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Positive attitudes toward and perceived importance of wearable display technology as an effective learning tool among nursing students: Turkish validity and reliability study

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Abstract

Objective This research aimed to adapt “Positive Attitudes Toward and Perceived Importance of Wearable Display Technology (PATPIWDT) as an Effective Learning Tool Among Nursing Students” into Turkish and to examine the validity and reliability of its translation.

Methods This methodological study included 698 nursing students recruited via convenience sampling. Construct validity was evaluated using Confirmatory Factor Analysis (CFA) with the Maximum Likelihood (ML) estimation method. Internal consistency was assessed using Cronbach’s Alpha and McDonald’s Omega coefficients.

Results The model demonstrated excellent fit according to the confirmatory factor analysis results. The CFA results for the “Positive Attitudes” subscale indicated a good model fit (CMIN/DF = 4.79, GFI = 0.93, CFI = 0.97, RMSEA = 0.07, SRMR = 0.03). For the “Perceived Importance” subscale, the single-factor structure showed acceptable fit indices (CMIN/DF = 5.82, GFI = 0.98, SRMR = 0.03). As a result of examining the standardized loadings of the items, it was seen that the item factor loadings were 0.40 and above, indicating sufficient factor loading. Cronbach’s alpha coefficients were 0.91 for the positive attitudes subscale and 0.84 for the perceived importance subscale. The respondents also demonstrated an above-average overall score, with a mean of 3.40 (SD = 0.69).

Conclusion The Turkish version of the scale provides a dependable measure of nursing students’ positive attitudes toward wearable screens and how important they consider this technology for future educational use.

Keywords Learning tool, Nursing students, Perceived importance, Positive attitude, Wearable technology, Validity, Reliability

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Introduction

Technological advancements are profoundly impacting learning methodologies in health education. Innovative tools such as wearable display technologies (WSD), augmented reality (AR), virtual reality (VR), and smart wearable devices hold significant potential for diverse applications in nursing education, ranging from theoretical knowledge transfer to clinical skill acquisition [1]. These technologies offer students a pedagogical advantage over traditional education models by providing real-time access, interactive simulations, and experiential learning opportunities in patient care scenarios [2].

Wearable display technologies are particularly salient in this regard, given their wide range of potential applications and opportunities they offer [3]. Notably, the utilisation of this technology, within health education, has demonstrated success even in initiatives requiring its primary application [4, 5]. The extensive accessibility of virtual content presents a viable alternative solution in nursing student education, facilitating the acquisition of skills and enabling clinical repetition. A systematic review has indicated that wearable devices offer a significant opportunity to enhance nursing skills, including physical examinations and medication administration [6, 7]. Another systematic review emphasises that virtual reality glasses provide effective results in students' acquisition of nursing care-related skills [8]. Given these findings, it is evident that while the use of wearable display technologies in healthcare is widespread, there remains a lack of validated measurement tools to quantify this phenomenon.

Regardless of the specific purpose of technology, determining its perceived benefit and ease of use is crucial for student adoption [9]. In this context, a number of measurement tools have been employed in nursing education studies that utilise head-mounted devices to assess the benefit of educational activities. These include the "Simulation Activity Tool" [10], the "Student Satisfaction and Self-Confidence in Learning Scale" [11], the "Virtual Reality Design Scale (VRDS)" [12], and the "Presence Questionnaire" [13]. It is noteworthy that these measurement tools do not include evaluation questions specifically of VR goggles, thereby providing limited information regarding the potential attribution of results to this particular intervention. In light of this information, a valid and reliable measurement tool is needed to evaluate the effectiveness of education using virtual reality technology.

The complex and dynamic nature of nursing education necessitates that students can apply theoretical knowledge swiftly and accurately in a clinical setting [14]. Recent studies have demonstrated that the incorporation of WSD into this process leads to enhancements in students' decision-making skills, an increase in their

self-confidence in clinical settings, and the generation of favorable outcomes concerning patient safety [15, 16]. Furthermore, research indicates that the incorporation of these technologies can aid students in acclimating to emerging technologies in their future careers, thus providing them with the essential skills to advance health-care systems [15]. The present study has been designed to ascertain the validity and reliability of a scale, "(PAT-PIWDT) as an Effective Learning Tool Among Nursing Students," in the Turkish context.

