HOW DO MEDICAL AND NURSING STUDENTS VIEW HEALTHCARE TECHNOLOGY? A PSYCHOMETRIC VALIDATION STUDY OF THE USABILITY EVALUATION QUESTIONNAIRE IN BANGLADESH

COMO É QUE OS ESTUDANTES DE MEDICINA E ENFERMAGEM VEEM A TECNOLOGIA DE SAÚDE? UM ESTUDO DE VALIDAÇÃO PSICOMÉTRICA DO QUESTIONÁRIO DE AVALIAÇÃO DE USABILIDADE EM BANGLADESH

10.29073/jim.v4i2.767

Receção: 20/05/2023 Aprovação: 30/05/2023 Publicação: 10/08/2023

Farhana Manzoor [a]; Nandita Islam Pia [b]; Ridwanur Rahman [c]; Naheyan Bin Rahman [d]; Debashish Debnath [f]; Hasan Shahriar Rahman [g]; Masood Mohammed Abdul Aziz [h]; Farhana Ferdaus [i]; Nahida Sultana [j]; Kazi Shafiqul Halim [k]; Mohammad Gilam Iqbal [l]; Israt Jahan Ummon [m]; Bui Vu Binh [n]; Le Thi Tra My [o]; Le Thi Cuc [p]; Le Thanh Tung [q]; Ngo Huy Hoang [r]; Nguyen Thi Minh Chinh [s]; Nguyen Thi Thanh Huong [t]; Pham Thi Thuy Chinh [u]; Mai Thi Thanh Thu [v]; Essi Ylistalo [w]; Katariina Kunnas [x]; Annukka Huuskonen [y]; Nina Smolander [z]; Anabela de Sousa Salgueiro Oliveira [aa]; João Manuel Garcia do Nascimento Graveto [ab]; João Gonçalo Ribeiro Pardal [ac]; Paulo Jorge dos Santos Costa [ad]; Pedro Miguel dos Santos Dinis Parreira [af];

[a] Universal Medical College and Hospital; famimanzoor2020@gmail.com; [b] Universal Medical College and Hospital; dr.nandita123@gmail.com; [c] Universal Medical College and Hospital; ridwanurr@yahoo.com; [d] Universal Medical College and Hospital; naheyanbinrahman@gmail.com; [f] National Institute of Preventive and Social Medicine (NIPSOM); hm254debashish202021@gmail.com; [g] Atish Dipankar University of Science and Technology; shahriar4593@gmail.com; [h] Khulna City Medical College & Hospital; maziz15@gmail.com; [i] Khulna City Medical College & Hospital; farhanasumi87@yahoo.com; [j] Khulna City Medical College & Hospital; nahidanitu004@gmail.com; [k] City Medical College & Hospital, Gazipur; drzimmunipsom@gmail.com; [l] City Medical College & Hospital, Gazipur; Iqbalbabu9@gmail.com; [m] City Medical College & Hospital, Gazipur; Ummonsbmc@gmail.com; [n] Hanoi Medical University, Hanoi Medical University Hospital; bvbinh@hmu.edu.vn; [o] Hanoi Medical University; letramy@hmu.edu.vn; [p] Hanoi Medical University, Hanoi Medical University Hospital; Lecuc@hmu.edu.vn; [q] Nam Dinh University of Nursing; tungpcnd@ndun.edu.vn; [r] Nam Dinh University of Nursing; ngohoang64@gmail.com; [s] Nam Dinh University of Nursing; Nguyenminhchinhsdh@gmail.com; [t] Nam Dinh University of Nursing; huong.ndun@ndun.edu.vn; [u] Nam Dinh University of Nursing; thuychinh.pham@85gmail.com; [v] Nam Dinh University of Nursing; maithanhthu@ndun.edu.vn; [w] Tampere University of Applied Sciences; essi.ylistalo@tuni.fi; [x] Tampere University of Applied Sciences; katariina.kunnas@tuni.fi; [y] Tampere University of Applied Sciences; annukka.huuskonen@tuni.fi; [z] Tampere University of Applied Sciences; nina.smolander@tuni.fi; [aa] The Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra; anabela@esenfc.pt; [ab] The Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra; jgraveto@esenfc.pt; [ac] The Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra; jgrpardal@esenfc.pt; [ad] The Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra; paulocosta@esenfc.pt; [af] The Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra; parreira@esenfc.pt;

ABSTRACT

The modernization of healthcare delivery is a reality in various international settings. To ensure efficient and safe use of the diverse forms of healthcare technology available, professionals and students must be receptive to incorporating such tools into their practice. Currently, there is no instrument in Bangladesh to assess healthcare students' technology acceptance. **Objective:** To translate, culturally adapt, and validate the Usability Evaluation Questionnaire (UtEQ) among Bangladeshi healthcare students.

Method: A cross-sectional study with a methodological approach was conducted in two phases. The first phase involved the translation of the UtEQ questionnaire to Bengali, following the six stages proposed by Beaton et al. In the second phase, the psychometric properties of the questionnaire were evaluated using a non-probability sample of 486 undergraduate

healthcare students from three higher education institutions in Bangladesh. Confirmatory factor analysis was performed, and the Cronbach's alpha coefficient was estimated to find out the internal consistency.
Results: Internal consistency was found to be excellent for all scale dimensions, ranging from 0.88 to 0.92, while confirmatory factor analysis showed adequate goodness-of-fit indicators.
Conclusion: The UtEQ-B provides a reliable and valid method for healthcare educators and researchers to assess technology acceptance among healthcare students during clinical training in Bangladesh.
Keywords: Technology Acceptance; Medical Students; Nursing Students; Scale; Bangladesh

RESUMO

A modernização da prestação de cuidados de saúde é uma realidade em vários contextos internacionais. Para garantir a utilização eficiente e segura das diversas formas de tecnologia em saúde disponíveis, os profissionais e estudantes devem estar receptivos à incorporação dessas ferramentas na sua prática. Atualmente, não existe em Bangladesh um instrumento para avaliar a aceitação da tecnologia pelos estudantes de saúde.
Objetivo: Traduzir, adaptar culturalmente e validar o Questionário de Avaliação da Usabilidade (UtEQ) entre estudantes de saúde de Bangladesh.
Método: Foi realizado um estudo transversal com uma abordagem metodológica em duas fases. A primeira fase envolveu a tradução do questionário UtEQ para bengali, seguindo as seis etapas propostas por Beaton et al. Na segunda fase, foram avaliadas as propriedades psicométricas do questionário usando uma amostra não probabilística de 486 estudantes de graduação em saúde de três instituições de ensino superior em Bangladesh. Foi realizada uma análise fatorial confirmatória e estimou-se o coeficiente alfa de Cronbach para verificar a consistência interna.
Resultados: Foi encontrada uma consistência interna excelente para todas as dimensões da escala, variando de 0,88 a 0,92, enquanto a análise fatorial confirmatória mostrou indicadores adequados de ajuste.
Conclusão: O UtEQ-B fornece um método confiável e válido para educadores e pesquisadores em saúde avaliarem a aceitação da tecnologia entre estudantes de saúde durante o treinamento clínico em Bangladesh.
Palavras-Chave: Aceitação de Tecnologia; Estudantes de Medicina; Estudantes de Enfermagem; Escala; Bangladesh.

