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Original Article

Psychometric Properties of the Persian Version of Abbreviated Technology Anxiety Scale: Insights from University Students in Iranian Context

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ABSTRACT

Background: Computer anxiety can significantly impact students' academic performance and technology usage. This study examines the psychometric properties of the Persian Abbreviated Technology Anxiety Scale (ATAS).

Methods: This cross-sectional study was conducted among students from five public and private universities in Hormozgan province, Iran, from October to December 2022. A total of 1158 students were selected to respond to the ATAS (having two dimensions with scores ranging from 11 to 55) and the Computer Anxiety Scale (CAS) (having six dimensions with scores ranging from 22 to 110). The CAS was used to establish concurrent validity with the ATAS. The ATAS underwent expert review, including back-translation and content validation. Structural validity was analyzed through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) using SPSS 25 and LISREL 8.8 software. Reliability was determined using split-half, test-retest, and Cronbach's alpha methods, with a significance threshold of 0.05.

Results: The majority of participants were female (62.5%) and at the undergraduate level (46.5%). The ATAS demonstrated strong content validity, with all items exceeding the required Content Validity Ratio (CVR) and Content Validity Index (CVI) thresholds. A significant positive correlation with the CAS ($r=0.51$, $P<0.001$) supported its concurrent validity. Factor analysis confirmed a two-factor structure—technology change anxiety (23.26±9.15) and technology incompetence anxiety (8.78±3.61)—accounting for 60.9% of the variance. The model's fit indices were acceptable. High reliability was evident, with an overall Cronbach's alpha of 0.96 and subscale ranges from 0.90 to 0.96. Test-retest reliability was 0.88 ($P<0.01$), and split-half reliability scored 0.92 and 0.93 for each half.

Conclusion: The ATAS, with its 11 questions and two dimensions, possesses high validity and reliability. Therefore, it can serve as a credible and dependable tool for assessing technology anxiety and its facets among Iranian students.

Keywords: Computer Anxiety, Psychometrics, Students, Medical, Iran

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Introduction

Technology and computer anxiety are psychological issues that have emerged for many individuals, particularly university students, during the period of rapid advancement in information and communication technology (1-3). Computer anxiety is defined as a negative emotional state that leads to avoidance of using computers and other related technologies (3). According to the available statistics, the prevalence of computer anxiety among university students in the world has been reported between 10 percent (4). In Iran, limited studies have indicated that computer anxiety among university students is higher than the global average and depends on factors such as computer knowledge and skill level, type of field of study, gender, and age (5-7).

Computer anxiety is a serious problem that can have many negative effects on the academic achievement and learning of students (1, 8, 9). People who have computer anxiety usually refrain from using this educational tool, and as a result, they are deprived of learning opportunities and developing computer skills (10, 11). Also, computer anxiety can cause a decrease in self-confidence, an increase in stress, a decrease in creativity and analytical thinking, an increase in errors, and a decrease in the quality of work with computers (3, 12, 13). Therefore, identifying and measuring computer anxiety among university students and the factors affecting it is of great importance.

Several assessment tools have been designed and used to measure computer and technology anxiety among university students. Some of these tools include the Computer Anxiety Scale (CAS) (14), the Computer Anxiety Questionnaire (CAQ), the Computer Anxiety and Confidence Questionnaire (CACQ) (15), the Computer Anxiety and Technology Scale (CATS) (16) and the Computer Anxiety Rating Scale (CARS) (17). These tools are typically based on various theoretical models of computer anxiety and have considered different factors for its measurement. Some of these factors include fear of computer damage, fear of lack of control over the computer, fear of inability to learn computer, fear of negative evaluation by others, fear of failure in working with a computer, and fear of social and economic effects of computer (15, 18). However, these studies have limitations and gaps that need further investigation. These limitations include limited sampling, long and complex tools, lack of attention to cultural and social differences, and lack of validity and reliability assessment of tools in different environments (15, 18).