Methods

Design and sample

The population of this methodological study consisted of nursing students in Türkiye. To ensure comprehensive representation, participants were recruited from seven universities, each located in one of Türkiye's distinct geographical regions. The study's inclusion criteria consisted of students who were 18 years of age or older, proficient in Turkish, and enrolled in a nursing program at one of the participating universities for the 2023–2024 academic year. Students who opted to withdraw at any point were excluded. The sample size was determined based on the principle that the number of participants should be at least 10 times the number of items on the scale, with a target of 20 times to establish a stronger structural foundation [17]. Given that the adapted scale consisted of 19 items, a minimum sample size of 380 participants was required. The research was ultimately completed with 698 students.

Instrument

Positive attitudes toward and perceived importance of wearable display technology (PATPIWDT)

The 'Positive Attitudes Toward and Perceived Importance of Wearable Display Technology (PATPIWDT)' scale was adapted into Turkish in this study. The scale's conceptual foundation was established by Frederick and Van Gelderen (2021), and the 19-item version validated by Kim et al. (2023) was used as the reference for this study [18]. To address structural and metric differences, the current study treats the revised instrument not as a single scale with two sub-dimensions, but rather as two distinct measurement scales:

1. **Positive Attitudes Towards Wearable Displays**

Scale: This scale consists of 13 items evaluated on a 5-point Likert scale. Based on the theoretical revision by Kim et al. (2023), this construct is modeled as a three-factor correlated structure representing different device types: general wearable displays (5 items), smart glasses (4 items), and head-mounted displays (HMD) (4 items).

2. Perceived Importance of Wearable Displays Scale:

This is a distinct, single-factor construct comprising 6 items evaluated on a 4-point Likert scale.

The original revised forms of these scales were validated with nursing students. There are no reverse-coded items in either scale, and higher scores indicate a higher level of positive attitude or perceived importance, respectively. Kim et al. (2023) reported satisfactory internal consistency for these independent structures, with a Cronbach's alpha of 0.79 for the positive attitudes scale and 0.93 for the perceived importance scale.

Procedure

Language adaptation and cross-cultural validation

The translation and cultural adaptation of the scales were conducted following a systematic, step-by-step approach based on international guidelines to ensure robust cross-cultural validity:

Step 1: Forward Translation: The original English scales were independently translated into Turkish by seven bilingual health professionals. These translators acted as subject matter experts to ensure the clinical and educational terminology was accurately captured.

Step 2: Synthesis and Reconciliation: The research team meticulously reviewed the seven independent translations. Discrepancies in wording were discussed and resolved through a consensus process among the researchers, resulting in a single, synthesized Turkish version.

Step 3: Back-Translation: To ensure linguistic validity [19, 20], the synthesized Turkish version was back-translated into English by a new group of seven independent bilingual health professionals. These back-translators were blinded to the original English scales. The differences arising from the back-translation were compared with the original items, and the researchers resolved any discrepancies to ensure absolute conceptual accuracy.

Step 4: Expert Committee Review (Equivalence and Content Validity): Based on the feedback from the 14 experts, the content validity of the scales was found to be highly satisfactory. The Item-Level CVI (I-CVI) values for individual items ranged from 0.79 to 1.00. The overall scale-level CVI calculated via the average method (S-CVI/Ave) was 0.89 [21–23]. Furthermore, the universal agreement among experts (S-CVI/UA) was calculated as 0.16 (meaning full consensus was achieved on approximately 16% of the items). Because all I-CVI values exceeded the acceptable threshold of 0.78 for a panel of 14 experts [24], no items were eliminated, and only minor wording adjustments were made to enhance clarity.

Data collection

Study data were collected from volunteer nursing students across Türkiye between March and June 2024. Given the wide geographic scope of the target population, a cross-sectional online survey method was utilized via Google Forms. The survey link was distributed to prospective participants through nursing faculty networks, student communication channels (e.g., WhatsApp groups), and relevant academic social media platforms. The first page of the online form included a detailed informational text explaining the primary purpose of the study, the voluntary nature of participation, and strict guarantees regarding data confidentiality and anonymity. Participants were required to provide digital informed consent by checking a mandatory box stating, 'I agree to participate voluntarily,' before they could access the main questionnaire. Furthermore, to ensure data integrity and prevent duplicate responses, the form settings were configured to allow only one submission per user. On average, the completion of the entire survey took approximately 15 min.