1. INTRODUCTION

In recent years, Bangladesh has made significant strides in healthcare outcomes. However, the country is currently undergoing sociodemographic and epidemiological transitions characterized by increasing longevity, decreasing fertility, and a shift in disease epidemiology [1]. Non-communicable diseases (NCDs) have been on the rise across different geographic locations (both rural and urban settings), age groups, sexes, and ethnicities [1]. A national study conducted in Bangladesh on NCD risk factors revealed that a majority of adults aged 18–69 (70.9%) had at least one risk factor, while 26.2% had three or more risk factors [2]. These risk factors included inadequate fruit and vegetable intake, tobacco use, low physical activity, obesity (particularly central obesity), high blood pressure, diabetes mellitus, excessive salt intake, dyslipidemia, and binge drinking. Recognizing the importance of addressing this situation, the Country Office for Bangladesh of the World Health Organization emphasized the need for effective strategies to enhance accessibility to healthcare services [2]. Therefore, it is crucial to proactively take steps to tackle this emerging health challenge and ensure that comprehensive care delivery is accessible to all.

The increasing adoption of information and communication technology (ICT) in private and public healthcare settings is playing a crucial role in bridging the gap between citizens and healthcare providers in Bangladesh [3–5], mirroring efforts made in the recent years by other countries [6]. However, progress in Bangladesh lags behind that of other countries in Southeast Asia [7,8]. In a scoping review

conducted by Ahmed et al. [9] on eHealth and mHealth initiatives in Bangladesh, the authors emphasized the absence of fundamental medical training, specifically hands-on sessions focusing on the utilization of technical materials and technological platforms. A similar viewpoint was shared by Islam [10], who conducted interviews with 68 healthcare professionals in Bangladesh. The study findings suggested that healthcare staff should receive technology training to enhance service efficiency and promote transparency in health services [10].

The use of such technologies is crucial to increase the work efficiency and effectiveness of healthcare professionals and students, leading to better care outcomes for patients and their families [3–5,11]. Electronic patient health records, internet-based health websites, digital applications, and telemedicine software are some of the information technologies and applications that healthcare professionals and students will use in their daily clinical work. Before deciding to use a specific technological device, users evaluate its advantages and limitations. It is, therefore, essential to understand how these individuals react to new technologies [12].

Low levels of technology acceptance can lead to failure or delay in implementing a specific technology in daily clinical practice, which can negatively impact healthcare objectives and hinder the quality and safety of care delivery [13,14]. Technology acceptance refers to users' willingness to use technology for the tasks it is designed to support [15]. Healthcare professionals and students' knowledge and beliefs influence the evaluation process and contribute to their adoption, not just during its design phase or immediately after its implementation in a clinical setting [16]. Changes are expected to occur in information systems, their designs, working environments, potential users, and social and cultural factors, which can affect healthcare professionals and students' needs and acceptance of technology [15,17].

Current literature references the existence of several technology acceptance models and theories which can assist researchers understand users' behaviors towards technology by examining the underlying factors [17]. Identifying these factors can improve the effectiveness of healthcare technologies by allowing researchers to investigate technical, social, and cultural aspects and understand the correlation between those factors and users' readiness to use such innovation [12,18,19]. The Technology Acceptance Model (TAM) is widely accepted in literature for understanding predictors of user intention towards technology usage [19]. It is considered the common ground theory in this field. According to TAM, an individual's intention to use new technology is influenced by two primary factors: perceived ease of use and perceived usefulness. Building on the TAM model, a group of researchers developed the Usability Evaluation Questionnaire (UtEQ) to assess end-users' assessment of medical devices and technology efficacy, performance, and safety [20]. The UtEQ has been adapted by healthcare educators and researchers in various countries, including Portugal, Belgium, Finland, Slovenia, and Vietnam, to assess healthcare students' acceptance of different technologies during their clinical training, with positive results [21,22].

As there is currently no such instrument available in Bangladesh, we aim to culturally adapt and validate the psychometric properties of the UtEQ among Bangladeshi undergraduate medical and nursing students.

2. MATERIALS AND METHODS

This study is part of the DigiCare Project, an international research initiative supported by the Erasmus+ Agency through its Strategic Partnerships for Higher Education Programme (grant number 598267-EPP-1-2018-1-FI-EPPKA2-CBHE-JP). The project aims to address the specific needs and challenges of healthcare education in the Asian region and facilitate the effective integration of digital technologies to enhance learning outcomes and prepare students for the evolving healthcare landscape.

2.1 STUDY DESIGN

This study consisted of two main phases. The first phase involved the translation and adaptation of the UtEQ questionnaire into

Bengali, as well as the assessment of its psychometric properties among undergraduate healthcare students in three universities in Bangladesh. The second phase focused on the validation of the translated and culturally adapted version of the UtEQ-B in three higher education institutions in Bangladesh.

During the initial phase, in stage I, the questionnaire was translated from English to Bengali through a rigorous process following the methodology proposed by Beaton et al. [23]. Two independent healthcare reviewers proficient in both English and Bengali performed the forward translation. In the synthesis stage (stage II), the translations were thoroughly analyzed and discussed by the research team and reviewers, resulting in the development of the Bengali version of the UtEQ (UtEQ-B). In stage III, two official translators with native English proficiency back-translated the initial Bengali version into English. The back-translations were then reviewed by the research team and translators to ensure linguistic correspondence between the original UtEQ and the Bengali version.

