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DEVELOPMENT AND VALIDATION OF SCALE FOR MEASURING ACCEPTANCE OF TECHNOLOGY AMONG UNDERGRADUATE STUDENTS (SMATS)

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ABSTRACT
This study investigates undergraduate students' acceptance of technology through a gender-based lens using the newly developed Scale to Measure Acceptance of Technology Students (SMATS). The research aims to identify key factors influencing technology acceptance. The SMATS originally comprised 40 items across five factors: awareness of use, attitude towards use, willingness to use, satisfaction with technology, and social influence, initially validated by 14 experts. Following expert evaluation, 10 items were discarded due to a content validity ratio below 0.42. A pilot study was conducted to ensure construct validity, with data collected via Google Forms distributed through WhatsApp groups, yielding 107 responses. Exploratory Factor Analysis (EFA) with varimax rotation confirmed the scale's validity, converging on three factors over five iterations. The scale demonstrated high internal consistency (Cronbach's alpha = 0.91). To further validate the internal structure, Confirmatory Factor Analysis (CFA) was performed using AMOS-21. The CFA results indicated that while some fit indices (CMIN/df, PNFI, and PCFI) met recommended thresholds, others (IFI, NFI, CFI, and RMSEA) suggested the need for model refinement. Overall, the findings provide significant insights into technology acceptance among undergraduates and present a robust tool for further research in educational technology acceptance.

Keywords: Technology acceptance, SMATS, awareness, attitude, willingness, satisfaction, social influence, factor analysis; EFA & CFA

INTRODUCTION
In today's digital age, technology has become an integral part of the educational landscape, significantly altering the ways in which students learn, interact, and engage with educational content. The proliferation of digital tools, from learning management systems to virtual classrooms, necessitates an in-depth understanding of how students accept and utilize these technologies. This is particularly important as educational institutions strive to create inclusive and effective learning environments.

Technology plays a crucial role in modern education by enhancing learning experiences and expanding access to educational resources. It enables personalized learning, where educational content can be tailored to meet the individual needs and pace of each student. Interactive tools and multimedia resources make learning more engaging and can help clarify complex concepts. Furthermore, technology facilitates collaboration and communication among students and teachers, breaking down geographical barriers and enabling access to a wealth of information and expertise from around the world. By integrating technology into education, we prepare students for the digital economy, equipping them with essential skills for their future careers.

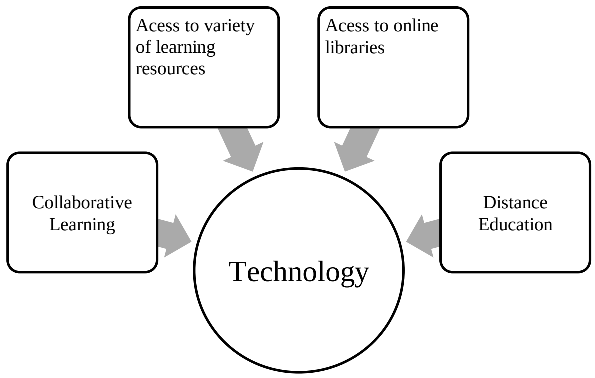

Figure 1
Naunced understanding of Technology in the field of Education

Research indicates that the acceptance and effective use of technology can enhance learning outcomes, increase engagement, and facilitate personalized learning experiences (Venkatesh et al., 2003). However, acceptance of technology is not uniform across all student demographics. Gender differences have emerged as a significant factor influencing technology adoption, with numerous studies reporting that male students often exhibit higher levels of confidence, usage, and positive attitudes towards technology compared to their female counterparts (Gefen & Straub, 1997; Ong & Lai, 2006).

This study seeks to address this need by developing and validating a robust instrument, the Scale to Measure Acceptance of Technology Students (SMATS). The SMATS is designed to capture various dimensions of technology acceptance among undergraduate students, with a particular focus on identifying and analyzing gender differences.

The development of SMATS involved a comprehensive process of item generation and validation. Initially, 40 items were constructed across five key factors: awareness of use, attitude towards use, willingness to use, satisfaction with technology, and social influence. These factors were selected based on an extensive review of existing literature and theoretical models, notably the Technology Acceptance Model (TAM) and its extensions, which emphasize the importance of perceived ease of use and perceived usefulness (Davis, 1989; Venkatesh & Davis, 2000).