Statistical analysis

The study data were analyzed using SPSS 26.0 and AMOS 24.0 programs. To evaluate construct validity, two independent measurement models were tested using maximum likelihood (ML) estimation. In this study, ML estimation was employed for CFA. Although the scales utilize Likert-type items, ML estimation was deemed appropriate as the data met the assumptions of univariate normality, with skewness and kurtosis values. The skewness values for the 19 items ranged from -2.02 to 0.03 , and the kurtosis values ranged from -0.65 to 2.97 . Although one item slightly exceeded the ± 2 skewness threshold, all values remained within the broader acceptable limits for Maximum Likelihood estimation (skewness $< \pm 3$, kurtosis $< \pm 3$) (25).

Furthermore, literature suggests that ML estimation is robust and provides reliable parameter estimates for Likert-type data when the sample size is sufficiently large ($n > 250$) and the distribution is not severely non-normal. To ensure the stability of the results, local fit diagnostics were examined, and no Heywood cases or anomalous standard errors were observed, confirming the suitability of the ML estimator for the current dataset.

Specifically, a first-order, three-factor correlated model was tested for the Positive Attitudes construct, and a single-factor model was tested for the Perceived Importance construct. The suitability of the data for normal distribution was assessed by examining the skewness and kurtosis of each measurement variable. All standardized skewness and kurtosis coefficients were between -2 and $+2$, confirming that the distribution of the data adhered to normality requirements. The general characteristics

of the participants were analyzed using frequencies, percentages, means, and standard deviations. Overall model performance was evaluated using a combination of fit indicators CMIN/DF, GFI, CFI, TLI, IFI, SRMR, and RMSEA that collectively provide evidence of the model's alignment with the observed data. A model fit is considered acceptable when CFI, GFI, TLI, and IFI values are ≥ 0.90 and RMSEA and SRMR values are ≤ 0.08 [25]. The reliability of the scale was assessed using Cronbach's alpha reliability coefficient.

Results

General characteristics of the participants

The mean age of the students was 21.3 ± 3.0 and 74.6% of the students were female. Approximately one-third of the students were in their first year of study (35.5%). 24.8% of the students stated that they used virtual glasses. The participants' characteristics are present in Table 1.

Confirmatory factor analysis

Positive attitudes toward wearable displays

Confirmatory factor analysis (CFA) was conducted on the "Positive attitudes toward wearable displays" subscale,

which includes items related to wearable displays, smart glasses, and head-mounted displays (HMD) subcategories. The CFA model demonstrated an acceptable goodness of fit, with the following indices: CMIN=297.528, DF=62, CMIN/DF=4.79, $p < .001$, GFI=0.93, CFI=0.97, TLI=0.96, IFI=0.97, SRMR=0.06, RMSEA=0.07. Given the sensitivity of the CMIN/DF ratio to sample size, an acceptable fit value of CMIN/DF < 5 is recommended for studies with a sample size exceeding 250 [26]. The correlations among the latent factors were moderately to strongly positive (General Wearable Displays and Smart Glasses: $r = .33$; General Wearable Displays and HMD: $r = .65$; Smart Glasses and HMD: $r = .36$). The CFA results indicated that the standardized factor loadings varied between 0.41 and 0.93, with all values reaching statistical significance (Table 2; Fig. 1).