During stage IV, an Expert Committee (n = 6) consisting of PhD researchers and professors from three medical colleges and hospitals in Bangladesh was formed to review the UtEQ-B. After several rounds of discussion, a final consensus was reached, and the experts unanimously approved the questionnaire as a valuable tool for the assessment of technology acceptance by medical and nursing students in Bangladesh. A pre-test involving 78 students from the three institutions was conducted to assess the suitability and average response time of the instrument, with a predetermined average response time of 20 minutes. The original authors of the questionnaire reviewed the results from the previous phases and approved the process.

In the second phase of the study, the UtEQ-B was administered to a convenience sample of students from three higher education institutions in Bangladesh. The participants were asked to complete the questionnaire, and their responses were collected between November 2021 and February 2022. The collected data were then subjected to statistical analysis to evaluate the psychometric properties of the UtEQ-B.

2.2 SAMPLE SIZE, STUDY RECRUITMENT AND DATA COLLECTION

The participants of the study were recruited among the healthcare students from City Medical College and Hospital, Gazipur (CIMCH), Khulna City Medical College, Khulna (KCMCH), and Universal Medical College, Dhaka (UMCH). To be included in the study, a participant was required to be a bachelor in nursing or a medical student interested in participating and available during data collection. Students who were not available nor interested in participating during data collection time were excluded from the study.

The sample size was defined ensuring a minimum of 10 individuals per questionnaire item according to Terwee and collaborators [24]. A sample of 486 students participated in the study, considering the number of parameters and dimensions present in the questionnaire, to ensure an adequate stability of the variance/covariance matrix when performing a Confirmatory Factor Analysis (CFA).

2.3. INSTRUMENTS AND VARIABLES

Parreira et al. [20] developed the UtEQ questionnaire based on the TAM model, which originally comprises 45 items divided into four factors: Utility Performance (UP), Utility Empowerment (UE), Utility Relationship (UR), and Ease of Use (EU). The UR factor of the scale evaluates students' perceptions regarding how technology aligns with their workflow, integrates with existing clinical processes, and enhances communication and collaboration with patients and healthcare professionals [20]. This factor comprises 10 items that specifically assess the role of technology in facilitating a positive and effective relationship between healthcare professionals and patients [20]. These items, such as "Facilitates an empathic relationship with a patient" (item 20), "Enhances my understanding of a patient's experience" (item 21), "Establishes a true relationship with the patient" (item 23), and "Builds an effective relationship with the patient" (item 32), collectively measure the extent to which

technology is perceived to support meaningful interactions, empathy, and rapport in the context of patient care [20].

The UP factor within the scale assesses the perceived performance-enhancing aspects of technology in healthcare settings [20]. This factor consists of nine items, including examples such as "Supports my recordkeeping" (item 5), "Allows me to complete task(s) quickly" (item 9), and "Allows me to control the task(s) to be performed" (item 14). These items collectively capture students' perceptions of how technology contributes to their efficiency, effectiveness, and control in performing various tasks related to patient care [20]. By evaluating the utility of technology in terms of performance, this factor provides insights into the extent to which technology enables students to streamline their workflow, manage tasks efficiently, and have greater control over their work processes [20].

The UE factor in the scale consists of six items that assess the role of technology in empowering patients to take an active role in managing their own health. These items, including "Supports the patient's self-management skills" (item 33), "Motivates the patient to take control of his/her own health" (item 35), and "Motivates the patient's interest in his/her own health" (item 38), capture the perceived utility of technology in promoting patient empowerment and engagement in their healthcare journey. This factor emphasizes the potential of technology to support patients in developing self-management skills, fostering motivation, and encouraging a proactive approach towards their own health [20].

The EU factor focuses on the perceived ease of use and user-friendliness of technology in the clinical care of patients. It evaluates students' perceptions of the simplicity of learning and navigating the technology, as well as the intuitiveness of its interface and features [20]. The factor's eight items assess various aspects, such as the requirement of a short learning period (e.g., item 17), the need for previous knowledge (e.g., item 19), and the demand for minimal mental effort (e.g., item 3).

Respondents rate each item on a scale of 1 (Strongly disagree) to 7 (Strongly agree), with higher scores indicating a greater inclination to incorporate technology into their clinical practice due to its perceived benefits [14]. Additionally, the data collection instrument includes a brief section that asks about participants' sociodemographic characteristics (e.g., age, gender) and academic information (e.g., course year, enrollment status).

2.4. STATISTICAL ANALYSIS

We employed the AMOS software (SPSS Inc., Chicago IL) to conduct CFA and estimate the structural model. Internal consistency of the constructs in the study was assessed using Cronbach's alpha (α), where a value of greater than 0.70 was considered to indicate adequate reliability [25].

To evaluate the goodness of fit of the data to the model, we employed a range of goodness-of-fit indexes, along with their acceptable thresholds. These thresholds were derived from Hu and Bentler [26]. The evaluation of the proposed structures' goodness of fit to the correlational structure of the data was based on measures such as χ^2/df, comparative fit index (CFI), Tucker-Lewis index (TLI), Standardized Root Mean Squared Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), and the 90% confidence interval for RMSEA.

To determine a good fit, we set the threshold of chi-square/degrees of freedom to be less than 5.0. A CFI greater than .97 was considered a good adjustment, and a CFI between .95 and < .97 was considered an acceptable fit. Concerning the goodness-of-fit (GFI) index, we regarded a value greater than .95 as indicative of a good fit, and a value between .90 and < .95 as acceptable. We deemed a Root Mean Square Error of Approximation (RMSEA) value of less than .05 as indicative of a good fit, and a value between .05 and .08 as acceptable. We assumed a statistical significance level of .05.

2.5. ETHICAL CONSIDERATIONS

The research proposal bearing number P781-5/2021 was authorized by the Ethics Committee of the Health Sciences Research Unit of the Nursing School of Coimbra. Prior to participating in the study, participants voluntarily provided informed consent. Participants were provided with

comprehensive information about the study's objectives as well as data collection and analysis methods. To ensure participant confidentiality and anonymity, the data collection instruments used in the study were coded randomly. This coding process was designed to prevent the research team from accessing any personal identification details of the participants, promoting a secure and ethical research environment. Additionally, they were informed of their right to withdraw from the study at any time without fear of academic or personal repercussions.