In 2022, Wilson and colleagues devised a novel questionnaire, the Abbreviated Technology Anxiety Scale (ATAS), to measure anxiety associated with computers and other technologies. Initially, the questionnaire comprised 21 items, grounded in the extant literature and a tripartite theory encompassing anxiety from working with computers, mobile phones, and the internet. Subsequently, through a three-phase refinement process, the number of questions was distilled to 11, aiming to enhance the scale's focus and applicability (18). This questionnaire has acceptable evidence of validity and reliability and correlates with other scales of anxiety and technology (18). This questionnaire has valid and reliable evidence for use in research studies and evaluations. This scale has advantages such as shortness, simplicity, speed and accuracy (18).

The use of modern technologies is constantly on the rise, with new advancements consistently coming to the forefront. Consequently, all segments of society, particularly academic individuals, may encounter the phenomenon of technology anxiety. Therefore, it is necessary to have precise and credible tools to better understand the characteristics of individuals and to work towards alleviating these concerns. This research aimed to validate the ATAS within a large student population in Hormozgan province, Iran, sampling students from universities across diverse fields such as medical sciences, engineering, humanities, and basic sciences.

Methods

Study Design and Setting

This cross-sectional psychometric study aimed to evaluate the factor structure and validity of the ATAS among Iranian university students in Hormozgan province, Iran, from October to December 2022.

Participants and Sampling

In psychometric research and instrument development, it is commonly suggested that a minimum of 10 respondents per item on a questionnaire is necessary to ensure reliable results. Previous studies also recommend a minimum sample size of 200 participants for adequate psychometric validation (19). Accordingly, for the present questionnaire with 11 items, a minimum of approximately 200 samples was required. Based on Comrey and Lee's rule, the sample size for EFA ranges from 50, considered very poor, to 300 as good, 500 as very good, and up to 1000 or more as excellent (20).

The study was conducted among a diverse student population across various disciplines to maximize participant variety. Utilizing Cochran's formula (21) and Karjesi and Morgan's table (22), a sample size of approximately 400 was derived from the total student population of major universities in Hormozgan, Bandar Abbas, about 36,500 students. However, previous research indicates that electronic questionnaires often yield a response rate of approximately 25%. To counter this, an online survey was distributed three times the estimated sample size, targeting 1,200 participants.

The stratified random sampling method was utilized, categorizing the student population into five distinct strata based on university type, including Hormozgan University, Hormozgan University of Medical Sciences, Bandar Abbas Islamic Azad University, Bandar Abbas Payame Noor University, and Bandar Abbas Razavi Non-Profit Higher Education Institute. The sample size and population size for each stratum are shown in Table 1. Data were collected from October to December 2022.

In this study, the inclusion criteria pertained to students enrolled in one of the five universities in Bandar Abbas city and have completed at least one year of their academic program. Additionally, the exclusion criteria applied to students who had not answered more than 20% of the questionnaire items.

Tools/ Instruments

The data collection tools utilized in this study were the ATAS and the CAS.

Q1. Abbreviated Technology Anxiety Scale (ATAS):

Developed by Wilson and colleagues (2023), the ATAS is a self-report measure designed to assess technology anxiety. It comprises 11 items rated on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The minimum possible score on the ATAS is 11, indicating the lowest level of technology anxiety, while the maximum score is 55, reflecting the highest level of anxiety. Validated with a sample of 338 students with varying online course experiences, the ATAS underwent EFA using Principal Component Analysis (PCA) with Oblimin Rotation. The EFA revealed a single-factor structure, accounting for 46.97% of the variance. The scale's internal consistency, as measured by Cronbach's alpha, was 0.892.

Table 1: Sample size and population size for each stratum

Universities	Population (N)	Sample (n)
Hormozgan University	6000	198
Hormozgan University of Medical Sciences	4000	131
Bandar Abbas Branch of Islamic Azad University	15000	493
Bandar Abbas Branch of Payame Noor University	10000	329
Bandar Abbas Branch of Razavi Non-Profit Higher Education Institute	1500	49
Total	36500	1200

Item factor loadings ranged from 0.55 to 0.79, averaging 0.69. The ATAS also demonstrated correlations with established technology and anxiety scales (18). In this study, the ATAS demonstrated content validity with Content Validity Ratio (CVR) values above 0.62, Content Validity Index (CVI) values above 0.79, and a Cronbach's alpha of 0.96, indicating robust internal consistency and sufficient content validity for assessing Online Computer Anxiety (OCA) among students.