Perceived importance of wearable displays

The CFA was performed to test a single-factor measurement model for the "Perceived importance of the wearable displays" scale. Based on modification indices and semantic overlap between the items, residual covariances were added between items 14 and 15, and between items 15 and 16. The initial CFA model for the 'Perceived Importance' construct, without any modifications, showed a poor fit to the data (CMIN/DF=11.63, RMSEA=0.12). The CFA model exhibited an acceptable fit with the following indices: CMIN=40.774, DF=7, CMIN/DF=5.82, $p < 0.001$, GFI=0.98, CFI=0.97, TLI=0.95, IFI=0.97, SRMR=0.03, RMSEA=0.08 after residual covariances. Except for the CMIN/DF ratio, which slightly exceeded the acceptable threshold, all other fit indices were found to be within the acceptable range. The residual covariances between items 14, 15, and 16 were not merely data-driven but were grounded in semantic redundancy. These items share a specific conceptual focus on the clinical utility and educational applications of wearable technologies, leading to overlapping error variance that is unique to the phrasing of these indicators and not fully captured by the general 'Perceived Importance' factor. By accounting for these correlations, the model achieved a more parsimonious and representative structure. Standardized loadings obtained from the CFA fell within the range of 0.60 to 0.74, and each coefficient reached statistical significance (refer to Table 2; Fig. 2). The convergent validity of the scale was assessed using Composite Reliability (CR) and Average Variance Extracted (AVE). All CR values exceeded the 0.70 threshold, and AVE values were generally close to or above the 0.50 criterion, supporting convergent validity (Table 4).

Detailed psychometric properties of the measurement models are presented in Table 2. The standardized factor loadings for all items were substantial and statistically

Table 1 Characteristics of subjects ($n=698$)

Variables	<i>n</i>	(%)
Sex		
Female	521	74.6
Male	177	25.4
Class standing		
1st class	248	35.5
2nd class	144	20.6
3rd class	164	23.5
4th class	142	20.3
Geographic area where students are enrolled in school		
Aegean	115	16.5
Southeast Anatolia	112	16.0
Eastern Anatolia	105	15.0
Black Sea Region	103	14.8
Marmara	102	14.6
Central Anatolia	100	14.3
Mediterranean Region	61	8.7
Playing computer/phone games		
Yes	582	83.4
No	116	16.6
Daily gaming time on computer/phone		
Not playing	116	16.6
Less than 30 min	198	28.4
30 min.–1 h	127	18.2
1–2 h	112	16.0
2–4 h	91	13.0
Over 4 h	54	7.7
Using virtual reality glasses		
Yes	173	24.8
No	525	75.2

Table 2 Positive attitudes toward and perceived importance of wearable display technology items confirmatory factor analysis results (n = 698)

Items								Standardized loadings	S.E	R ²
Positive attitudes toward wearable displays										
Wearable displays										
I_1								0.84	---	0.709
I_2								0.93	0.032	0.870
I_3								0.93	0.032	0.872
I_4								0.93	0.032	0.865
I_5								0.93	0.032	0.870
Smart glasses										
I_6								0.41	0.047	0.169
I_7								0.85	0.044	0.736
I_8								0.93	0.046	0.859
I_9								0.76	---	0.585
HMD										
I_10								0.91	0.041	0.824
I_11								0.92	0.039	0.850
I_12								0.74	0.040	0.549
I_13								0.82	---	0.669
Fitness index	CMIN/DF	GFI	CFI	TLI	IFI	SRMR	RMSEA			
Reference value	≤ 5	≥0.90	≥0.90	≥0.90	≥0.90	≤0.08	≤0.08			
Model	4.79	0.93	0.97	0.96	0.97	0.06	0.07			
Perceived importance of wearable displays										
I_14								0.64	-	0.404
I_15								0.64	0.062	0.411
I_16								0.60	0.074	0.362
I_17								0.72	0.069	0.518
I_18								0.70	0.070	0.484
I_19								0.74	0.077	0.546
Fitness index	CMIN/DF	GFI	CFI	TLI	IFI	SRMR	RMSEA			
Reference value	≤ 5	≥0.90	≥0.90	≥0.90	≥0.90	≤0.08	≤0.08			
Model	5.82	0.98	0.97	0.95	0.97	0.03	0.08			