3. RESULTS

A total of 486 nursing (*n* = 274, 61.2%) and medical (*n* = 174, 38.8%) students from three higher education institutions in Bangladesh participated in the study. These institutions were CIMCH (*n* = 172, 38.4%), KCMCH (*n* = 140, 31.3%), and UMCH (*n* = 136, 30.4%). Female students (*n* = 349, 77.9%) outnumbered male students (*n* = 99, 22.1%) by almost four to one. Most participants *(n* = 418, 93.3%) were full-time students, with only a small proportion (*n* = 30, 6.7%) being part-time students. In terms of age, most students were between 19 and 25 years *(n* = 404, 90.2%), followed by students ages 26 to 30 *(n* = 36, 8%) and ages between 31 and 36 years *(n* = 8, 1.8%). Concerning their academic course year, most participants were in their third year (*n* = 206, 46%), followed by second *(n* = 200, 44.6%), fourth (*n* = 37, 8.3%), and first-year students (*n* = 5, 1.1%).

In terms of the results of phase two, the descriptive statistics of the UtEQ-B can be found in Table 1.

Table 1 – Descriptive statistical analysis of UtEQ-B factors (*n* = 486)

Factor	***Min.***	***Max.***	***Mean***	***SD***
Utility Relationship (UR)	*1*	*7*	*5.34*	*1.18*
Utility Performance (UP)	*2.11*	*7*	*5.50*	*1.05*
Utility Empowerment (UE)	*1*	*7*	*5.40*	*1.15*
Ease of Use (EU)	*1*	*7*	*5.40*	*1.15*

Min. = Minimum value; Max. = Maximum value; SD = Standard deviation

Reliability analysis revealed that the EU factor of the UtEQ-B had an α value of 0.88, indicating adequate reliability. Similarly, the UR factor with 10 items presented an α value of 0.92, indicating good reliability. The UP factor with 9 items (α = 0.90) was deemed good. The UE factor with 6 items was also deemed adequate (α = 0.88).

Concerning the EU factor, we first explored its confirmatory structure analysis as a single model (Table 2). All the eight items of EU factor showed positive and significant impact with $p < .001$.

Table 2 – Confirmatory structure analysis of the UtEQ-B's EU factor

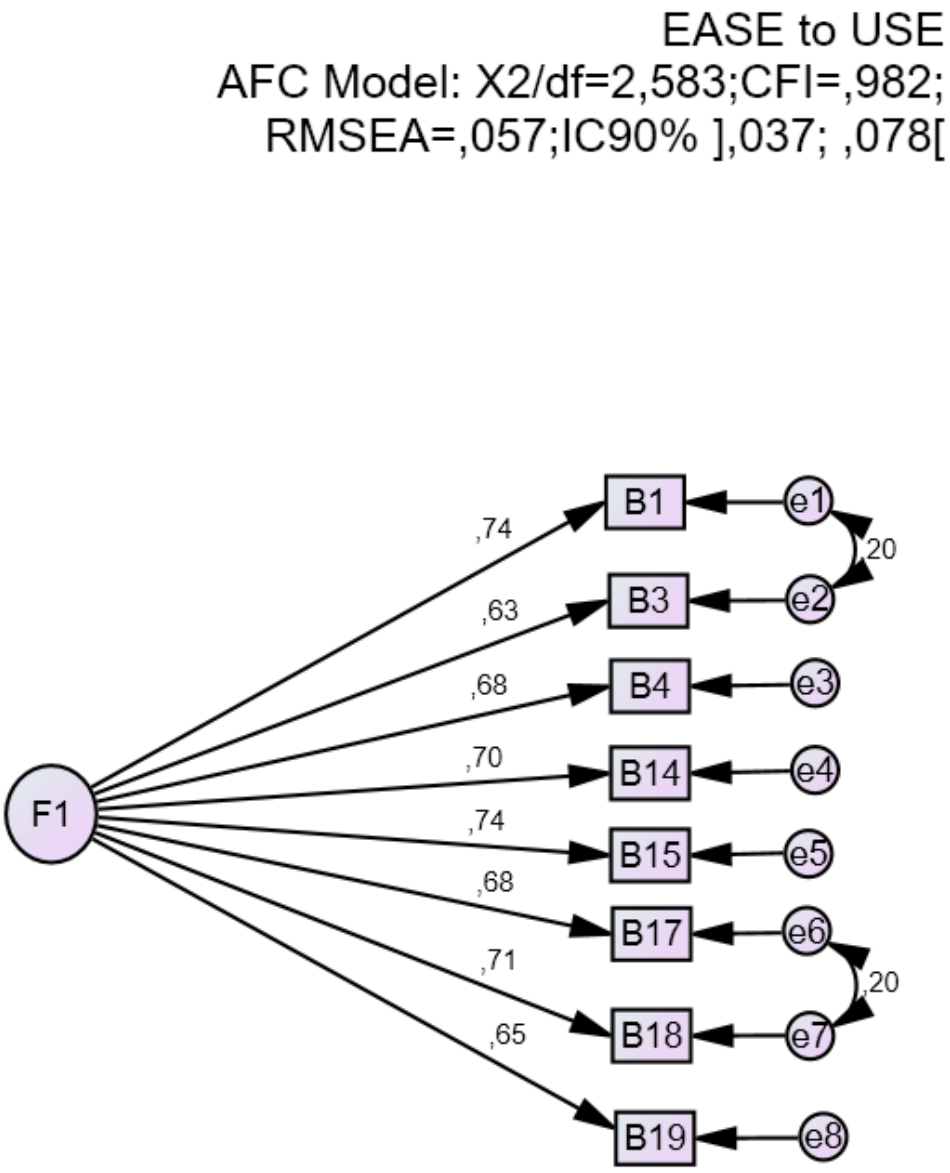
Item	**Estimates**	**SE**	**t-value**	**Sig.**
1. Is intuitive	1.000	.053		.000
3. Requires minimal mental effort	.781	.057	14.77	.000
4. Meets my expectations	.819	.054	14.31	.000

14. Allows me to control the task(s) to be performed	.794	.058	14.67	.000
15. Requires formal instructions to use them	.896	.057	15.55	.000
17. Requires a short learning period to use them	.808	.055	14.18	.000
18. Allows me to complete the task(s) according to the patient's needs	.803	.055	14.69	.000
19. Requires previous knowledge (e.g., computer science) to use them	.741	.053	13.54	.000

SE = Standard Error; Sig. = Statistical significance ($p \leq .05$)