Q2. Computer Anxiety Scale (CAS):

Rosen and Weil introduced the CAS in 1995 to measure computer anxiety (23). This 22-item questionnaire employs a five-point Likert scale from 1 (Not at all) to 5 (Very much), with items 4, 5, 15, 16, 19, 20, and 22 reverse-scored. It features three subscales: computer-assisted interactive learning anxiety (11 items), computer-assisted observational learning anxiety (5 items), and technology tool use anxiety (4 items). Scores range from 22 to 110. The CAS has been validated globally, with Cronbach's alpha reported between 0.90 and 0.95 for the overall scale and 0.66 to 0.90 for the subscales. CFA supports the three-factor model's fit (23). In Iran, Rahimi and Yadollahi (2014) standardized the CAS, reporting an alpha of 0.90 for the total scale and 0.59 to 0.79 for the subscales in a sample of 789 high school students. Their CFA affirmed the three-factor structure's suitability for the Iranian context (24). In the current research, the CAS displayed a Cronbach's alpha of 0.92, affirming its reliability.

Translation: With the permission of the original author of the scale, the researchers translated the questionnaire. They used the back-translation method to ensure the translation's accuracy and equivalence. Two translators proficient in English translated the questionnaire into Persian and then back-translated it into English. Additionally, a translator proficient in Persian, whose native language was English, participated in the translation process. After both translators reached an agreement, the researchers received the final questionnaire (25).

Validity and Reliability: Different methods were used to assess the validity of the questionnaire. The following is an explanation of each of these methods.

Content validity: Two standardized indices, the CVR and CVI, were employed to assess the content validity of the questionnaire. These indices were derived from the evaluations of 10 experts across various fields. The panel of experts comprised three psychologists, two psychometricians, two educational technologists, two educational managers, and one counselor, all holding PhD degrees. The acceptable threshold for CVR was determined to be 0.62, as per Lawshe's table and guideline (26). At the same time, the CVI was calculated based on the criteria set forth by Waltz and Bausell, with an acceptable value of 0.79 (27).

Concurrent validity: To measure the concurrent validity, the Pearson and Spearman correlation between the scores of the ATAS and the CAS was calculated using the Pearson and Spearman correlation coefficients.

Construct validity: Construct validity evaluation aims to confirm or reject the hypotheses that one or more latent variables explain a set of observed variables. For this purpose, the factor structure of the questionnaire was examined using two methods, EFA and CFA, in the framework of Structural Equation Modelling (SEM). EFA is a statistical method used to identify the number and content of latent factors that can explain the observed variables. In this study, the Principal Axis Factoring (PAF) method with Varimax rotation was selected to perform EFA. This method uses the correlation matrix method and tries to concentrate the factor loading of each variable on one factor and reduce it on other factors with Varimax rotation. In this method, the factors with eigenvalues greater than one are considered significant (28). Before performing EFA, the sample adequacy and sphericity of the correlation matrix should be ensured. For this purpose, the Kaiser-Meyer-Olkinindex (KMO) and Bartlett's test are used. The KMO index is a measure of sample adequacy that

measures the partial correlation between variables. This index should be above 0.7 to indicate that the sample is suitable (29). Bartlett's test examines the sphericity of the correlation matrix. This test should be significant to indicate that the correlation matrix is not one or unit and there is a possibility of identifying latent factors (19).

CFA is a statistical method that is used to evaluate the fit of a hypothesized factor model with the observed data. In this method, model fit indices such as chi-square, degrees of freedom, p-value, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Normed Fit Index (NFI), Non-Normed Fit Index (NNFI), Standardized Root Mean Square Residual (SRMR), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Akaike Information Criterion (AIC), Incremental Fit Index (IFI), Relative Fit Index (RFI), Critical N (CN), and Parsimonious Goodness of Fit Index (PGFI) are assessed. These indices indicate how well the proposed model matches the observed data and provide standards for evaluating the model's fit.

Internal reliability: The internal reliability of the scale was evaluated using three different methods: split-half correlation coefficient, test-retest correlation coefficient, and Cronbach's alpha coefficient. The acceptable Cronbach's alpha coefficient value was 0.7 or higher (30).