Abbreviations: HMD, head-mounted display; CMIN/DF, minimum discrepancy per degree of freedom; GFI, goodness-of-fit index; CFI, comparative fit index; TLI, Tucker–Lewis index; IFI, incremental fit index; SRMR, standardized root mean square residual; RMSEA, root mean square error of approximation. S.E. = Standard Error; R² = Squared Multiple Correlation. Dashes (---) indicate parameters fixed to 1.00 for model identification. All loadings are significant at $p < .001$

significant ($p < .001$), with the majority exceeding the recommended threshold of 0.70. Standard errors (S.E.) were found to be within narrow ranges (0.032 to 0.077), indicating high precision in parameter estimation. Furthermore, squared multiple correlations (R^2), representing item uniqueness and reliability, ranged from 0.40 to 0.87 for the majority of items, confirming strong construct validity. To evaluate local fit diagnostics, standardized residual covariances were examined; except for a single marginal value of 2.620 (between items 14 and 16), all residuals were within the acceptable range ($< |2.58|$), indicating no significant local misfit issues that would compromise the overall model integrity.

Reliability

The reliability of the scale was assessed by calculating Cronbach's α internal consistency coefficient. Table 3 presents the corrected item-total score correlation

coefficients for the scale items and the Cronbach's alpha coefficient values if each item were deleted. Upon examination of the corrected item-total score correlations, it was observed that the correlation coefficients of all items ranged from 0.437 to 0.794. Furthermore, the Cronbach's alpha value remained consistent upon the deletion of individual items. Consequently, no scale items were identified as candidates for deletion based on the correlation-based item analysis. The Cronbach's α coefficient for the Positive Attitudes Toward Wearable Screens subscale was calculated as 0.91. The internal consistency values for its subcomponents were 0.96 for wearable screens, 0.82 for smart glasses, and 0.91 for head-mounted displays. Additionally, the Cronbach's α value for the Perceived Importance of Wearable Screens subscale was determined to be 0.84 (see Table 4).

To assess known-groups validity, the total scale scores were compared based on participants' prior experience

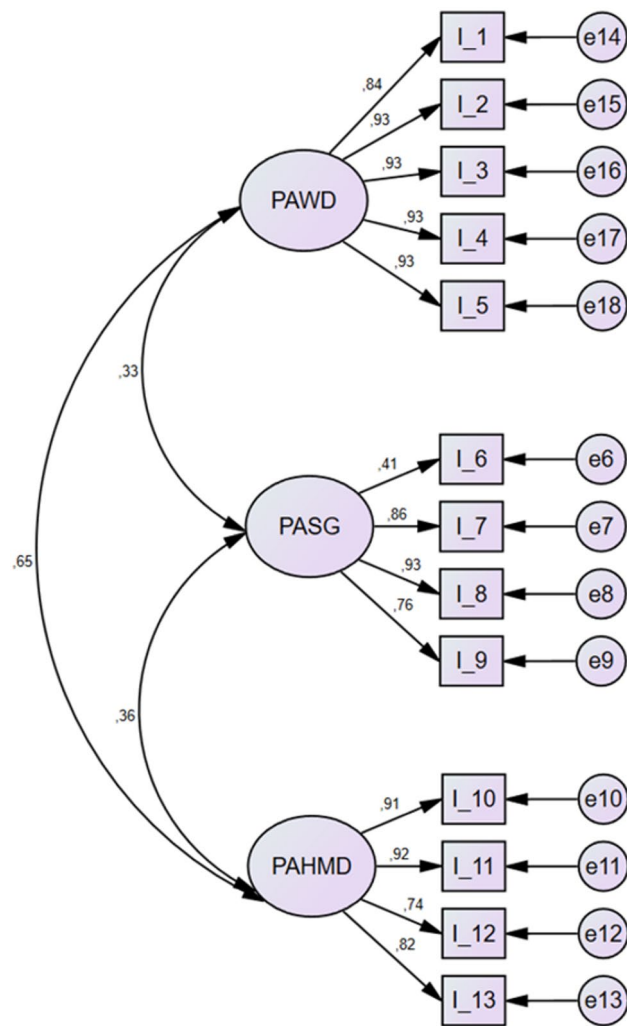


Fig. 1 First-order, three-factor CFA path diagram for the positive attitudes scale

