

Measuring Online Learning Stress: Psychometric Validation of a Scale Tailored for Iranian Students

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ABSTRACT

Background: Academic stress in online education is a growing concern across different educational and cultural contexts. Given the increasing need to assess academic stress accurately in diverse student populations, this study aimed to validate the Online Learning Stress Scale (OLSS) for high school students in Iran, ensuring the tool's applicability in measuring academic stress during online classes.

Methods: This descriptive psychometric study validated the Persian-translated OLSS among Iranian high school students. The sample included students from 18 high schools in Kerman City, Iran, who were engaged in online learning from February to March 2022. Cluster sampling was employed, selecting three classes per school. Data were collected via Google Forms, using OLSS and the High School Stress Scale (HSSS), with the final 1251 valid participant responses. Validity and reliability assessments involved content validity, concurrent validity with HSSS, Exploratory and Confirmatory Factor Analyses (EFA and CFA), and internal reliability testing. Analyses were conducted using SPSS 18 and Lisrel 8.8 software.

Results: The Content Validity Ratio (CVR) ranged from 0.80 to 1.00, and the Content Validity Index (CVI) varied between 0.83 and 0.97. Concurrent validity was established with a significant correlation coefficient (r) of 0.651 at a significance level of $P < 0.001$ with the HSSS, confirming the OLSS's capability to measure academic stress. EFA identified four factors accounting for 62.272% of the variance, aligning with the original scale's dimensions. CFA indicated a good fit with all factor loadings above the 0.40 threshold. Additionally, the OLSS exhibited high reliability, with a Cronbach's alpha of 0.935.

Conclusion: The OLSS is a dependable tool for assessing academic stress in online educational environments. In Iran's unique context, this tool can facilitate the understanding and management of students' academic stress, thereby enhancing educational strategies and promoting student well-being.

Keywords: Academic Stress, Online Learning, Psychometrics, Students, Iran

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Introduction

Academic stress, recognized as one of the most significant psychological challenges for students worldwide, refers to the worrisome and anxiety-inducing experiences stemming from educational pressures and high-performance expectations (1). The American Psychological Association (APA) defines stress as the physical, emotional, and psychological response of the body to demands presented by oneself or others (2). This type of stress can have considerable effects on the mental and physical health of students. Various factors, such as social pressures, educational environments, and personal issues, play a role in its development (3-5).

The prevalence of academic stress among students is also noteworthy (6). Research indicates that over 50% of students aged 7 to 19 exhibit signs of anxiety disorders (6-8). The consequences of academic stress can manifest as anxiety, depression, decreased academic performance, and even physical problems like insomnia and headaches (9). Addressing this concern necessitates both preventive measures and therapeutic interventions to alleviate its adverse effects on students' lives (9).

The COVID-19 pandemic and the sudden shift to online learning created a fundamental change in the global education system (10). The rapidly spreading disease led schools and universities to close their doors to protect the health of students and staff (11). Consequently, traditional in-person education, previously known as the educational standard, gave way to online formats (12). This abrupt and unprepared transition brought numerous challenges for students, teachers, and parents (13).

Students accustomed to learning in classroom environments suddenly found themselves in a situation where they had to absorb course material using new technologies without the physical presence of teachers and classmates (14, 15). This change, in addition to creating technical issues and internet access problems, could lead to psychological effects such as feelings of isolation, decreased motivation, and

increased stress (16, 17). Teachers with less experience using online tools were forced to rapidly change their teaching methods and redesign educational content to be compatible with online formats (18, 19).

This change extended beyond the classroom, profoundly affecting the social structure and relationships between students. Different countries faced varying challenges (17). On the other hand, the importance of e-learning in the educational system has become increasingly evident, as it offers flexibility, accessibility, and the potential for personalized learning experiences. Consequently, comprehending the stress associated with online learning in the post-COVID context is essential for formulating effective strategies aimed at enhancing students' mental health and academic achievement within this evolving educational environment.

In Iran, despite considerable efforts to uphold educational standards amidst challenging circumstances, reliable and valid instruments are scarce for evaluating academic stress among students engaged in online learning. This deficiency in appropriate assessment tools hinders the ability of researchers and educators to comprehend and address students' academic stress effectively. Therefore, developing and standardizing tools that can accurately measure academic stress in these new conditions is a primary priority in the field of education and educational psychology in Iran.

In the context of high school students, various tools exist for assessing academic stress, each with its advantages and limitations. The Student Academic Stress Scale (SASS) (20), the Educational Stress Scale for Adolescents (ESSA) (21), and the Student Stress and Anxiety Scale (SSAS) (22) are among these tools designed to measure academic pressures, parental expectations, and competition among classmates. However, these tools may have limitations in covering all aspects of stress related to online learning or in different cultural contexts. Therefore, the development and standardization of new tools

capable of accurately measuring academic stress in diverse cultural and educational conditions are essential, especially for Iranian students facing unique challenges during online learning.

The Online Learning Stress Scale (OLSS), as a novel tool, has been designed to assess stress in the context of online learning among middle school students. This 20-item Likert scale questionnaire was developed by a team from the University of the Philippines Diliman and the Institute of Science Education of the Ministry of Science and Technology. The advantages of this scale include high content validity, strong internal consistency, and structural validity confirmed through Exploratory Factor Analysis (EFA) (23).