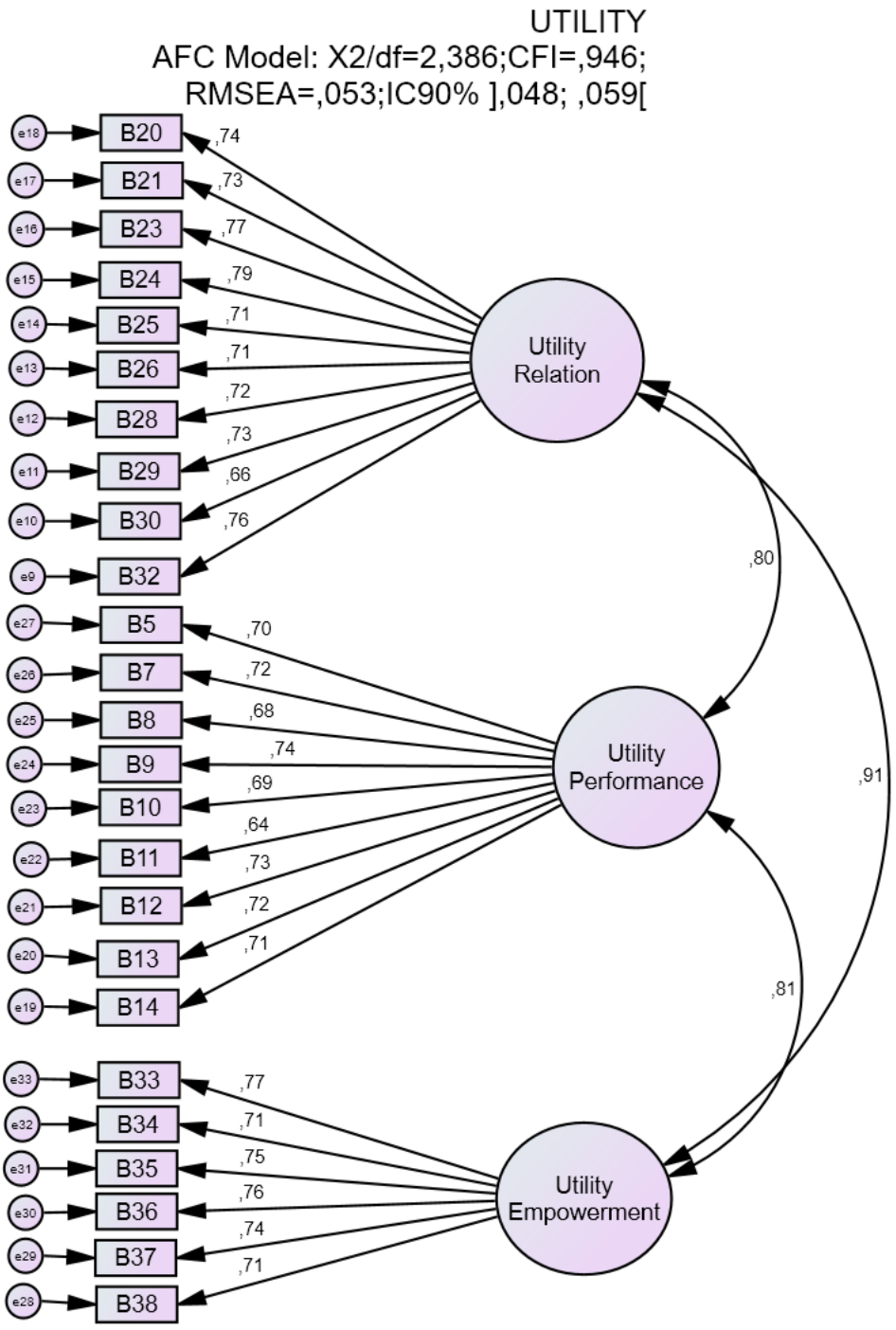
The fit indexes for the EU factor fell within the acceptable range (Figure 1), considering the found results for CMIN/df = 2.583, GFI = .977, CFI= .982, RMSEA = .057 [LO90 = .037; HI90 = .078], and a TLI = .973.

Figure 1 – Confirmation factor analysis of the EU factor (UtEQ-B)



We performed CFA on a joint model that combines all utility-related aspects of professional performance, relationship, and empowerment. The fit indexes for the model focusing on “Utility” (Figure 2), with CMIN/df = 2.386, GFI = .902, TLI = .940, CFI = .982, and RMSEA = .053 [LO90 = .048; HI90 = .059], were also considered acceptable.

Figure 2 – Confirmation factor analysis of the utility combined factors (UtEQ-B)



4. DISCUSSION

In Bangladesh, a country with a low socio-economic status, patients encounter significant obstacles in accessing essential healthcare services, both in community settings and hospitals [27]. The country's population-nurse ratio of 5000:1, bed-nurse ratio of 13:1, and doctor-nurse ratio of 2.5:1 are significantly lower than international standards [28,29]. Consequently, doctors and nurses struggle to deliver quality care and improve patient's experience. To address this issue, the Ministry of Health and Family Welfare (MOHFW), supported by WHO Bangladesh, has launched the development of a national digital health strategy. The primary aim of this strategy is to

improve the accessibility, quality, and affordability of health services, considering the low access to healthcare services in Bangladesh and the potential of technological advances to enhance people's health [27]. Digital health technology provides an opportunity to transform inadequate healthcare systems into more appropriate ones by offering cost-effective, faster, and more effective solutions for treating chronic diseases [30].

Additionally, digital technology can level the playing field between patients and healthcare professionals, allowing patients to access healthcare services more efficiently and enable healthcare professionals to deliver care more effectively. However, there is a risk that care quality may be compromised due to poor technology acceptance by both patients and healthcare professionals. In a recent multicenter study conducted in Swiss psychiatric hospitals, it was found that physicians and nurses who have greater interaction with digital technologies tend to report higher levels of stress and lower levels of digital competence compared to individuals in other professions [31]. Another multicenter cross-sectional study conducted by Kasemi et al. [32] examined the relationship between technology-related stress and various outcomes among Egyptian medical staff members and students. The study revealed that participants reported moderate-to-high levels of stress, which were associated with increased burnout, strain, and cortisol levels. Additionally, high levels of technology-related stress were found to be associated with decreased work engagement and lower CoQ10 enzyme levels [32]. To address this, targeted interventions should be conducted during formal education to enhance students' perceptions of the role and utility of technology in care delivery [16].