To ensure content validity, the items were reviewed by a panel of 14 experts in the fields of educational technology and psychometrics. Items with a content validity ratio below 0.42 were discarded, resulting in a refined set of 30 items. These items were then administered to undergraduate students via an online survey distributed through WhatsApp groups, facilitating a wide and diverse range of responses.

The validation of SMATS involved conducting an exploratory factor analysis (EFA) using varimax rotation to confirm the factor structure and ensure the scale's construct validity. Additional statistical analyses, including the Kaiser-Meyer-Olkin (KMO) measure, Bartlett's Test of Sphericity, scree test, and calculation of total variance explained, were performed to rigorously evaluate the scale's psychometric properties. Internal consistency was assessed using Cronbach's alpha, ensuring the reliability of each factor.

In summary, this study aims to provide a validated tool for assessing undergraduates' acceptance of technology.The findings have significant implications for designing targeted interventions that promote equitable technology use among all students, ultimately enhancing the educational experience in a technology-driven world.

2. LITERATURE REVIEW

The advent of technology in education has ushered in a new era of learning, where digital tools and resources play a pivotal role in shaping educational experiences. Understanding how students accept and integrate these technologies into their learning processes is crucial for educators and policymakers.

Technology Acceptance Models

One of the foundational frameworks for studying technology acceptance is the Technology Acceptance Model (TAM), developed by Davis (1989). TAM posits that perceived usefulness (PU) and perceived ease of use (PEOU) are primary determinants of technology acceptance. Venkatesh and Davis (2000) expanded TAM with the TAM2 model, incorporating additional factors such as subjective norms and voluntariness of use. These models have been instrumental in predicting and explaining user behavior towards technology. Technology Acceptance Model (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) evolved from the Theories of Reasoned Action and Planned Behavior that were introduced in Chapters 4 and 5. This original inception of the Technology Acceptance Model stated that the goal of this theory was to "provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" [Davis et al. 1989, p. 985]. The use of the Technology Acceptance Model has since been expanded to include various other technologies beyond computers, including use of telemedicine services (Kamal, Shafiq, & Kakria, 2020), digital technologies for teachers (Scherer, Siddiq, & Tondeur, 2019), phone apps (Min, So, & Jeong, 2019), and e-learning platforms for students (Sukendro et al., 2020).

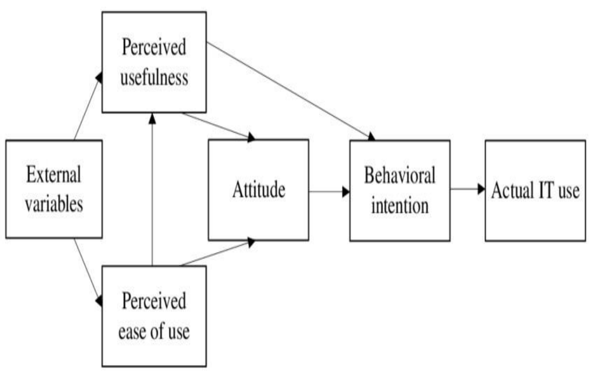

Figure 2

Theoretical Framework

The theoretical framework for this study is grounded in the Technology Acceptance Model (TAM) as developed by Davis (1989), which posits that user acceptance of technology is influenced by perceived usefulness and perceived ease of use. Expanding on TAM, this study incorporates five factors to measure technology acceptance: awareness of use, attitude towards use, willingness to use, satisfaction with technology, and social influence. Awareness of use reflects users' understanding and familiarity with the technology, influencing their perceived ease of use and perceived usefulness. Attitude towards use captures the users' overall affective response to the technology, which is directly influenced by their awareness and experience. Willingness to use represents the users' behavioral intention, a core component of TAM, and is shaped by their attitudes and satisfaction with the technology. Satisfaction with technology evaluates the contentment users feel towards the technology's performance and utility, closely tied to perceived usefulness. Lastly, social influence assesses the impact of peers and organizational culture on users' acceptance, aligning with the subjective norm component of the Theory of Reasoned Action from which TAM is derived. These constructs collectively provide a comprehensive framework to understand and measure the factors driving technology acceptance in this study.

Measurement Instruments in Technology Acceptance Research

Numerous instruments have been developed to measure technology acceptance, each tailored to specific contexts and user populations. For example, Venkatesh and Bala (2008) created the UTAUT questionnaire, which integrates multiple constructs from different acceptance models to provide a comprehensive tool for assessing user acceptance. These instruments typically employ Likert-scale items to capture user perceptions and attitudes towards technology. In the context of higher education, instruments have been adapted to evaluate specific technologies such as learning management systems (LMS) and e-learning platforms, reflecting the unique requirements and experiences of undergraduate students.