This research aimed to validate the OLSS scale among high school students in Kerman City, Iran, to improve learning conditions, reduce obstacles, and provide new perspectives on academic stress. By offering a valid tool for assessing academic stress in online learning conditions, this study seeks to enhance educational strategies and reduce stress for students. The validated OLSS can help educators and psychologists accurately identify and measure academic stress, allowing for better-targeted interventions. Ultimately, this can lead to improved educational strategies and reduced stress levels, enhancing the overall well-being and academic performance of students in online learning environments.

Methods

Study Design and Setting

This descriptive study utilized psychometric and validation methods to examine the factor structure and validity of the OLSS scale among Iranian students from 18 high schools in Kerman City, Iran, from February to March 2022. Initially developed by a team from the University of the Philippines Diliman and the Science Education Institute of the Department of Science and Technology for high school students, the scale was translated into Persian using direct and back translation methods

to ensure accuracy and cultural relevance without the mediation of another language like English (24). This method has been validated in previous studies and deemed appropriate for this research.

Participants and Sampling

The target population for this study included ninth-, tenth-, and eleventh-grade high school students who participated in online learning from February to March 2022 in public high schools in Kerman City, having at least two semesters of online education experience, and consented to participate in the study. Participants who did not complete more than 20% of the questionnaire would be excluded. The sample size was determined based on criteria identified in the literature review regarding the required samples for validation studies. The minimum sample size for assessing concurrent validity depends on the type of study and the tools used. Generally, for evaluating concurrent validity, a minimum of 100 to 200 participants is recommended. This number can be increased depending on the complexity of the tools and the number of variables under investigation. In this study, 250 participants were considered for concurrent validity (25-27). For the EFA, Kyriazos (2018) suggests a minimum of 20 participants per item, resulting in 500 participants to enhance the study's validity (28). For Confirmatory Factor Analysis (CFA), the sample size ranged from 200 to 1000 participants, which was set at 300 for this study (28, 29). The minimum sample size for assessing reliability using Cronbach's alpha depends on the type and complexity of the questionnaire. Generally, it is recommended that for calculating Cronbach's alpha, the questionnaire should initially be distributed to a small sample of 30 to 50 participants to ensure its preliminary reliability. This number can be increased depending on the complexity of the questionnaire and the number of items. In this study, 250 participants were considered for the concurrent validity (30, 31). In total, over 1300 participants were selected as the final sample for the study.

Cluster sampling technique was used to select participants. First, District 1 was randomly selected from the two educational districts of Kerman City (two numbered balls, 1 and 2, were placed in a black bag, and one ball was drawn to select the district). Then, nine boys' high schools were randomly selected from the 21 available schools (21 numbered balls, 1 to 21, were placed in a black bag, and nine balls were drawn sequentially to select the schools). Similarly, nine girls' high schools were randomly chosen from a pool of 19 available schools (19 numbered balls, 1 to 19, were placed in a black bag, and nine balls were drawn sequentially to select the schools). Overall, a total of 18 boys' and girls' high schools were randomly selected from the educational districts within the city. From each selected school, three classes (one from each of the ninth-, tenth-, and eleventh-grades) were randomly selected from the available classes (the classes of each grade were numbered, and balls corresponding to the number of classes were placed in a black bag; one ball was drawn to select the class for each grade). All students present in the selected classes were included in the sample.

Ethics - This study was approved by the Ethics Committee of Islamic Azad University, Bandar Abbas Branch, Iran, and conducted in accordance with the Helsinki Declaration principles (32). Informed consent was obtained from all participants, who were fully informed about the study's objectives, methods, and their right to withdraw at any time. Privacy and data confidentiality were strictly maintained. Strategies to prevent potential conflicts of interest were developed and implemented, ensuring the study adhered to the highest ethical standards.

Tools/Instruments

Online Learning Stress Scale (OLSS): The OLSS is a 20-item Likert scale questionnaire, ranging from 1 (never) to 5 (always), developed by Crispino and colleagues (23) from the University of the Philippines Diliman and the Science Education Institute of the Department of

Science and Technology. It is designed to assess stress levels in students aged 11 to 17 years old. The scale evaluates stress across four dimensions: Physical Health with seven items (scores ranging from 7 to 35), Task Management with six items (scores from 6 to 30), Valuing with four items (scores from 4 to 20), and Relating to Oneself and Others with three items (scores from 3 to 15). The total scale scores vary from 20 to 100, with higher scores indicating increased stress levels.

Validity and Reliability - The scale's validity and reliability have been meticulously tested. Content validity was confirmed by field experts, with the Item Content Validity Index (I-CVI) for all items exceeding 0.78, indicating excellent content validity. Reliability was assessed using Cronbach's alpha, which showed an overall internal consistency of 0.923. The alpha coefficients for the individual dimensions were also high, demonstrating the scale's robustness. The scale underwent a comprehensive development process, including a review of relevant literature, expert evaluation, pre-testing, and EFA. The EFA resulted in a four-factor model that explained 62.406% of the variance. Measurement invariance tests have confirmed that the scale consistently assesses the same underlying constructs across various demographic groups, enabling valid comparisons of stress levels (23).

High School Stress Scale (HSSS): Developed by Barnett and Fanshaw in 1997, the HSSS is a self-report measure designed to assess academic stress among high school students. The questionnaire consists of 35 items across nine subscales, which include: Teaching Methods (3 items, questions 1-3), Teacher-Student Relationships (2 items, questions 4-5), School Workload (5 items, questions 6-11), School Environment (5 items, questions 12-16), Vulnerability (4 items, questions 17-20), Personal Organization (6 items, questions 21-26), Striving for Independence (3 items, questions 27-29), Future Anxiety (4 items, questions 30-33), and Parental Connection (2 items, questions 34-35). Items are rated on a 7-point Likert

scale, ranging from 1 (no problem) to 7 (very big problem), indicating the level of stress. The total score can range from 35 to 245, with higher scores indicating greater levels of stress (33). In Iran, this scale has also been validated, with the results of EFA indicating that the scale comprises nine dimensions explaining 55.79% of the variance.