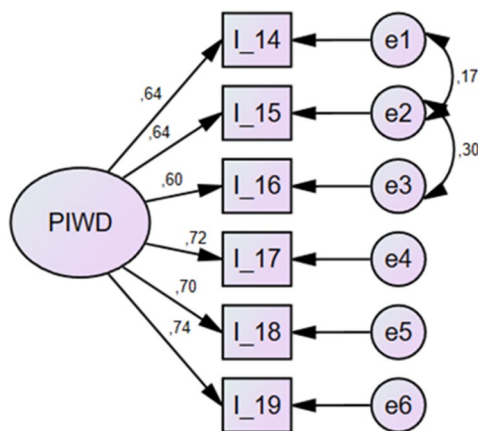


Fig. 2 Single-factor CFA path diagram for the Perceived Importance Scale

Table 3 Total correlations of scale items and Cronbach α values when items were deleted ($n = 698$)

Item analysis of the sub-dimension: Positive attitudes toward wearable displays

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I_1	0.712	0.906
I_2	0.770	0.904
I_3	0.778	0.903
I_4	0.777	0.904
I_5	0.794	0.903
I_6	0.437	0.917
I_7	0.469	0.916
I_8	0.499	0.915
I_9	0.463	0.917
I_10	0.710	0.906
I_11	0.715	0.906
I_12	0.601	0.911
I_13	0.696	0.907

Perceived importance of wearable displays sub-dimension item analysis

I_14	0.614	0.818
I_15	0.656	0.809
I_16	0.603	0.820
I_17	0.620	0.816
I_18	0.602	0.820
I_19	0.630	0.814

with virtual reality (VR) glasses. Although not statistically significant at the $p < .05$ level, students without prior VR experience (Mean = 73.58) reported higher scores than those with prior experience (Mean = 72.10) ($t = -1.916$, $p = .056$). This near-significant trend suggests that the scale is sensitive to experiential differences in technology perception.

To ensure a more robust estimate of internal consistency, McDonald's Omega (ω) coefficients were calculated. The (ω) values were found to be 0.94 for the Positive Attitudes subscale and 0.85 for the Perceived Importance subscale, both exceeding the recommended threshold of 0.70 and confirming high reliability even in the presence of uniform factor loadings.

Nursing students' level of PATPIWDT

The descriptive statistics revealed that the students' positive attitudes varied across the three specific factors. The mean scores for the distinct factors of the Positive attitudes toward wearable displays scale were as follows: General Wearable Displays (3.72 ± 0.77), Smart Glasses (3.32 ± 0.75), and Head-Mounted Displays (3.44 ± 0.73). The overall average score reflecting this multidimensional construct was 3.40 ± 0.69 (Min: 1.08, Max: 5.00). The mean score for the perceived importance of wearable

Table 4 Results of reliability (N=698)

Classification	Subcategory	Number of Items	Cronbach's α	McDonald's Omega (ω)	CR (Composite Rel.)	AVE
Positive attitudes toward wearable displays	Wearable displays	5	0.96	0.96	0.87	0.57
	Smart glasses	4	0.82	0.86	0.78	0.50
	HMD	4	0.91	0.92	0.79	0.49
	Total	13	0.91	0.85		
Perceived importance of wearable displays		6	0.84	0.85	0.79	0.38

Acknowledgment: HMD: Head-mounted display

screens among nursing students is 3.48 ± 0.59 , with a minimum score of 1.50 and a maximum score of 4.00

Discussion

For a measurement tool to be considered appropriate, it must demonstrate both validity and reliability. In this context, the adapted instruments were initially evaluated for content validity. Content validity refers to the extent to which a measurement method comprehensively encompasses all fundamental elements associated with the measured construct [27]. The items underwent expert evaluation, yielding a Content Validity index of 0.89. As the CVI for each item exceeded 0.80, the exclusion of any item was deemed unnecessary [28]

In determining construct validity, independent CFA models were employed, utilizing the factor structures that had been previously verified [29]. The model fit was evaluated by examining key goodness-of-fit indices, including CMIN/DF, GFI, CFI, TLI, IFI, RMSEA, and SRMR values [30]. For the three-factor “Positive attitudes toward wearable displays” scale, the CMIN/DF ratio was 4.79, indicating an acceptable fit. It is recognized that this value is sensitive to sample size; thus, for studies with a sample size exceeding 250, an acceptable CMIN/DF value is typically considered to be less than 5 [26]. The GFI fit value was determined to be 0.93, which is above the acceptable threshold. As the CFI, TLI, and IFI values were all higher than 0.95 (CFI=0.97, TLI=0.96, IFI=0.97), these were valued as indicative of a good fit. Furthermore, SRMR and RMSEA values were found to be within acceptable fit ranges [27, 29]. The fit index values for the “Positive attitudes toward wearable displays” construct of the original scale were similar to those observed in our study [18]. Consequently, the measurement model successfully met the fit index criteria for the “Positive attitudes toward wearable displays” scale