However, a valid measurement scale is necessary to predict user technology acceptance in Bangladeshi healthcare education. Our findings suggest that the UtEQ-B is a reliable and well-suited tool for assessing technology acceptance among healthcare students in Bangladesh. Its "Easy to Use" factor, composed of eight items, showed a positive and significant impact ($p < .001$) on overall technology acceptance. These results are a surprising addition to the ones by Hoque and Bao [8], who found that perceived usefulness was a significant indicator of e-health adoption decisions, whereas Perceived Ease of Use was an insignificant predictor of e-health adoption among 146 respondents from private and public hospitals in Dhaka.

Overall, the Cronbach's alpha values were within normal limits, confirming the reliability of the questionnaire. The goodness-of-fit indexes of the final model proposal were found to be adequate, indicating that the original model proposed by Parreira and colleagues [9] is appropriate for evaluating technology acceptance among healthcare students in Bangladesh. Therefore, the UtEQ-B is a valid and comprehensive measurement tool that can be utilized by healthcare educators and researchers in Bangladesh to accurately assess students' technology acceptance during their academic journey, prior to their entry into the job market. Utilizing such measurement tool is vital in addressing existing challenges in Bangladesh, where healthcare staff are often considered ill-prepared to navigate technologically advanced care environments [33].

Our study findings show that medical and nursing students in Bangladesh exhibit a moderate level of acceptance towards the technology utilized in patient care. This is evident from the average scores ranging from 5.34 (Utility Relationship factor) to 5.50 (Utility Performance factor) across the different factors of the UtEQ-B scale. While young adults are generally proficient in technology, our findings indicate that there is still room for improvement and further acceptance among medical and nursing students.

The understanding of this moderate level of acceptance among students holds significance for the development of educational curricula and policymaking in Bangladesh. Medical and nurse educators should consider incorporating electronic health records (EHRs), wearable technologies, big data and data analytics, and increased patient engagement as crucial areas in curriculum development [39,40]. Additionally, clinical supervisors and tutors

involved in student training should be mindful of the potential impact of technology on students' professional development during clinical placements. This includes areas where technology is employed in care delivery, such as communication with patients and their families, and updating patients' healthcare plans in EHRs. Such unpreparedness can lead to unfavorable outcomes for both students and professionals (e.g., technostress [34,35]), as well as patients (e.g., occurrence of adverse events, low-quality care experience [36,37]).

To equip both current and future medical and nursing professionals with a comprehensive set of technological and informatics skills, ongoing educational opportunities should be made available [13,16,38]. As the healthcare landscape evolves, it is imperative for clinicians in Bangladesh to be well-prepared for the prominent role technology will play in transforming healthcare practices. Therefore, medical and nurse educators need to proactively prepare themselves to guide these practitioners into the future [39,40]. By recognizing the current acceptance level and addressing the evolving technological needs of medical and nursing students, we can foster a more adept national healthcare workforce that embraces and effectively utilizes technology to enhance patient care and outcomes.

While our study provides valuable insights into technology acceptance among medical and nursing students in Bangladesh, it is important to acknowledge its limitations. Although we followed established recommendations for sample size in initial validation studies, the total number of participants (n = 486) may not provide a comprehensive representation of the entire student population in Bangladesh. In addition, our sample selection process did not include defining the students' course year as an inclusion criterion, which may introduce potential biases. Clinical practice and experience can vary significantly throughout course completion, and this variability was not accounted for in our study. To address these limitations, future research should aim to include specific inclusion criteria related to the students' course year or level, as well as more representative samples that can better capture the diversity of the undergraduate and postgraduate healthcare student population in Bangladesh. Such efforts would enhance the generalizability of our findings and provide a more complete understanding of technology acceptance among medical and nursing students in the country.

Another significant limitation of our study is that it did not specifically focus on doctors and nurses, who are key populations within the context of technology acceptance in healthcare. While our research provides valuable insights into the perceptions of medical and nursing students, it does not fully capture the experiences and perspectives of practicing healthcare professionals in Bangladesh. Including both clinicians and students in future studies would have several advantages. Firstly, incorporating clinicians in the study would allow for a more comprehensive understanding of technology acceptance across different professional roles and levels of experience. Clinicians bring their unique perspectives, practical insights, and real-world challenges to the table. Their involvement would provide a deeper understanding of how technology impacts clinical workflows, patient care, and outcomes. Secondly, having a sample that includes both clinicians and students would enable a more robust evaluation of the psychometric properties of the UtEQ-B. By including a diverse range of participants, we could gather a broader range of responses, allowing for a thorough examination of its reliability, validity, and factor structure. This would further refine the questionnaire and enhance its applicability across various healthcare contexts in the country.

5. CONCLUSIONS

The UtEQ-B showed semantic and idiomatic equivalence to the original version and was well-received by academic experts and undergraduate healthcare students in Bangladesh. The questionnaire demonstrated satisfactory reliability properties, indicating that it is a useful tool for assessing healthcare students' technology acceptance during their formal education. A structured evaluation of this domain could be advantageous for higher education teachers and researchers in Bangladesh, enabling targeted interventions to

enhance students' perceptions of the role of technology in care delivery, as well as its ease of use and utility. Nevertheless, future research endeavors should consider expanding the sample size to include students and professionals from various healthcare disciplines to further validate these findings and ensure the instrument's applicability across a broader context.

ACKNOWLEDGMENTS

The authors would like to thank all the nursing students involved in this study. The authors would also like to thank the Health Sciences Research Unit: Nursing of the Nursing School of Coimbra (UICISA: E, ESEnfC) for the ongoing support of the project activities. The authors would also like to acknowledge the support given by all academic experts and healthcare students who graciously decided to participate in this study.

REFERENCES

Kabir, A.; Karim, M.N.; Billah, B. Primary Healthcare System Readiness to Prevent and Manage Non-Communicable Diseases in Bangladesh: A Mixed-Method Study Protocol. *BMJ Open* 2021, *11*, e051961, doi:10.1136/bmjopen-2021-051961.