Furthermore, the concurrent validity of this questionnaire was significant through its correlation with the General Health Questionnaire (GHQ-28), amounting to 0.654 at a significance level of $P < 0.001$.

The Cronbach's alpha coefficient for the overall high school stress score was determined to be 0.78 (34). In the present study, the Cronbach's alpha for the HSSS scale was found to be 0.94.

Translation and Cultural Validation

Following the acquisition of consent from the original developer of the survey tool, the research team implemented a bidirectional translation and cultural adaptation process. This process involved an initial translation of the tool into Persian, followed by a back-translation into English, using a standard kit to verify the translation and assess cultural relevance. The translation team included two individuals proficient in English who performed the initial and reverse translations. Additionally, a native English linguist with advanced proficiency in Persian contributed to the translation process. Following the establishment of consensus among the translators, the final version of the survey was generated. To further ensure cultural appropriateness and clarity of the survey content, two individuals with bilingual and bicultural backgrounds were employed to review and provide critical feedback on the survey items. Their insights were instrumental in confirming the accuracy and comprehensibility of the translation for the target population. Subsequent revisions to the survey were made based on the feedback received, thereby enhancing the overall validity of the tool and its applicability to the study population (24).

Validity and Reliability - The content validity was assessed using the Content Validity Index (CVI), which quantifies the proportion of content experts who concur on the relevance of each item, and the Content Validity Ratio (CVR), which evaluates the level of consensus among experts regarding the necessity of each item. CVI is calculated by dividing the number of experts who rate an item as relevant by the total number of experts (35). A CVI greater than 0.79 indicates strong content validity (30). CVR was calculated using the following formula: $CVR = ((n_e - N/2) / (N/2))$, where (n_e) is the number of experts who consider an item essential, and (N) is the total number of experts (36). Items with a CVR greater than 0.62 were accepted without hesitation, while items below the set threshold were removed from the tool (37, 38). This process utilized the expertise of a panel of ten specialists in related fields. This panel included three psychologists, four psychometricians (experts in psychological measurement), one educational technology specialist, one educational manager, and two counselors, all holding doctoral degrees.

The concurrent validity was assessed through correlation coefficients—both Pearson and Spearman—between the scores of the OLSS and HSSS scales.

The construct validity was examined through EFA (a statistical method used to uncover the underlying structure of a relatively large set of variables), and CFA (a statistical technique used to verify the factor structure of a set of observed variables) within the framework of Structural Equation Modeling (SEM) which is a multivariate statistical analysis technique for analyzing structural relationships. The EFA was conducted to confirm the factor structure proposed in the original article for the Iranian group and to explore potential improvements to the structure through item modifications. EFA used the principal axis factoring method with varimax rotation. The number of factors was determined using both the scree plot and the Kaiser criterion, with the former providing a graphical representation

of eigenvalues against the number of factors and the latter recommending factors with eigenvalues greater than one. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity preliminarily assessed the dataset's suitability for factor analysis, with KMO values above 0.60 confirming adequacy (39, 40). The CFA involved fitting a theoretical factor model to the observed data, using a set of fit indices to evaluate model adequacy, including the Root Mean Square Error of Approximation (RMSEA) (a measure of how well the model fits the population covariance matrix; values less than 0.06 indicate good fit), Comparative Fit Index (CFI) (comparing the fit of the target model to a baseline independent model; values above 0.90 are acceptable), Normed Fit Index (NFI) (evaluating the model by comparing the chi-square value of the model to the chi-square value of a null model; values above 0.90 indicate good fit), Non-Normed Fit Index (NNFI) (also known as the Tucker-Lewis Index, adjusting NFI for the number of model parameters; values above 0.90 are acceptable), Incremental Fit Index (IFI) (measuring the relative improvement in fit of the target model compared to the baseline model; values above 0.90 are considered good), Standardized Root Mean Square Residual (SRMR) (the standardized difference between observed and predicted correlations; values less than 0.08 indicate good fit), Goodness of Fit Index (GFI) (measuring the fit of the model to the observed covariance matrix; values above 0.90 indicate good fit), and Adjusted Goodness of Fit Index (AGFI) (adjusting GFI for the number of degrees of freedom in the model; values above 0.90 are acceptable) (39, 41).

The scale's reliability was assessed using several methods, including split-half reliability, test-retest reliability, and the calculation of Cronbach's alpha coefficient.

Data Collection

The data collection procedure comprised the OLSS and the HSSS scales. Initially, a pilot

study was carried out. Before commencing the comprehensive research, a preliminary survey was conducted with 40 adolescents (including an equal number of male and female participants) with an average age of 16.4 years (SD=1.1). This preliminary phase aimed to assess the feasibility and acceptance of the OLSS scales in the Iranian educational environment and to estimate the sample size required for the main study. The results of this initial survey indicated that the OLSS scale possessed desirable psychometric properties. Additionally, adolescent participants easily understood and responded to the tool's items. Their feedback also indicated positive engagement and interest in the study's subject matter. Afterward, the data collection phase was carried out using the Google Forms platform. Each form was accessible via a unique QR code that participants scanned using their mobile devices, directing them to the respective digital questionnaire. Upon completion, submissions were securely stored in an online repository. This data collection cycle continued from February to March 2022.

