanding of lecture content (13.3%) - surprisingly low, suggesting that theoretical teaching is generally effective.

These limitations highlight the importance of purposeful instructional design, especially for the communicative and practical components that benefit most from face-to-face interaction.

Integration of SWOT results

The results of the study are consistent with the SWOT analysis conducted for the programme:

- Strengths: Strong digital infrastructure, faculty expertise in developing e-resources, positive student attitude, compliance with national legislation.
 - Weaknesses: gaps in communication skills training, lack of formative feedback cycles, uneven digital readiness among some faculty.
 - Opportunities: expand international cooperation, use of immersive technologies (VR/AR), microcredit.
 - Threats: Regulatory rigidity, over-reliance on self-directed learning, potential burnout due to screen time, and dual role stress.
- This integrative perspective confirms that hybrid education is a viable and effective model in the context of Bulgarian higher medical education, especially for PhD students. However, its long-term success depends on continuous investment in faculty development, pedagogical adaptation and technological improvement.

Strengths	Weaknesses
• Technical infrastructure: Medical University - Pleven has a platform based on the international SCORM standard and dedicated rooms with high-speed internet and modern equipment. • Institutional support: the Distance Learning Centre (DLC) plays a key role in the organisation, management and technical support of the process. • Trained teachers: specially trained teachers and administrators ensure high quality courses by being trained to use the platforms and create interactive learning materials. • Content tailored to medical practice: the courses developed reflect the specificity of medical science as a practical discipline. They include case studies, simulations and interactive tests that allow students to develop skills despite the distance format. • Accessibility and Equity: Online learning provides opportunities for students who cannot attend on-site, while being equivalent to traditional curriculum and credit instruction.	• Limited experience in distance medical education: despite the existing infrastructure, the university is in the early stages of DFE development due to the specific nature of medical education, which limits the number of courses and specialties available. • Lack of face-to-face practice: medical science is extremely practice-oriented, and the distance form limits opportunities for face-to-face contact with clinical situations and direct work with patients. • Limited simulations: although simulation elements are included, they cannot fully replace work in a real clinical environment. • Technical Challenges: Continuous technical support is necessary to prevent technical problems that can interrupt the learning process.
Opportunities	Threats
• Expanding Programs: Ability to develop distance courses for specialized medical disciplines that incorporate virtual labs and cutting-edge technologies such as augmented and virtual reality. • Integration of new technologies: the introduction of simulations for surgical procedures and other clinical interventions through virtual reality/telemedicine can compensate for the lack of direct access to patients. • Cooperation with international institutions: exchange of experience and development of joint programmes with leading universities that have established practices in distance medical education. • Adapting to the needs of practical medicine: developing hybrid forms of learning that combine online lectures with face-to-face practical sessions. • Increasing accessibility: distance learning can attract students from remote regions who are unable to study full-time and provide greater flexibility for working students.	• Regulatory requirements: accreditation requirements and regulatory constraints can complicate the process of expanding distance programs. • Risk of disengagement: lack of direct contact with lecturers and colleagues can lead to reduced student engagement and motivation, which is critical for the development of practical skills. • Simulation limitations: despite the technological possibilities, simulations cannot fully replace clinical experience and patient interaction. • Technical and financial constraints: the constant need to update software and hardware, as well as to provide technical support, requires significant resources.

Figure 4. SWOT analysis Source: dissertation on "Integration and optimization of digital learning platforms and telecommunication technologies for improving the quality of higher medical education at Medical University - Pleven".

The results of the study overlap with the SWOT analysis data and are an objective prerequisite for future research in the area of digital transformation in higher medical education.

DISCUSSION

The findings of this study are consistent with more extensive research on digital transformation in medical education, particularly in the context of the COVID-19 pandemic. Similar conclusions were drawn by Kirkova-Bogdanova et al. (2023), who examined the experiences of health care students at the Medical University of Plovdiv, identifying on the one hand improved flexibility and digital competencies, accompanied by persistent communication challenges and lack of practical experience. These results are entirely analogous to the results of students in

the hybrid program in health care management at Medical University of Pleven.

Mihaylova et al. (2022) further support these insights by emphasizing the importance of institutional support, clear guidelines, and blended models that allow for both theoretical and applied learning. Their practical experience supports this study's recommendation for hybrid structures that combine synchronous learning with real-world clinical practice.

International literature similarly highlights the complexities of implementing distance or online learning in clinical education. Al-Balas et al. (2020), for example, describe the urgent transition to digital education in Jordan, noting the limitations of replicating learning at the patient's bedside and student-patient interaction. This reflects the concerns expressed in our

SWOT analysis about the irreplaceable value of face-to-face clinical practice.

In the Bulgarian context, (16) outlines the technological and pedagogical reforms needed for a meaningful digital transformation, highlighting the need for long-term planning and teacher training. Earlier Bulgarian research by (17) also anticipates many of the structural and cultural barriers that continue to influence the adoption of distance education today.

From a pedagogical perspective, the classic frameworks of (18) and (19) remain relevant, especially in terms of designing content for flexibility and managing cognitive load. These principles are central to the success of the e-learning modules used in the Pleven programme and should be more widely implemented in Bulgarian medical universities.

Conceptual clarity is also essential. The definitions promoted by the Distance Learning Association of the United States (20) provide a useful distinction between types of distance learning, thus reinforcing the need for purposeful integration of digital formats rather than impromptu substitution.

A more forward-looking perspective is offered by (21), who highlights the potential of immersive technologies (VR/AR), intelligent tutoring systems and simulation platforms to bridge the gap between theory and practice. These tools offer opportunities to enrich hybrid educational models and to address one of the most cited problems of students - limited hands-on participation.

The World Health Organization (22) places digital education within the global health workforce development agenda, highlighting its potential to reach disadvantaged groups, support lifelong learning and improve learning outcomes at scale.

CONCLUSION

Medical education is unique in that it relies on both scientific knowledge and irreplaceable human contact. As such, digital tools are not intended to replace, but rather to complement and enrich the learning process. Efforts to improve the quality of education-through better instructional design, faculty support, and the integration of technologies such as simulation, virtual reality, and telepresence-must continue

to evolve in response to the needs of both students and ever-evolving and powerfully digitizing health systems.

The case of the Medical University of Pleven shows that hybrid education can be more than a temporary solution - it can be a sustainable model that allows professionals to continue their education without distancing themselves from patients or their careers. When implemented carefully, hybrid education supports not only academic achievement, but also professional development, digital literacy, and confidence with digital tools. Ultimately, digital transformation in medical education is not about replacing traditions - rather, it is a process of transformation and enrichment to better reflect the realities of 21st century healthcare while remaining true to the values of quality, empathy, ethics, and person-centered care.

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