The slightly elevated CMIN/DF ratio (5.82) for the Perceived Importance of Wearable Displays scale raises important considerations regarding its factor structure. If the 6-item single-factor model does not fully capture the construct, it could imply a potential multidimensionality within ‘perceived importance’ that remains latent in the current nursing student sample. For instance, items might differentiate between clinical utility and

educational value, rather than forming a monolithic importance factor. Failure to capture these potential distinct categories could lead to a slight inflation of measurement error or a lack of sensitivity in detecting specific nuances in student perceptions. However, the exceptional absolute fit indices (GFI=0.98, SRMR=0.03) and the high standardized factor loadings (0.60 to 0.74) suggest that even if such nuances exist, the single-factor structure remains a robust and parsimonious representation for this population. To address this, future research should employ larger and more diverse samples to conduct EFA and CFA concurrently, exploring whether a two-factor structure provides a superior fit. Nevertheless, the current results confirm the scale’s utility as a valid screening tool for assessing the overall perceived importance of wearable technologies in nursing education. The original validation of the “Perceived importance of wearable displays” provided model fit in all indices except for χ^2 and RMSEA values [18]

Furthermore, an examination of the standardized loadings of the items revealed that they ranged from 0.41 to 0.93. The literature presents divergent perspectives on the optimal factor loading for an item’s inclusion in a factor. De Vellis and Thorpe (2021) reported a lower acceptable factor loading value of 0.40 [30], while Grove, Burns & Gray (2012) proposed a lower limit of 0.30. As the standardized factor values of the translated scales exceeded 0.40, no items were eliminated. The factor standardized values of the original scale ranged from 0.46 to 0.91 [18]

The reliability was evaluated through the calculation of Cronbach’s α coefficient. The Cronbach’s α coefficient for the multidimensional “Positive attitudes toward wearable displays” scale was found to be 0.91, and for the “Perceived importance of wearable displays” scale, it was 0.84. In comparison, the Cronbach’s α coefficient for positive attitudes in the original study was calculated as 0.79, and for perceived importance, it was 0.93 [18]. Given that the generally accepted value of the Cronbach’s α coefficient is 0.70, these results demonstrate that the current scales exhibit high reliability [31]

The average score representing nursing students’ overall positive attitudes toward wearable display technologies was 3.40 on a 5-point scale, and the mean score for the perceived importance of these devices was 3.48 on a

4-point scale, indicating that both values were above the midpoint. Similarly, in the study conducted by Frederick and Van Gelderen (2021), nursing students regarded smart-glass technology as an important tool for nursing education and healthcare practice [32]. Similarly, the score average in Kim et al.'s (2023) study was higher than the median value [18]. The results of the validity and reliability analyses collectively indicate that the adapted scales are highly valid and reliable measurement tools. Consequently, these adapted instruments can serve as significant tools for evaluating the perceived importance and positive attitudes toward wearable technologies among nursing students. Beyond the statistical validation, the high average scores for both positive attitudes and perceived importance provide substantive evidence of the digital readiness among nursing students [33]. These findings suggest that the current generation of students does not view wearable technology as a mere futuristic concept but as a functional tool for professional development. This psychological receptivity is a critical precursor to successful technology integration in nursing curricula. It implies that students are cognitively prepared for a transition from traditional learning methods to immersive, tech-enhanced educational environments, viewing these tools as essential components of their future clinical competency. The high level of positive attitudes observed in this study can be understood within the specific context of Turkey's rapid digital health transformation. In recent years, the Turkish Ministry of Health has prioritized 'Digital Hospitals' (HIMSS O-EMRAM stages), leading to a healthcare environment where technology is increasingly visible. For Turkish nursing students, who are largely members of Generation Z, technology is perceived as a natural and necessary evolution of their professional identity. Their openness to wearable displays reflects a broader cultural trend in Türkiye—a desire to align national nursing education with global technological standards and a belief that digital tools can mitigate the heavy clinical workloads common in the Turkish healthcare system.