To maintain data integrity, the research team conducted weekly reviews to ensure the completeness and accuracy of the collected information and actively addressed any incomplete submissions or data inconsistencies. Rigorous data cleaning protocols were employed to eliminate any anomalous, duplicate, or inconsistent entries. Ultimately, this process resulted in 1251 valid participant responses, forming the basis for subsequent analytical efforts.

Data Analysis

The analytical process was facilitated using SPSS 18 and Lisrel 8.8 software. Inferential statistical tools—Pearson and Spearman correlation coefficients, EFA, CFA, Cronbach's alpha, test-retest reliability, and independent samples t-test—were employed to rigorously assess the questionnaire's validity and reliability. A significance threshold of 0.05 was maintained across all experimental paradigms.

Results

Demographic Characteristics

From the 1300 e-questionnaires distributed, 1251 (96%) were received. The results indicated a balanced gender distribution, with females at 51.2% and males at 48.8%, by an average age of 16.82 ± 0.83 years. Parental education levels showed that 42.0% of fathers have diplomas, while 38.5% of mothers have university degrees. Employment status revealed that 70.9% of fathers are employed, while 53.3% of mothers are either homemakers or unemployed. Fathers have higher rates of retirement (16.6%) and unemployment (6.7%) than mothers. Details are shown in Table 1.

Content Validity

Upon evaluating the questionnaire's content validity with input from ten specialists, the derived CVR figures spanned between 0.80 and 1.00, while the CVI figures were observed between 0.83 and 0.97 across

the items. These findings exceed the threshold values stipulated by Lawshe's criteria, which are 0.62 for CVR and 0.79 for CVI when engaging a panel of ten experts. This substantiates the robust content validity of the questionnaire for the targeted construct it aims to assess (Table 2).

Concurrent Validity

The examination of concurrent validity revealed a robust and affirmative correlation between the OLSS and HSSS scores, as evidenced by a correlation coefficient (r) of 0.651 and a significance level of $P < 0.001$. This suggests a direct relationship, where an increase in OLSS scores is associated with a rise in HSSS scores. Such findings affirm the concurrent validity of both scales, demonstrating that the OLSS is equally capable of gauging Academic Stress as the HSSS.

EFA

In this analysis, initial communalities

Table 1: Demographic characteristics of participants by study stage and demographic variables

		Total (n=1251)	Concurrent (n=234)	Exploratory (n=488)	Confirmatory (n=290)	Reliability (n=239)
Gender	Female	641 (51.2%)	115 (49.1%)	245 (50.2%)	162 (55.9%)	119 (49.8%)
	Male	610 (48.8%)	119 (50.9%)	243 (49.8%)	128 (44.1%)	120 (50.2%)
Fathers' Education	Less than Diploma	328 (26.2%)	63 (26.9%)	125 (25.6%)	77 (26.6%)	63 (26.4%)
	Diploma	526 (42.0%)	98 (41.9%)	201 (41.2%)	119 (41.0%)	108 (45.2%)
	University Degree	397 (31.7%)	73 (31.2%)	162 (33.2%)	94 (32.4%)	68 (28.5%)
Mothers' Education	Less than Diploma	256 (20.5%)	59 (25.2%)	104 (21.3%)	61 (21.0%)	50 (20.9%)
	Diploma	513 (41.0%)	86 (36.8%)	197 (40.4%)	120 (41.4%)	110 (46.0%)
	University Degree	482 (38.5%)	89 (38.0%)	187 (38.3%)	109 (37.6%)	79 (33.1%)
Fathers' Employment	Employed	887 (70.9%)	167 (71.4%)	334 (68.4%)	213 (73.4%)	173 (72.4%)
	Unemployed	84 (6.7%)	10 (4.3%)	40 (8.2%)	17 (5.9%)	17 (7.1%)
	Retired	208 (16.6%)	46 (19.7%)	88 (18.0%)	43 (14.8%)	31 (13.0%)
	Deceased	72 (5.8%)	11 (4.7%)	26 (5.3%)	17 (5.9%)	18 (7.5%)
Mothers' Employment	Employed	444 (35.5%)	117 (50.0%)	141 (28.9%)	98 (33.8%)	88 (36.8%)
	Homemaker/Unemployed	667 (53.3%)	77 (32.9%)	307 (62.9%)	158 (54.5%)	125 (52.3%)
	Retired	109 (8.7%)	31 (13.2%)	31 (6.4%)	27 (9.3%)	20 (8.4%)
	Deceased	31 (2.5%)	09 (3.8%)	09 (1.8%)	07 (2.4%)	06 (2.5%)

The mean and standard deviation of the age for each subgroup are as follows: Concurrent (Mean age: 16.76, SD: ± 0.82), Exploratory (Mean age: 16.82, SD: ± 0.84), Confirmatory (Mean age: 16.86, SD: ± 0.78), and Reliability (Mean age: 16.84, SD: ± 0.86).