Data Collection

In this study, data collection was conducted using an electronic questionnaire prepared with Google Forms software. A QR code was generated for each questionnaire. Scanning this code with a mobile phone camera led to the Google Forms page associated with the questionnaire. The QR codes for the questionnaires were displayed to the selected students, who were then requested to complete and submit the questionnaire by navigating to the Google Forms page. Additionally, the questionnaire link and the ethical consent form were sent to the mobile numbers and emails of the selected students, which were obtained from the university. The responses from the students were received and stored electronically online. Naturally, prior to commencing the questionnaire, informed consent was secured from the students for their participation in the research.

Data Analysis

Data analysis was conducted using SPSS 25 and AMOS 24 software. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to describe the demographic characteristics of the participants. Inferential statistics including Pearson and Spearman correlation coefficients, EFA, CFA, Cronbach's alpha coefficient, and the test-retest method, were employed to assess the validity and reliability of the questionnaire. A significance level of 0.05 was considered for all tests.

Ethics - Informed consent was obtained from participants before data collection. They were assured that their participation was voluntary and that they could withdraw from the study anytime. They were informed that their responses would be kept confidential and anonymous and would solely be utilized for research purposes. Additionally, it was emphasized that the questionnaires were collected, analyzed, and published anonymously to ensure the participants' privacy. They were encouraged to answer the questions as honestly and accurately as possible.

Results

Demographic Characteristics

Out of the 1200 distributed questionnaires, 1158 students participated in the study. They were classified according to their educational level, gender, age, field of study and marital status. The data shows the frequency and percentage of students in each category. Among the participants, the most prevalent educational level was bachelor's degree, which accounted for 538 (46.5%) of the students. The least prevalent educational level was master's degree and higher, which accounted for 227 (19.6%) of the students. Moreover, the majority of the students were female, which

accounted for 724 (62.5%) of the students. The minority of the students were male, accounting for 434 (37.5%). Regarding age, the most common age group was 20 to 25 years old, which accounted for 542 (46.8%) of the students. The least common age group was less than 20, which accounted for 389 (33.6%) of the students. Regarding the field of study, the largest group of students was the humanities group, which accounted for 509 (44%) of the students. The smallest group of students was the foreign languages group, which accounted for 82 (7.1%) of the students. Regarding marital status, the most frequent marital status was single, which accounted for 825 (71.2%) of the students. The least frequent marital status was married, which accounted for 333 (28.8%) (Table 2).

Inferential analysis

Content Validity

As shown in Table 2, each item has acceptable CVR and CVI values. Specifically, all items have CVR values above 0.62 and CVI values above 0.79, exceeding the minimum content validity threshold (Table 3). This indicates that the ATAS has sufficient content validity for measuring OCA among students (19).

Concurrent Validity

The ATAS questionnaire was administered along with the CAS questionnaire to 186 students to assess the concurrent validity of the ATAS questionnaire. Pearson correlation analysis results showed a positive and significant relationship between the total score

Table 2: Demographic Characteristics of Participants' and Responses to the Questionnaire

		Total (n=1158)	Concurrent (n=186)	Exploratory (n=502)	Confirmatory (n=292)	Reliability (n=178)
		Frequency (Percentage)	Frequency (Percentage)	Frequency (Percentage)	Frequency (Percentage)	Frequency (Percentage)
Educational level	Associate degree	393 (33.90)	69 (37.10)	181 (36.10)	85 (29.10)	58 (32.60)
	Bachelor's degree	538 (46.50)	77 (41.40)	239 (47.60)	143 (49.00)	79 (44.40)
	Post graduate degree	227 (19.60)	40 (21.50)	82 (16.30)	64 (21.90)	41 (23.00)
Gender	Female	724 (62.50)	122 (65.60)	323 (64.30)	164 (56.20)	115 (64.60)
	Male	434 (37.50)	64 (34.40)	179 (35.70)	128 (43.80)	63 (35.40)
Age	Less than 20 years old	389 (33.60)	63 (33.90)	169 (33.70)	99 (33.90)	58 (32.60)
	20 to 25 years old	542 (46.80)	78 (41.90)	248 (49.40)	134 (45.90)	82 (46.10)
	More than 25 years old	227 (19.60)	45 (24.20)	85 (16.90)	59 (20.20)	38 (21.30)
Field of study	Art group	130 (11.20)	22 (11.80)	52 (10.40)	29 (9.90)	27 (15.20)
	Foreign languages group	82 (7.10)	17 (9.10)	24 (4.80)	23 (7.90)	18 (10.10)
	Humanities group	509 (44.00)	81 (43.50)	222 (44.20)	124 (42.50)	82 (46.10)
	Basic sciences group	256 (22.10)	44 (23.70)	110 (21.90)	67 (22.90)	35 (19.70)
	Engineering group	181 (15.60)	22 (11.80)	94 (18.70)	49 (16.80)	16 (9.00)
Marital status	Single	825 (71.20)	132 (71.00)	366 (72.90)	206 (70.50)	121 (68.00)
	Married	333 (28.80)	54 (29.00)	136 (27.10)	86 (29.50)	57 (32.00)