Factors Influencing Technology Acceptance

In addition to gender, several other factors influence technology acceptance among students. Awareness of use, attitude towards use, willingness to use, satisfaction with technology, and social influence are critical components that shape students' acceptance levels. Awareness of use refers to the extent to which students are informed about the available technologies and their functionalities. Attitude towards use encompasses the feelings and predispositions students have towards technology, which can significantly impact their willingness to use it.

Willingness to use is a direct measure of students' intention and readiness to engage with technology, often influenced by their attitudes and previous experiences. Satisfaction with technology reflects the contentment students derive from using technological tools, which can enhance or diminish their overall acceptance. Lastly, social influence, the impact of peers, educators, and societal norms, plays a crucial role in shaping technology acceptance, particularly in a collaborative learning environment.

Implications for Educators and Policymakers

Understanding these gender-based differences and the factors influencing technology acceptance can help educators design more inclusive and effective technology-enhanced learning environments. Policymakers can leverage this knowledge to develop strategies and policies that address the unique needs and challenges faced by different student demographics, ensuring that technology integration benefits all students equally.

In conclusion, the literature underscores the complexity of technology acceptance among students, influenced by various factors and moderated by gender differences. By developing and validating the Scale to Measure Acceptance of Technology Students (SMATS), this study contributes to the growing body of knowledge in this field, providing a robust tool for assessing and addressing technology acceptance in educational settings.

4. Methodology

Item Piloting

A preliminary pool of 40 items was developed through an extensive literature review and consultation with experts. These items were intended to assess five dimensions: awareness of use, attitude towards use, willingness to use, satisfaction with technology, and social influence. Fourteen experts in educational technology and psychometrics evaluated these items. Based on their feedback, 10 items were discarded due to inadequate content validity, as determined by a content validity ratio (CVR) below 0.42. This process resulted in a final set of 30 items. Additionally, Linn (2008) recommends creating twice as many items as desired for scale development purposes.

Content validity of SMATS

Before pilot testing the instruments, establishing face and content validity is essential. Therefore, a panel of 14 experts was asked to assess the language suitability and relevance of the items in measuring students' disposition towards technology acceptance. The experts rated each item on Lawshe's (1975) three-point scale: essential, necessary, and unnecessary. Based on their evaluations, 10 items were removed from the initial pool due to low CVR, repetitive concepts, irrelevant content, or confusing statements. The table below presents the content validity ratio of the items and the content validity index of the finalized scale.

Table 1

Content validity estimates

Item NO.	CVR	Item No.	CVR
1	1	16	.71
2	.71	17	.57
3	.71	18	1
4	.57	19	.71
5	.71	20	.71
6	.85	21	.85
7	1	22	.71
8	.85	23	1
9	.71	24	.57
10	1	25	.57
11	.71	26	.85
12	.85	27	.85
13	.85	28	.85
14	1	29	.85
15	.85	30	.85
CVI= 0.80			

Construct Validity

A questionnaire, comprising 30 items retained through expert opinion, was administered to 107 undergraduate students. The survey was conducted using Google Forms and distributed across various WhatsApp groups of students. The sample consisted of 83 female students (77.6%) and 23 male students (21.5%). Exploratory Factor Analysis (EFA) with varimax rotation was initially applied to estimate the number of items converging under three factors.

According to DeVellis (2012), theory, the scree test, and parallel analysis should be used for factorization in scale development. Table 2 outlines the measures for scale development recommended by experts. Additionally, Tabachnick and Fidell (2013) endorse the use of varimax rotation for EFA.

KMO and Bartlett's Test

KMO and Bartlett's test was employed to assess sampling adequacy and significance level to move forward for further statistical operations.

KMO		.825
Bartlett's Test of Sphericity	Approx. Chi-Square	1623.148
	df	406
	Sig.	.000

The value of KMO is estimated at .825 which is greater than the minimum value of .60 (Tabachnick & Fidell, 2013). Similarly, the value of Bartlett's test is significant (0.000 < 0.05) that allows the researcher to proceed further.

Scree Test

The scree test graph determines the number of factors in the data by identifying a cutoff line (Preacher & MacCallum, 2002). The plot suggested a vibrant three-factor solution. However, experts criticize the scree test for its facilitation of subjective judgments, recommending parallel analysis as a more reliable measure.