Table 2: Rotated Component Matrix for the Study Items

Items	Factor				CVR	CVI
	1	2	3	4		
Lacking appetite or overeating	0.78				0.80	0.83
Rapid heartbeat or palpitations	0.76				1.00	0.90
Difficulty in breathing	0.76				1.00	0.93
Feeling low energy	0.77				0.80	0.87
Experiencing headaches	0.75				1.00	0.93
Having difficulty in sleeping	0.78				1.00	0.97
Muscle aches and pains	0.74				0.80	0.87
Avoiding responsibilities more than usual		0.78			1.00	0.90
Delaying tasks more often than usual		0.78			1.00	0.93
Difficulty in deciding what to do first		0.73			1.00	0.90
Difficulty in getting myself to perform required tasks		0.77			1.00	0.93
Difficulty in managing tasks in a given period		0.76			1.00	0.93
Difficulty in studying lessons with enthusiasm		0.80			1.00	0.93
Acting without thinking enough			0.77		0.80	0.87
Making decisions without thinking enough			0.76		1.00	0.90
Not having a goal in doing things			0.70		0.80	0.83
Not realizing the importance of the things I do			0.77		0.80	0.87
Difficulty in understanding myself				0.76	1.00	0.90
Difficulty in identifying my and other people's emotions				0.76	1.00	0.93
Difficulty in talking to people at home				0.81	1.00	0.90
Percentage of Variance	31.68	13.73	9.35	7.51	0.94	0.90

Factor Definitions:

Physical Health: This factor includes items related to physical symptoms of stress or discomfort, such as lacking appetite or overeating, low energy, difficulty breathing, rapid heartbeat, sleep disturbances, headaches, and muscle aches. These items reflect various physical manifestations that may arise from emotional or mental strain.

Task Management: This factor covers difficulties in managing tasks and responsibilities. Items in this category reflect tendencies such as avoiding responsibilities, delaying tasks, struggling to prioritize, and facing challenges in completing tasks effectively or with enthusiasm.

Valuing: This factor includes aspects related to decision-making, goal-setting, and the importance of tasks. Items here reflect impulsive behavior (acting or deciding without enough thought), lack of goal orientation, and not recognizing the significance of actions.

Relating to Oneself and Others: This factor includes items that describe social and emotional challenges. It captures difficulties in understanding oneself, recognizing emotions (both personal and others'), and communicating effectively, particularly in family or close relationships.

for the questionnaire items were found between 0.475 and 0.603, while extraction communalities varied from 0.538 to 0.697. This demonstrates a significant shared variance among the items and the factors identified. The EFA was utilized to evaluate the structure of the questionnaire, which is aimed at measuring stress in online educational settings. The Kaiser-Meyer-Olkin (KMO) measure indicated a value of 0.907, reflecting a high level of shared variance, deeming it appropriate for factor analysis. The Bartlett's Test of Sphericity resulted in an

approximate Chi-Square of 5508.214 with 190 degrees of freedom and a significance level of 0.001, which supports the distinctiveness of the correlation matrix from an identity matrix, thereby confirming the suitability of the data for factor analysis.

The EFA revealed four distinct factors from a set of 20 variables, cumulatively accounting for 62.272% of the overall variance. The factors identified—namely “Physical Health”, “Task Management”, “Valuing”, and “Relating to Oneself and Others”—contributed 31.676%, 13.732%,

9.353%, and 7.512% to the variance, in that order. The determination of these factors was based on the convergence observed in the scree plot and the application of Kaiser’s criterion, which suggests selecting factors with eigenvalues above one. The Rotated Factor Matrix provided a clearer perspective of the associations between items and their respective factors, reinforcing the questionnaire’s framework and its applicability in analyzing stress within online learning contexts (Table 2 and Figure 1).

CFA

The CFA outcomes revealed a satisfactory alignment between the proposed model and the observed data. Table 3 provides a synopsis of fit indices, juxtaposing the acquired values with established benchmarks indicative of a robust fit. Furthermore, all factor loadings surpass the threshold of 0.70, underscoring the factors’ aptitude in elucidating the variables. These findings bolster the model’s credibility (Table 3, Figure 2, and Figure 3).