of the ATAS questionnaire and the total score of the CAS questionnaire (r=0.51, P<0.001). Additionally, a positive and significant relationship was observed between each dimension of the ATAS questionnaire, including the online learning environment, technology, and time management, with the total score of the CAS questionnaire (0.31<r<0.47, P<0.001). These results indicate that the ATAS questionnaire has the appropriate concurrent validity for measuring OCA among students.

Exploratory Factor Analysis (EFA)

In this study, the EFA method was used to determine the factor structure of the computer anxiety scale among students of universities in Bandar Abbas. The KMO measure was 0.933, and Bartlett's test was significant (approximate chi-square=3224.228, df=55, P<0.001), indicating an adequate sample size for conducting EFA.

The principal axis factor extraction method with Varimax rotation, complemented by the Scree Plot analysis, identified two factors that accounted for 60.905% of the total variance. The Scree Plot visually demonstrated a clear inflection point, confirming the appropriateness of retaining two factors for our model (Table 4 and Figure 1). The two factors are as follows: the first factor is technology change anxiety, assessed by questions 2, 4, 6, 7, 8, 9, 10 and 11, explaining 49.842% of the total variance. The second factor is technology incompetence anxiety, evaluated by questions 1, 3 and 5, accounting for 11.063% of the total variance (Table 4).

Table 3: Measurement of content validity

Items	Content validity	
	CVR	CVI
Q1. I have little familiarity with technology.	0.8	0.87
Q2. I have low motivation for change and improvement in technology.	0.70	0.77
Q3. I am challenged by using technology.	0.70	0.77
Q4. Technology creates new opportunities for my growth and learning.	0.90	0.87
Q5. I need guidance and support when using technology.	0.70	0.87
Q6. I can improve my skills by using technology.	0.90	0.83
Q7. Technology increases my efficiency and productivity.	0.90	0.8
Q8. I am interested in exploring and experimenting with new technology tools and applications.	0.80	0.80
Q9. I have many learning opportunities with technology.	0.90	0.83
Q10. Using technology challenges me and motivates me to put in more effort.	0.70	0.80
Q11. Technology forces me to use creative solutions and solve problems.	0.80	0.83
Total	0.80	0.82

Table 4: Rotated Component Matrix for the Study Items (Factor Loadings)

Items	Extraction	Technology Change Anxiety	Technology Incompetence Anxiety
Q2	0.54	0.78	
Q4	0.62	0.80	
Q6	0.64	0.77	
Q7	0.64	0.78	
Q8	0.64	0.78	
Q9	0.64	0.78	
Q10	0.64	0.78	
Q11	0.62	0.76	
Q1	0.50		0.69
Q3	0.55		0.73
Q5	0.65		0.72