World Health Organization—Country Office for Bangladesh *National STEPS Survey for Non-Communicable Diseases Risk Factors in Bangladesh 2018*; Country Office for Bangladesh: Dhaka, 2018;

Uddin, J.; Biswas, T.; Adhikary, G.; Ali, W.; Alam, N.; Palit, R.; Uddin, N.; Uddin, A.; Khatun, F.; Bhuiya, A. Impact of Mobile Phone-Based Technology to Improve Health, Population and Nutrition Services in Rural Bangladesh: A Study Protocol. *BMC Med Inform Decis Mak* 2017, *17*, 101, doi:10.1186/s12911-017-0502-9.

Bhattacharyya, D.S.; Shafique, S.; Akhter, S.; Rahman, A.; Islam, M.Z.; Rahman, N.; Anwar, I. Challenges and Facilitators of Implementation of an Information Communication and Technology (ICT)-Based Human Resources Management Tool in the Government Health Sector in Bangladesh: Protocol for an Exploratory Qualitative Research Study. *BMJ Open* 2020, *10*, e043939, doi:10.1136/bmjopen-2020-043939.

Prodhan, U.K.; Rahman, M.Z.; Jahan, I. Design and Implementation of an Advanced Telemedicine Model for the Rural People of Bangladesh. *THC* 2018, *26*, 175–180, doi:10.3233/THC-171101.

Bayramzadeh, S.; Aghaei, P. Technology Integration in Complex Healthcare Environments: A Systematic Literature Review. *Appl Ergon* 2021, *92*, 103351, doi:10.1016/j.apergo.2020.103351.

Islam, S.M.S.; Tabassum, R. Implementation of Information and Communication Technologies for Health in Bangladesh. *Bull. World Health Organ.* 2015, *93*, 806–809, doi:10.2471/BLT.15.153684.

Hoque, Md.R.; Bao, Y. Cultural Influence on Adoption and Use of E-Health: Evidence in Bangladesh. *Telemedicine and e-Health* 2015, *21*, 845–851, doi:10.1089/tmj.2014.0128.

Ahmed, T.; Lucas, H.; Khan, A.S.; Islam, R.; Bhuiya, A.; Iqbal, M. EHealth and MHealth Initiatives in Bangladesh: A Scoping Study. *BMC Health Serv Res* 2014, *14*, 260, doi:10.1186/1472-6963-14-260.

Islam, M.S. Introducing Modern Technology to Promote Transparency in Health Services. *International Journal of Health Care Quality Assurance* 2015, *28*, 611–620, doi:10.1108/IJHCQA-01-2015-0016.

Alam, M.Z.; Hu, W.; Uddin, A. DIGITAL TRANSFORMATION IN HEALTHCARE SERVICES SECTOR OF BANGLADESH: CURRENT STATUS, CHALLENGES AND FUTURE DIRECTION. *RISUS* 2020, *11*, 30–38, doi:10.23925/2179-3565.2020v11i1p30-38.

Plch, L. Perception of Technology-Enhanced Learning by Medical Students: An Integrative Review. *Medical Science Educator* 2020, *30*, 1707, doi:10.1007/S40670-020-01040-W.

Ketikidis, P.; Dimitrovski, T.; Lazuras, L.; Bath, P.A. Acceptance of Health Information Technology in Health Professionals: An Application of the Revised Technology Acceptance Model. *Health Informatics J* 2012,

18, 124–134, doi:10.1177/1460458211435425.

Parreira, P.; Bernardes, R.A.; Santos-Costa, P.; Graveto, J.; Ferreira, P.A.; Salgueiro-Oliveira, A.; Sousa, L.B.; Serambeque, B.; Mónico, L.; Kapun, M.M.; et al. Digital Technology Scale to Coach People with Chronic Diseases: Evidence of Psychometric Validity in Four European Countries. *Lecture Notes in Bioengineering* 2021, 245–252, doi:10.1007/978-3-030-72567-9_23/COVER.

Nadal, C.; Sas, C.; Doherty, G. Technology Acceptance in Mobile Health: Scoping Review of Definitions, Models, and Measurement. *J Med Internet Res* 2020, *22*, e17256, doi:10.2196/17256.

Arkorful, V.E.; Hammond, A.; Lugu, B.K.; Basiru, I.; Sunguh, K.K.; Charmaine-Kwade, P. Investigating the Intention to Use Technology among Medical Students: An Application of an Extended Model of the Theory of Planned Behavior. *J Public Affairs* 2020, doi:10.1002/pa.2460.

Mensah, N.K.; Adzakpah, G.; Kissi, J.; Boadu, R.O.; Lasim, O.U.; Oyenike, M.K.; Bart-Plange, A.; Dalaba, M.A.; Sukums, F. Health Professional's Readiness and Factors Associated with Telemedicine Implementation and Use in Selected Health Facilities in Ghana. *Heliyon* 2023, e14501, doi:10.1016/J.HELIYON.2023.E14501.

Teo, T. Technology Acceptance Research in Education. In *Technology Acceptance in Education*; Teo, T., Ed.; SensePublishers: Rotterdam, 2011; pp. 1–5 ISBN 978-94-6091-487-4.

Ammenwerth, E. Technology Acceptance Models in Health Informatics: TAM and UTAUT. *Stud Health Technol Inform* 2019, *263*, 64–71, doi:10.3233/SHTI190111.

Parreira, P.; Sousa, L.B.; Marques, I.A.; Santos-Costa, P.; Cortez, S.; Carneiro, F.; Cruz, A.; Salgueiro-Oliveira, A. Usability Assessment of an Innovative Device in Infusion Therapy: A Mix-Method Approach Study. *International Journal of Environmental Research and Public Health 2020, Vol. 17, Page 8335* 2020, *17*, 8335, doi:10.3390/IJERPH17228335.

Parreira, P.; Bernardes, R.A.; Santos-Costa, P.; Graveto, J.; Ferreira, P.A.; Salgueiro-Oliveira, A.; Sousa, L.B.; Serambeque, B.; Mónico, L.; Kapun, M.M.; et al. Digital Technology Scale to Coach People with Chronic Diseases: Evidence of Psychometric Validity in Four European Countries. In *Gerontechnology III*; García-Alonso, J., Fonseca, C., Eds.; Lecture Notes in Bioengineering; Springer International Publishing: Cham, 2021; pp. 245–252 ISBN 978-3-030-72566-2.