Limitation

This study utilized a convenience sample of nursing students; therefore, the findings cannot be broadly generalized to students in other universities. Although construct validity was supported through confirmatory factor analysis, no baseline assessment was performed to evaluate correlations with conceptually similar measures. To strengthen the reliability and generalizability of the results, future research should employ random sampling across a wider geographic area. Such an approach would provide evidence regarding the stability and validity of the measurement instrument used in the present study. Additionally, while this study provides strong evidence

for the overall factor structure of the scale, measurement invariance across different class years and geographic regions was not evaluated. Future research should employ multi-group confirmatory factor analysis to ensure that the scale items are perceived and interpreted consistently by students from different educational levels and backgrounds. Establishing measurement invariance would further enhance the tool's robustness and generalizability across diverse nursing student populations.

Regarding the psychometric properties, a limitation concerning the temporal stability of the instrument must be acknowledged. Test-retest reliability over a three-week period yielded a weak intra-class correlation coefficient ($ICC = .26$). However, rather than indicating a fundamental flaw, this low value reflects the psychometric nature of the variable. As established in the literature, 'attitude' toward an emerging technology operates as a dynamic, state-like construct rather than a stable trait, making students' perceptions highly susceptible to short-term fluctuations. Finally, the 'Perceived Importance' construct demonstrated borderline fit indices ($CMIN/DF = 5.82$, $RMSEA = .08$) and an average variance extracted (AVE) of .38. While this AVE value is below the strict .50 threshold, the composite reliability (CR) for this construct remained highly acceptable. According to [33], an adequate CR establishes the construct's convergent validity even when AVE is sub-optimal. Nevertheless, future studies could refine these specific indicators to capture a higher proportion of variance.

Conclusion

The present study applied confirmatory factor analysis to assess the construct validity of two instruments designed to measure nursing students' positive attitudes and perceived importance related to wearable display technology as a learning tool in Türkiye. All internal consistency coefficients were above 0.70, demonstrating adequate reliability for each factor. While these results provide initial evidence supporting the use of wearable display technology in nursing education, the borderline fit indices and sampling method suggest a cautious interpretation. Additionally, the current scale provides a practical means of assessing this construct. Consequently, the instrument may offer a baseline for future research within similar educational contexts. Given the limited number of items and the clarity of the content, the instruments are user-friendly. However, there is a need for further research exploring students' awareness and training experiences using these tools in combination with other variables. Moreover, insights obtained from these assessments could potentially inform the design of educational programs aimed at improving attitudes toward such technologies.

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Author contributions

Aydanur Aydin conceived the research topic, wrote the first draft, incorporated feedback, and finalized the manuscript. Sevinç Meşe, Ali Ay, Hale Sezer, Selda Rizalar, Sevil Güler, Ayla Gürsoy contributed to analysis, discussions, and initial ideas for the manuscript, reviewed drafts, provided feedback, and approved the final draft.

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Data availability

The necessary data will be shared upon request from the corresponding author.

Declarations

Ethics approval and consent to participate

Permission to use the “PATPIWDT as an Effective Learning Tool Among Nursing Students” scale developed by Kim was granted through e-mail correspondence. In addition, ethical approval was obtained from the Scientific Research Ethics Committee of a local university (27.03.2024/3, Gumushane University, Ethical Committee), as well as from the administrations of the participating institutions. All students who volunteered to take part in the research provided informed consent. The study was carried out in accordance with the ethical principles outlined in the Helsinki Declaration. To maintain confidentiality and emphasize the voluntary nature of participation—without any influence from instructors—students were asked to complete both the consent form and the online questionnaire independently.

Consent for publication

No identifying images or other personal or clinical information that would compromise the anonymity of participants were presented in this study. Written consent was obtained from participants for the collection of this data.

Competing interests

The authors declare no competing interests.

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