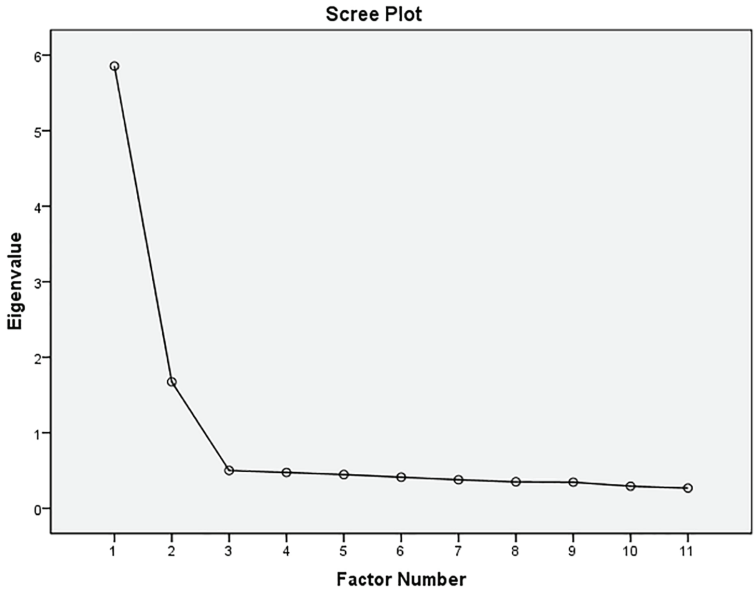

Figure 1: Scree Plot based on Exploratory Factor Analysis

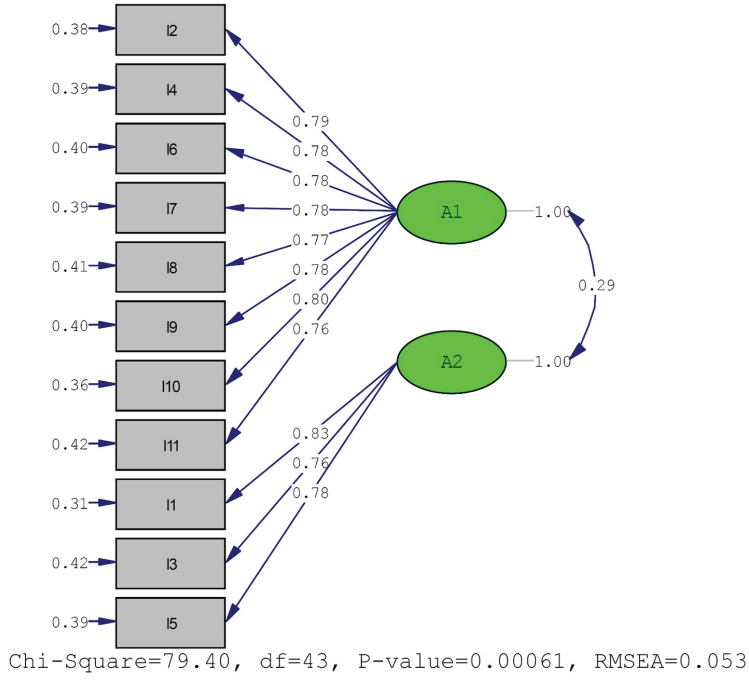

Figure 2: Confirmatory Factor Analysis results

Confirmatory Factor Analysis (CFA)

The CFA results showed that the two-factor model had a good fit with the data, as indicated by the following fit indices: SRMR=0.030 (less than 0.08), RMSEA=0.053 (less than 0.06), CFI=0.99 (more than 0.95), NFI=0.98 (more than 0.95), GFI=0.95 (more than 0.90), AGFI=0.93 (more than 0.90) and Minimum Discrepancy Function divided by Degrees of Freedom (CMIN/DF)=1.85 (less than 3) (31). Figure 2 also shows the model's consistency with the data, indicating that the data supports the two-factor model.

Reliability

The Cronbach's alpha coefficient for the whole scale was 0.96, and the two factors of anxiety due to technology change and anxiety due to technology incompetence were 0.90 and 0.96, respectively. All items

Table 5: Reliability and correlation of the scale and its sub-scales

Scale or Sub-scale	Cronbach's Alpha
Whole questionnaire	0.96
First half of the test	0.92
Second half of the test	0.93
Factor 1: Technology change anxiety	0.90
Factor 2: Technology incompetence anxiety	0.96

correlated positively and significantly with a scale score of 0.70 to 0.86 (P<0.01). The split-half reliability for the first half (four questions) was 0.92, and for the second half (three questions) was 0.93; the correlation between them was 0.88 (P<0.01) (Table 5). Deleting any item from the scale did not cause a noticeable change in the alpha coefficient, indicating no need to delete any item.