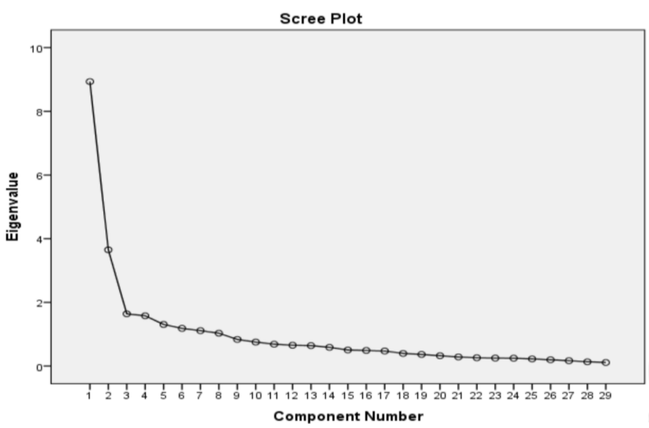

Figure 3
Scree plot presenting three factor solution

Total Variance Explained and Parallel Analysis

Parallel analysis is considered more robust than the scree test because it compares real component eigenvalues with those generated randomly. According to Kline (2013), a component is accepted if its real eigenvalue exceeds the randomly generated one and rejected if the opposite is true. Table 2 illustrates that three components are accepted as their real eigenvalues are higher than the randomly generated ones, while the fourth and fifth components are rejected because their randomized eigenvalues are higher. Moreover, achieving a total variance explained of 75% is essential for retaining factors, although a 50% threshold is also acceptable (Pett, Lackey, & Sullivan, 2003).

Table 2
Parallel Analysis

Sr #	Component Eigenvalue	Random Eigenvalue	Decision	% of Variance	Cumulative%
	8.933	1.439122	**Accepted**	30.804	30.804
	3.650	1.271080	**Accepted**	12.587	43.391
	1.640	1.133047	**Accepted**	5.654	49.045

Reliability Testing

Reliability of the instrument was examined through Cronbach's alpha for each factor. Cronbach's alpha is a suitable method for estimating internal reliability when scoring is polytomous (Linn, 2008). For all components of SMATS, Cronbach's alpha exceeds .75, which is acceptable given Karagoz's (2019) recommendation of a minimum level of .70. The following table 3 presents factor-wise and overall Cronbach alpha, which is 0.91, indicating excellent reliability and high internal consistency.

Table 3
Cronbach's alpha of the scale

Sr.No.	Components	No. of Items	Alpha	Judgement
1	Awareness of use	15	.921	Accepted
2	Attitude Towards use	10	.819	Accepted
3	Intention/ Willingness	4	.718	Accepted
	Overall SMATS	30	.916	Accepted

Rotated Component Matrix

Table 4 shows the rotated component matrix using Varimax rotation, which is preferred for orthogonal rotation due to its ease of interpretation (DeVellis, 2012). This procedure was conducted with value suppression to provide a clearer understanding of the table. The rotated components matrix shows cross-loading differences of less than 0.4. Thus, in line with Tabachnick and Fidell's (2013) recommendation, items with cross-loading differences of less than 0.4 compared to their highest loading on a component should be deleted.

Table 4
Rotated component matrix of SMATS.

Item No.	Components 1	2	3
Q1	**.721**	-.165	.209
Q2	**.724**		.177
Q3	**.654**		
Q4	**.679**	.117	.157
Q5	**.725**	.258	.135
Q6	**.775**	.210	
Q7	**.696**	.213	
Q8	**.695**		.161
Q9	**.723**		
Q10	**.724**		
Q11	**.564**	.286	
Q12	**.608**		.164
Q13	**.662**	.133	
Q14	**.690**	.105	
Q15	**.435**	.196	.215
Q16	.271	**.418**	.149
Q19	.262	**.444**	
Q22	.192	**.440**	.398
Q23	.398	**.496**	
Q24	.108	**.646**	
Q25	-.117	**.743**	
Q26	.134	**.720**	
Q27		**.499**	.169
Q28		**.632**	.284
Q30		**.660**	.240
Q17		.105	**.762**
Q18		.130	**.853**
Q20	.176	.428	**.596**
Q21	.284	.455	**.565**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 6 iterations.