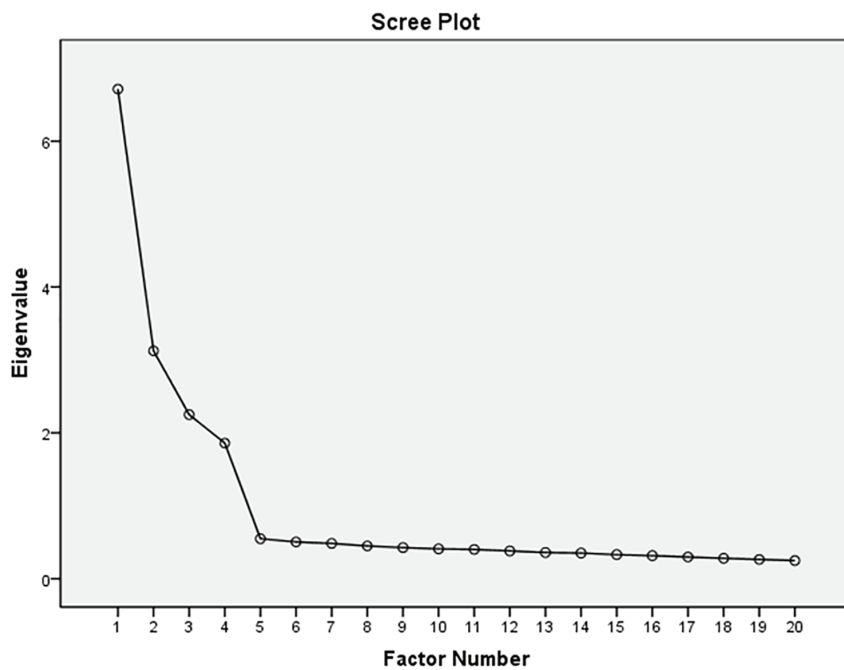
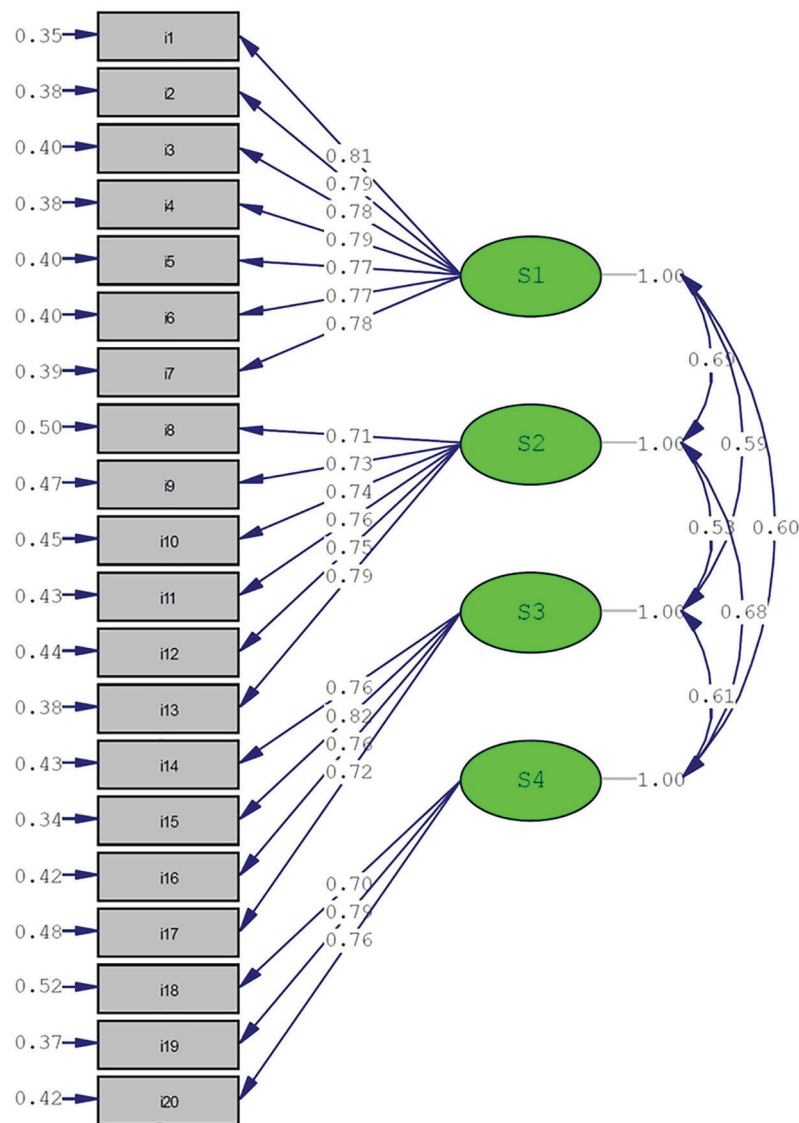


Figure 1: Scree plot of the eigenvalues of the factors

Table 3: Summary of CFA Fit Indices

Fit Index	Obtained Value	Standard Benchmark
χ^2 (Chi-square)	26453	-
p-value	<0.001	> 0.05
RMSEA	0.046	< 0.05
90% CI for RMSEA	(0.036; 0.056)	-
CFI	0.990	> 0.90
NFI	0.970	> 0.90
NNFI	0.990	> 0.90
IFI	0.990	> 0.90
SRMR	0.036	< 0.08
GFI	0.920	> 0.90
AGFI	0.890	> 0.90

* RMSEA: Root Mean Square Error of Approximation, CI for RMSEA: Confidence Interval, CFI: Comparative Fit Index, NFI: Normed Fit Index, NNFI: Non-Normed Fit Index, IFI: Incremental Fit Index, SRMR: Standardized Root Mean Square Residual, GFI: Goodness of Fit Index, AGFI: Adjusted Goodness of Fit Index



Chi-Square=264.53, df=164, P-value<0.001, RMSEA=0.046

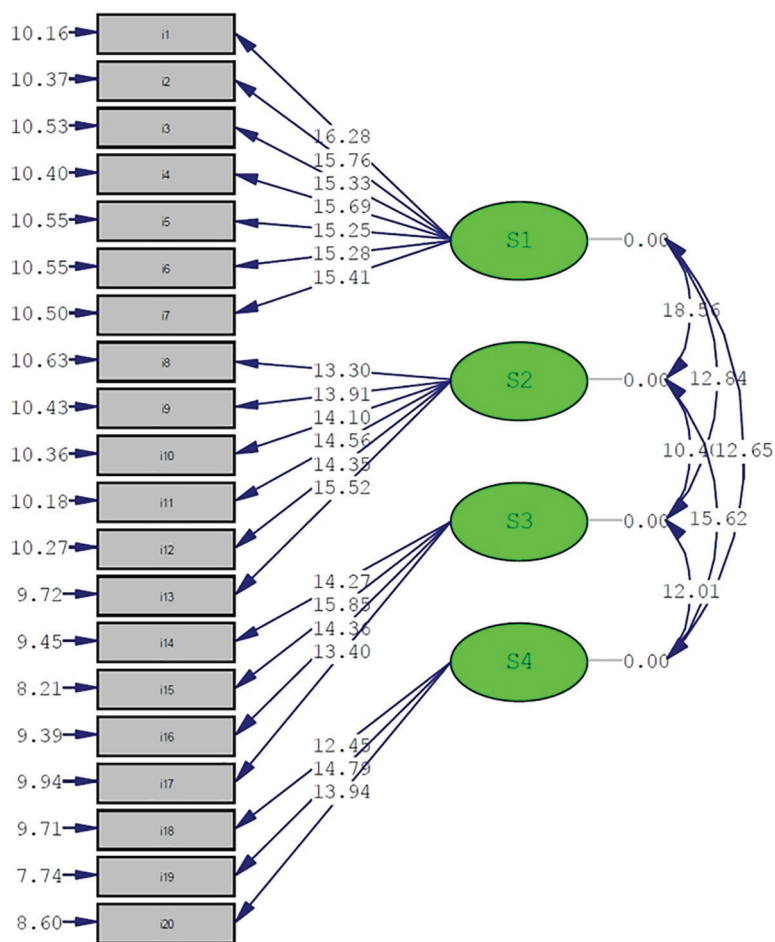
Figure 2: Factor loadings and model fit indices of the CFA for OLSS in the standard state *CFA: Confirmatory Factor Analysis; OLSS: Online Learning Stress Scale