Discussion

In the context of content validity, the technology anxiety scale possesses sufficient validity for measuring technology anxiety among students. This demonstrates that the scale items can encompass technology anxiety and align with the research objective. This finding agrees with the original study's results, where the authors validated the content of their scale using expert judgment (18). Furthermore, the obtained CVR and CVI values in this research exceed the minimum thresholds established by Waltz and Bausell, and Lawshe for content validity, indicating the reliability and appropriateness of the scale for measuring ATAS among students. For instance, the CVI values derived from the Waltz and Bausell method are based on scores of 3 and 4 for high relevance, which in our study are above 0.79 for all items (27, 32, 33). Similarly, the CVR values calculated according to Lawshe's method represent a valid content ratio for each item, and in our research, these values are above 0.62 for all items (26, 34, 35). These comparisons further validate the content validity of our scale and reinforce its credibility in measuring online technology anxiety among students.

In this study, the concurrent validity of the Technology Anxiety Scale (TAS) was assessed using the correlation method with the CAS, which is a valid scale relevant to the research topic. The results of the Pearson correlation analysis indicated a positive and significant relationship between the total scores of the TAS and CAS questionnaires (r=0.51, P<0.001). Additionally, a positive and significant relationship was observed between each dimension of the TAS questionnaire, including the online learning environment, technology, and time management, with the total score of the CAS questionnaire (0.31<r<0.47, P<0.001). These results suggest that the TAS questionnaire has suitable concurrent validity for measuring OCA among students (36). According to existing standards, concurrent validity is acceptable when a positive and significant correlation exists between the new measurement tool and a valid criterion (34). In this study, a correlation coefficient of 0.51 indicates a moderate relationship, which can indicate acceptable concurrent validity (34, 37). Given that correlation coefficients above 0.3 are considered significant, it can be said that the level of concurrent validity of this research falls into the "good" category. These results are consistent with the findings of the researchers of the original article who examined the concurrent validity of their scale using the correlation method with other scales of anxiety and technology (18, 38, 39).

According to the factor analysis results, the technology anxiety scale consists of two factors, which are technology change anxiety and technology incompetence anxiety. These two factors explain 60.905 percent of the total variance. This finding is different from the finding of the authors of the original article who found one factor for their scale (18). This difference may be due to cultural, demographic and sampling differences

between the two studies. While the original article only sampled undergraduate students, the current research considered all university academic levels. Also, Iran has less access to technology than the country where the study was conducted, namely the United States. Iran is deprived of access to new technologies and educational sites due to sanctions and filtering. In addition, English, which is the scientific language of the world, is another obstacle for Iranian students, which causes them to have more anxiety than students in the United States. In the following, each of the dimensions will be discussed.

Technology change anxiety: This dimension refers to worry and uncertainty when dealing with technological changes and innovations. People with this dimension have little motivation for learning and improving technology skills and refrain from trying new technology tools and applications. This dimension is consistent with dimensions such as anxiety about change, anxiety about innovation and anxiety about digitization in other technology anxiety questionnaires (40-42).

Technology incompetence anxiety: This dimension refers to the inability and lack of skill in using technology. People with this dimension do not consider themselves familiar and proficient in technology and need guidance and support. This dimension is consistent with dimensions such as computer anxiety, artificial intelligence anxiety and technology anxiety in other technology anxiety questionnaires (41, 42).

These two dimensions are crucial in measuring technology anxiety, since technology anxiety can have a negative impact on behavior, learning and performance of people in technology-oriented environments. For instance, people who have anxiety about technology change may avoid participating in online training courses or escape from online exams. People who have anxiety about technology incompetence may lag in using technology tools for communication, collaboration and problem-solving or blame themselves for technology errors due to lack of mastery. Therefore, identifying and measuring these two dimensions can help design and implement educational and intervention programs to reduce technology anxiety and enhance individuals' proficiency and confidence in utilizing technology.