Parreira, P.; Costa, P.S.; Salgueiro-Oliveira, A.; Ferreira, P.A.; Sousa, L.B.; Marques, I.A.; Bernardes, R.; Kokko, R.; Graveto, J. Nursing Students Digital Competencies for the Self-Management of Patients: Development of the DigiNurse Model's Interface. In *Gerontechnology*; García-Alonso, J., Fonseca, C., Eds.; Communications in Computer and Information Science; Springer International Publishing: Cham, 2019; Vol. 1016, pp. 249–256 ISBN 978-3-030-16027-2.

Beaton, D.E.; Bombardier, C.; Guillemin, F.; Ferraz, M.B. Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures. *Spine (Phila Pa 1976)* 2000, *25*, 3186–3191, doi:10.1097/00007632-200012150-00014.

Terwee, C.B.; Bot, S.D.M.; De Boer, M.R.; Van Der Windt, D.A.W.M.; Knol, D.L.; Dekker, J.; Bouter, L.M.; De Vet, H.C.W. Quality Criteria Were Proposed for Measurement Properties of Health Status Questionnaires. *Journal of Clinical Epidemiology* 2007, *60*, 34–42, doi:10.1016/j.jclinepi.2006.03.012.

Hu, L.T.; Bentler, P.M. Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria versus New Alternatives. *https://doi.org/10.1080/10705519909540118* 2009, *6*, 1–55, doi:10.1080/10705519909540118.

Hu, L.T.; Bentler, P.M. Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria versus New Alternatives.

Structural Equation Modeling 1999, *6*, 1–55, doi:10.1080/10705519909540118.

World Health; Organization, Country office for Bangladesh *WHO Bangladesh Country Cooperation Strategy: 2020–2024*; Dhaka, 2022; ISBN 978-92-9020-947-8.

(PDF) Activity Analysis of Nurses Working in a Teaching Hospital of Dhaka, Bangladesh Available online: https://www.researchgate.net/publication/317521285_Activity_Analysis_of_Nurses_working_in_a_Teaching_Hospital_of_Dhaka_Bangladesh (accessed on 10 May 2023).

Ahmed, S.M.; Hossain, M.A.; RajaChowdhury, A.M.; Bhuiya, A.U. The Health Workforce Crisis in Bangladesh: Shortage, Inappropriate Skill-Mix and Inequitable Distribution. *Hum Resour Health* 2011, *9*, 3, doi:10.1186/1478-4491-9-3.

Ahmed, T.; Rizvi, S.J.R.; Rasheed, S.; Iqbal, M.; Bhuiya, A.; Standing, H.; Bloom, G.; Waldman, L. Digital Health and Inequalities in Access to Health Services in Bangladesh: Mixed Methods Study. *JMIR Mhealth Uhealth* 2020, *8*, e16473, doi:10.2196/16473.

Golz, C.; Peter, K.A.; Müller, T.J.; Mutschler, J.; Zwakhalen, S.M.G.; Hahn, S. Technostress and Digital Competence Among Health Professionals in Swiss Psychiatric Hospitals: Cross-Sectional Study. *JMIR Ment Health* 2021, *8*, e31408, doi:10.2196/31408.

Kasemy, Z.A.; Sharif, A.F.; Barakat, A.M.; Abdelmohsen, S.R.; Hassan, N.H.; Hegazy, N.N.; Sharfeldin, A.Y.; El-Ma'doul, A.S.; Alsawy, K.A.; Abo Shereda, H.M.; et al. Technostress Creators and Outcomes Among Egyptian Medical Staff and Students: A Multicenter Cross-Sectional Study of Remote Working Environment During COVID-19 Pandemic. *Front Public Health* 2022, *10*, 796321, doi:10.3389/fpubh.2022.796321.

Hui, C.Y.; Abdulla, A.; Ahmed, Z.; Goel, H.; Monsur Habib, G.M.; Teck Hock, T.; Khandakr, P.; Mahmood, H.; Nautiyal, A.; Nurmansyah, M.; et al. Mapping National Information and Communication Technology (ICT) Infrastructure to the Requirements of Potential Digital Health Interventions in Low- and Middle-Income Countries. *J Glob Health* 2022, *12*, 04094, doi:10.7189/jogh.12.04094.

Califf, C.B. Stressing Affordances: Towards an Appraisal Theory of Technostress through a Case Study of Hospital Nurses' Use of Electronic Medical Record Systems. *Information and Organization* 2022, *32*, 100431, doi:10.1016/j.infoandorg.2022.100431.

Lucena, J.C.-R.; Carvalho, C.; Santos-Costa, P.; Mónico, L.; Parreira, P. Nurses' Strategies to Prevent and/or Decrease Work-Related Technostress: A Scoping Review. *CIN: Computers, Informatics, Nursing* 2021, *39*, 916–920, doi:10.1097/CIN.0000000000000771.

Konttila, J.; Siira, H.; Kyngäs, H.; Lahtinen, M.; Elo, S.; Kääriäinen, M.; Kaakinen, P.; Oikarinen, A.; Yamakawa, M.; Fukui, S.; et al. Healthcare Professionals' Competence in Digitalisation: A Systematic Review. *J Clin Nurs* 2019, *28*, 745–761, doi:10.1111/jocn.14710.

Carayon, P.; Hoonakker, P. Human Factors and Usability for Health Information Technology: Old and New Challenges. *Yearb Med Inform* 2019, *28*, 071–077, doi:10.1055/s-0039-1677907.

Ayatollahi, H.; Hemmat, M.; Nourani, A.; Saviz, P. Staff and Students' Perceptions about Using Telehealth Technology in a Medical University: A Qualitative Study. *Journal of American College Health* 2022, 1–9, doi:10.1080/07448481.2022.2082842.

Briscoe, G.W.; Fore Arcand, L.G.; Lin, T.; Johnson, J.; Rai, A.; Kollins, K. Students' and Residents' Perceptions Regarding Technology in Medical Training. *Acad Psychiatry* 2006, *30*, 470–479, doi:10.1176/appi.ap.30.6.470.

Risling, T. Educating the Nurses of 2025: Technology Trends of the next Decade. *Nurse Educ Pract* 2017, *22*, 89–92, doi:10.1016/j.nepr.2016.12.007.

PROCEDIMENTOS ÉTICOS

Conflito de interesses: Nada a declarar. **Financiamento**: Esta investigação foi financiada pela Agência Erasmus+, através do seu Programa de Parcerias Estratégicas para o Ensino Superior (número de bolsa 598267-EPP-1-2018-1-FI-EPPKA2-CBHE-JP). **Revisão por pares**: Dupla revisão anónima por pares.