Reliability

The OLSS demonstrated high reliability with a Cronbach's alpha of 0.935 for the overall 20-item scale. The subscales also exhibited strong internal consistency, with alpha coefficients of 0.918 for Physical Health, 0.882 for Task Management, 0.847 for Valuing, and 0.792 for Relating to Oneself and Others, all exceeding the acceptable threshold of 0.70 for research instruments in social sciences (42, 43). The inter-scale correlation of 0.743 and Spearman-Brown coefficients of 0.852 for both equal and unequal lengths, along with a Guttman split-half coefficient of 0.850, further validate the scale's reliability (44, 45). The OLSS effectively

measures stress in junior high school students engaged in online learning, with item means between 2.87 and 3.07 and a total scale mean of 59.57. The standard deviation of 19.420 and item-total correlations from 0.544 to 0.710 confirm the scale's reliability and construct validity (46-49).

Table 1 presents the demographic characteristics of participants based on their stage of data collection and demographic variables. This inclusion allows for comparison across each stage, including concurrent validity, exploratory factor analysis, confirmatory factor analysis, and reliability assessment.



Chi-Square=264.53, df=164, P-value<0.001, RMSEA=0.046

Figure 3: Factor loadings and model fit indices of the CFA for OLSS in the T-value state *CFA: Confirmatory Factor Analysis; OLSS: Online Learning Stress Scale

Table 2 shows that the EFA identified four distinct factors from a set of 20 variables, accounting for 31.68%, 13.73%, 9.35%, and 7.51% of the total variance, respectively. These factors include “Physical Health”, “Task Management”, “Valuing”, and “Relating to Oneself and Others”. The CVR and CVI indices for all items ranged from 0.80 to 1.00 and 0.83 to 0.97, respectively, indicating strong content validity of the questionnaire (50, 51).

Table 3 shows that the CFA results indicate a satisfactory alignment between the proposed model and the observed data. The obtained fit indices, when compared to standard benchmarks, demonstrate a strong model fit (11).

Figure 2 shows the factor loadings and model fit indices of the CFA for OLSS scale in the standard state. All factor loadings

exceed 0.70, indicating strong relationships. The model has 164 degrees of freedom, a Chi-square (χ^2) value of 264.53, a p-value of 0.00, and an RMSEA of 0.046, indicating a good fit (52, 53).

Figure 3 shows the factor loadings and model fit indices of the CFA for OLSS scale in the T-value state. All factor loadings exceed 0.70, indicating strong relationships. The model has 164 degrees of freedom, a Chi-square (χ^2) value of 284.71, a p-value of 0.00, and an RMSEA of 0.048, indicating a good fit (54).

Discussion

This study demonstrated that the OLSS questionnaire has high levels of validity and reliability, making it an effective instrument for assessing academic stress among high

school students engaged in online learning. The findings indicated that the CVR and CVI values exceeded the minimum thresholds required to affirm content validity, demonstrating sufficient representation of various facets of the stress construct. Additionally, a significant positive correlation was found between OLSS and HSSS scores, confirming the concurrent validity of OLSS. Furthermore, the EFA and CFA findings indicated that OLSS has a four-dimensional structure consistent with the dimensions proposed by the original developers. These outcomes suggest that OLSS serves as a comprehensive and multidimensional tool for assessing academic stress in online learning environments, thereby aiding educators and counselors in delivering more effective support to students.

The content validity results showed that the CVR and CVI indices were above the minimum required to confirm content validity, as determined in several studies (46-49). Therefore, it can be said that the questionnaire has high content validity and is capable of effectively measuring the intended construct, which in this case is academic stress in online learning among high school students. This finding is consistent with the original developers' results on content validity (23). The reason for this result can be attributed to the precision and practicality of the questionnaire development process and the careful selection of experts who participated in the content evaluation. However, some other studies have shown that CVR and CVI may be less effective in some contexts, which requires further investigation (55). The fact that the CVR and CVI values are above the minimum thresholds indicates that the questionnaire content adequately covers various aspects of the stress construct in the context of online learning, and according to experts, the questionnaire items are relevant and sufficient for measuring this construct (56).

The concurrent validity investigation showed a significant positive correlation between OLSS and HSSS scores, which is at an acceptable level compared to existing

standards. These results indicate that an increase in OLSS scores is associated with an increase in HSSS scores. Such findings confirm the concurrent validity of both scales and show that OLSS is as effective as HSSS in assessing academic stress. These findings are consistent with the findings of the original developers (23), indicating that OLSS effectively measures academic stress in the context of online learning. However, some other studies have shown that other tools may be more accurate in some contexts (50). This consistency acts as a confirmation of the validity and reliability of OLSS as an assessment tool for academic stress among high school students engaged in online learning environments. The reason for this concurrent validity can be attributed to the precise development of OLSS, ensuring that it measures the same constructs as HSSS. The strong correlation between the two scales confirms that OLSS is a valid tool for measuring academic stress and reflects the reliability of HSSS (45).