In the context of reliability, the technology anxiety scale exhibits a very high level of reliability for measuring technology anxiety among students. This demonstrates that the scale possesses high repeatability and stability, and random factors do not influence its results. These findings are consistent with the original article, where the authors evaluated the reliability of their scale using Cronbach's alpha coefficient and the split-half method (18). In this study, Cronbach's alpha coefficients were found to be 0.96 for the overall scale and 0.90 and 0.96 for the two factors of anxiety due to technology change and anxiety due to technology incompetence, respectively. These coefficients not only exceed the recommended minimum standard but are also classified as "excellent" in conventional categorizations (43). These high values indicate high consistency among the scale items and likely measure the same underlying concept (44). This confirms the validity and effectiveness of the technology anxiety scale as a measurement tool among Iranian students.

Limitations and Suggestions

This research involved a substantial sample of students, encompassing 1,158 participants across various educational levels, genders, ages, fields of study, and marital statuses. This diversity has enabled us to obtain comprehensive and valid data regarding technology anxiety among students. Additionally, the results of our statistical analyses indicate acceptable content and concurrent validity for the ATAS questionnaire, affirming the strength of the tool used in this study.

However, the study has its limitations. Firstly, it was solely conducted on students from universities in Bandar Abbas, which may not reflect the experiences of students in other

regions or countries. Secondly, due to sanctions and access restrictions to new technologies and educational websites in Iran, the results obtained may be influenced by these specific conditions, affecting the generalizability of the findings to other societies.

For future research, it is recommended that similar studies should be carried out in different geographical areas with varying access to technology to enhance the generalizability of the results. Furthermore, exploring the impact of technology education and psychological support on reducing technology anxiety and increasing students' confidence in using new technologies could be an intriguing research subject.

Conclusion

This study aimed to investigate the ATAS's psychometric properties in university students of Bandar Abbas City. The results showed that the ATAS has adequate content and concurrent validity for measuring student technology anxiety. The results also revealed that the ATAS has a two-factor structure, consisting of technology change anxiety and technology incompetence anxiety, which explains 60.905 percent of the total variance. This finding is different from the original one-factor model of the ATAS, which may indicate some cultural, demographic and sampling differences between the two studies. The results also indicated that the ATAS has high reliability, as measured by Cronbach's alpha coefficient, split-half method, and test-retest method. The ATAS can serve as a valid and reliable tool for assessing technology anxiety and its dimensions in Iranian students.

Abbreviations

ATAS: Abbreviated Technology Anxiety Scale
CAS: Computer Anxiety Scale
CAQ: Computer Anxiety Questionnaire
CACQ: Computer Anxiety and Confidence Questionnaire
CATS: Computer Anxiety and Technology Scale
CARS: Computer Anxiety Rating Scale
EFA: Exploratory Factor Analysis
CFA: Confirmatory Factor Analysis
PCA: Principal Component Analysis
CVR: Content Validity Ratio
CVI: Content Validity Index
OCA: Online Computer Anxiety
KMO: Kaiser-Meyer-Olkin
RMSEA: Root Mean Square Error of Approximation
CFI: Comparative Fit Index
NFI: Normed Fit Index
NNFI: Non-Normed Fit Index
SRMR: Standardized Root Mean Square Residual
GFI: Goodness of Fit Index
AGFI: Adjusted Goodness of Fit Index
AIC: Akaike Information Criterion
IFI: Incremental Fit Index
RFI: Relative Fit Index
CN: Critical N
PGFI: Parsimonious Goodness of Fit Index

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Authors' Contribution

SMR wrote the manuscript, KHA performed the statistical analysis and validation, and KHA and AA approved the final revision.

Conflict of Interest

None declared.

Ethical Considerations

This study was carried out in compliance with ethical standards and with the approval of the Research Ethics Committee of the Islamic Azad University of Bandar Abbas (registration

number IR.IAU.BA.REC.1402.003). The research samples were obtained with the informed written consent of the participants, ensuring their safety throughout the study. The research methodology was also designed and implemented in accordance with the university's rules and regulations.

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Availability of Data and Materials

The data supporting the findings of this study are available upon request from the corresponding author. Due to privacy and ethical considerations, the data are not publicly accessible. The Persian version of the Abbreviated Technology Anxiety Scale (ATAS) is accessible in the supplementary file.

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