SMATS Amos Graphics

Based on the findings presented in the table, a measurement model was constructed using AMOS-21 to critically confirm the internal factor structure. This model comprises 29 items and 3 components.

The model delineates three factors, each associated with a sufficient number of indicators, aligning with Kline's (2013) recommendation that a minimum of three indicators are necessary to measure a construct. Furthermore, the moderate correlations among the factors suggest unidimensionality and a lack of multicollinearity. In selecting the most appropriate indicators, eigenvalues were considered crucial, with each indicator exhibiting an eigenvalue above 0.40, which surpasses the threshold suggested by Hair, Ringle, & Sarstedt (2010). After reviewing the AMOS graphic for the scale, the next step involves examining the model fit indices.

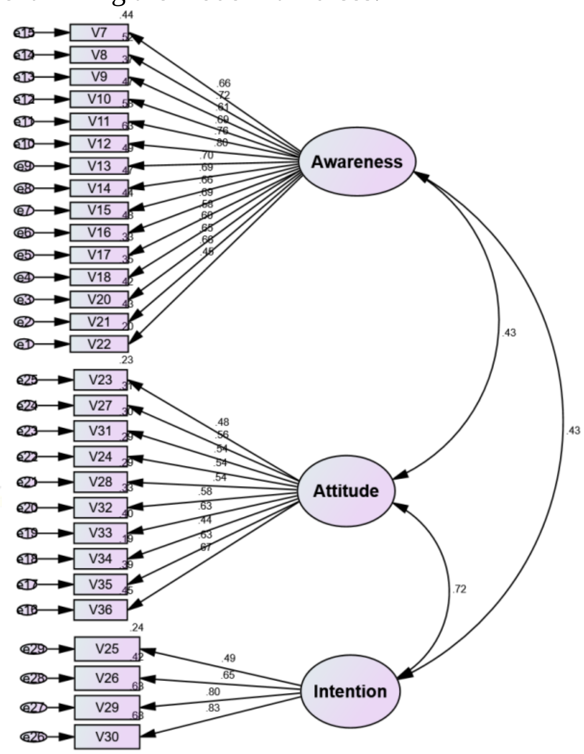

Figure 4 Technology Measurement Model

Model Fit Indices

According to McDonald and Hu (2002), CFI, GFI, NNFI, and NFI are important indices to report, while Kline (2013) emphasizes SRMR, RMSEA, and CFI. Additionally, Basak, Ekmekci, Bayram, and Bas (2013) identify RMR, GFI, AGFIA, NFI, and CFI as key model fit indices. However, Hu and Bentler (1999) caution that these values should not be regarded as rigid standards. For this analysis, the researcher considered CMIN/df, RMR, GFI, AGFI, NFI, CFI, SRMR, and RMSEA as indicators of acceptable model fit. The values for the goodness-of-fit indicators (CMIN/df, RMR, GFI, AGFI, NFI, and CFI) and the badness-of-fit indicators (SRMR and RMSEA) were all within acceptable ranges as per expert recommendations.

Table 4
Goodness and badness model fit indices of the Technology acceptance scale

Sr. #	Indicators	Estimates	Cutt off Value	Reference
1	CMIN/df	1.882	0< CMIN /df	Hair et al. (2010)
2	IFI	.769	>0.90	Hu et al. (1998)
3	PNFI	.524	>0.50	Mulaik et al. (1989)
4	NFI	.609	.90≤NFI≤.95	Basak et al. (2013)
5	CFI	.759	.90≤CFI≤.95	Basak et al. (2013)
6	PCFI	.652	>0.50	Mulaik et al. (1989)
7	RMSEA	.091	.05≤RMSEA ≤.08	Hair et al. (2010)

DISCUSSION

The EFA with varimax rotation effectively validated the factor structure of SMATS, confirming three primary factors: awareness of use, attitude towards use, and willingness to use. The high KMO measure of sampling adequacy and significant Bartlett's Test of Sphericity confirmed the suitability of the data for factor analysis. Suppressing values below 0.3 facilitated a clear and interpretable factor solution, with significant loadings for each item on their respective factors.

The CFA process using AMOS involved several steps to ensure the robustness and validity of the measurement model. The AMOS graphic output provided a visual representation of the model, which was evaluated using multiple fit indices. The CFA results indicated that some indicators (CMIN/df, PNFI, and PCFI) met the recommended thresholds, while others (IFI, NFI, CFI, and RMSEA) suggested the need for further model refinement. The validation of SMATS provided significant insights into the factors influencing undergraduates' acceptance of technology, revealing three key factors: Awareness of Use, Attitude Towards Use, and Willingness to Use.