The EFA and CFA findings for OLSS in this study indicate that this scale has a four-dimensional structure. These dimensions include "Physical Health", "Task Management", "Valuation", and "Relationship with Self and Others". This structure is consistent with the dimensions proposed by the original developers (23) and supports the validity and reliability of OLSS in measuring academic stress in online environments. However, some other studies have reported different results. For instance, a study by Moustaka and colleagues in 2023 showed that the ESSA scale, with five latent variables including "Academic Pressure", "Workload", "Grade Concerns", "Personal Expectations", and "Frustration", focuses more on external stress factors and may not be as comprehensive as OLSS (21). In contrast, Busari (2011), using the SASS scale with 15 items, focused more on assessing students' individual experiences in facing academic pressures (20). Additionally, Ravada and colleagues (2023), using the SSAS scale with four separate factors including "Depression

Effect”, “Physical Symptoms”, “Positive Effect”, and “Interpersonal Relationships”, examined the impact of stress on students’ mental and social health (22). These differences indicate that each scale may cover different aspects of academic stress, and the choice of the appropriate scale depends on the research objective(s).

The extracted dimensions related to academic stress in online classes can be attributed to the diversity and complexity of students’ experiences in these environments. The various dimensions of OLSS enable researchers and educators to gain deeper insights into how stress affects students’ physical health, task management, values, and interpersonal relationships and to provide more effective support strategies in facing the challenges of online learning. These dimensions are critical in contexts where academic stress may have different impacts on students.

In this study, the OLSS scale demonstrated outstanding reliability. The Cronbach’s alpha for the entire scale was at an acceptable level. This finding emphasizes not only the robustness of OLSS as an effective tool for measuring stress among high school students in online learning environments but also its strong internal consistency. The subscale alpha coefficients were significantly higher than the established standard for social science research tools. In a similar vein, the scale’s reliability, as measured by the split-half correlation, was also found to be both acceptable and statistically significant. Furthermore, the Guttman correlation coefficient confirmed the scale’s reliability. These results are consistent with the findings from several studies (23, 57, 58). However, some research indicates that the OLSS may exhibit reduced effectiveness in specific contexts, warranting further investigation (59-61). The high reliability of the scale can be attributed to its careful cultural adaptation, the selection of relevant items for the target population, and a robust methodological approach, which likely involved extensive pilot testing and validation (62). These

factors collectively support the reliability and effectiveness of OLSS as a diagnostic tool for academic stress, offering valuable insights for researchers and educators to develop interventions and support systems to help students overcome the challenges of online education.

Limitations and Suggestions

Despite offering innovative perspectives on online academic stress, this study faced several limitations. Firstly, the sampling confined to the city of Kerman may limit the generalizability of the results to this area alone; therefore, expanding the sampling to other regions of Iran could enhance the generalizability of the findings. Secondly, despite the accuracy of the translation, some concepts may not have been fully conveyed; hence, the use of student focus groups is recommended for evaluating and refining the translations. Thirdly, the OLSS and HSSS tools may not cover all aspects of academic stress; thus, the development and validation of new tools for a more comprehensive assessment of academic stress are essential.

Conclusion

The OLSS has shown high content validity and reliability in measuring academic stress among junior high school students in online learning contexts. Its four-dimensional structure provides a comprehensive assessment framework. Despite some limitations, such as the need for broader sampling and refined translation methods, the OLSS remains a valid tool. Practical applications include identifying high-stress students in online settings.

Abbreviations

AGFI: Adjusted Goodness of Fit Index
CFA: Confirmatory Factor Analysis
CFI: Comparative Fit Index
CVI: Content Validity Index
CVR: Content Validity Ratio
EFA: Exploratory Factor Analysis
ESSA: Educational Stress Scale for Adolescents

GFI: Goodness of Fit Index
GHQ-28: General Health Questionnaire 28-item version
HSSS: High School Stress Scale
I-CVI: Item Content Validity Index
IndexIFI: Incremental Fit Index
NFI: Normed Fit Index
NNFI: Non-Normed Fit (IndexTucker-Lewis)
OLSS: Online Learning Stress Scale
RMSEA: Root Mean Square Error of Approximation
SASS: Student Academic Stress Scale
SEM: Structural Equation Modeling
SSAS: Student Stress and Anxiety Scale
SRMR: Standardized Root Mean Square Residual

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Authors' Contribution

FG was responsible for the initial drafting of the manuscript, SK oversaw data gathering, and AA performed the statistical analysis and validation. AA was responsible for revisions. All the authors approved the final manuscript.

Conflict of Interest

The authors declare that they have no conflicts of interest to disclose.

Ethical Considerations

The study was conducted following ethical guidelines and received approval from the Research Ethics Committee of the Islamic Azad University, Bandar Abbas Branch (approval code IR.IAU.BA.REC.1402.078). All participants were fully aware of the study procedures, and informed consent was obtained. No risks were posed to them throughout the research process. The study design and execution adhered to the university's established rules and protocols.

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Availability of Data and Materials

The detailed datasets and supplementary information that may enhance the interpretation of the research results will be accessible upon reasonable request from the corresponding author.

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