Awareness of Use

The 'Awareness of Use' factor emphasizes the importance of students' knowledge about technological tools' availability and functionality. This factor's retention underscores that understanding technology's capabilities is crucial for acceptance. This aligns with the Technology Acceptance Model (TAM), which posits that perceived usefulness, influenced by users' awareness, is a key predictor of acceptance (Venkatesh & Davis, 2000).

Educational institutions should enhance students' technological literacy through workshops, orientation sessions, and ongoing training. Integrating technology education into the curriculum can provide hands-on experience, reinforcing students' awareness and competence in using these tools effectively.

Attitude Towards Use

'Attitude Towards Use' emerged as a critical component of technology acceptance among undergraduates. Positive attitudes towards technology significantly influence users' willingness to adopt technological innovations (Teo, 2008). Gender differences in attitudes, with male students often displaying more positive attitudes than female counterparts (Ong & Lai, 2006), highlight the need for targeted strategies to boost female students' confidence and interest in technology. Mentorship programs and a supportive community can help bridge this gap.

Willingness to Use

The 'Willingness to Use' factor indicates that students' readiness and intention to engage with technology are crucial for acceptance. This factor relates to behavioral intention in the TAM and UTAUT frameworks, emphasizing that willingness to use technology strongly predicts actual usage (Venkatesh et al., 2003).

Educational institutions should create a supportive and motivating environment to enhance students' willingness to use technology. This includes providing clear benefits of technology use, integrating technology into mandatory coursework, and offering resources for troubleshooting technical issues.

Implications for Practice and Policy

To enhance students' willingness to use technology, educational institutions should focus on creating a supportive and motivating environment. This can include providing clear benefits of technology use, such as improved academic performance and increased efficiency in completing tasks. Additionally, incorporating technology into mandatory aspects of coursework can ensure that students engage with it regularly, thereby increasing their willingness to use it independently.

Practical steps to foster willingness to use technology can involve integrating technology into the classroom through interactive assignments, digital resources, and online collaboration tools. Encouraging faculty to model effective technology use can also inspire students to follow suit. Providing resources and support for troubleshooting technical issues can reduce frustration and increase students' confidence in using technology.

Further research should explore specific factors influencing students' willingness to use technology in different educational contexts. Longitudinal studies could provide insights into how willingness evolves over time and in response to various interventions. Comparative studies across different demographic groups could identify unique challenges and motivators, enabling the development of tailored strategies to enhance technology acceptance.

In conclusion, the SMATS has proven to be a reliable and valid instrument for assessing undergraduates' acceptance of technology, with significant implications for educational practice and policy. By addressing the factors of awareness, attitude, and willingness, educators can foster a more inclusive and supportive environment that promotes the widespread adoption of technology among students.

The analysis also revealed notable gender differences, particularly in attitudes towards use and social influence. Male students generally exhibited higher levels of acceptance, aligning with existing literature on gender disparities in technology use (Gefen & Straub, 1997; Ong & Lai, 2006). These findings underscore the need for targeted strategies to enhance female students' confidence and engagement with technology, thus promoting a more equitable learning environment. The validated SMATS provides a comprehensive tool for assessing these factors and can guide future educational interventions and policy decisions.

6. CONCLUSION AND SUGGESTIONS

The results from EFA and reliability testing indicate that the scale effectively captures the multi-dimensional nature of technology acceptance, with particular sensitivity to gender-based differences. The CFA results suggested that while some fit indices were within acceptable ranges, others indicated a need for model refinement. Overall, the model demonstrated moderate reliability and validity, providing a basis for further refinement and analysis. Future research should address the identified issues to improve the model's fit and robustness.

The SMATS development process involved expert validation and rigorous statistical analysis, ensuring high content and construct validity. Despite its strengths, the study has limitations, including a sample potentially biased towards tech-savvy students and the cross-sectional design's inability to track changes over time. Future research should explore the longitudinal stability of the SMATS and its applicability across diverse educational contexts.

The analysis revealed notable gender differences in attitudes towards technology, underscoring the need for targeted strategies to enhance female students' confidence and engagement with technology. The validated SMATS provides a comprehensive tool for assessing these factors, guiding future educational interventions and policy decisions. By leveraging these insights, educators and policymakers can create more inclusive and effective technology-enhanced learning environments.

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