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Climate change anxiety scale: psychometric validation among university students in environmental sustainability contexts

Bassam M. A. Makram[1], Mohamed Sayed Abdellatif[2], Ahmed Abdelhalim Elnhal[3], Mohamed Ali Nemt-allah[3]
[1]Department of Physics, College of Sciences and Humanities, Prince Sattam Bin Abdulaziz University, Wadi Al-Dawaser, Saudi Arabia
[2]Department of Psychology, College of Education in Al-Kharj, Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia
[3]Department of Educational Psychology and Statistics, Faculty of Education, Al-Azhar University, Tafhna Al-Ashraf, Egypt

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ABSTRACT

This study employed a cross-sectional, two-sample validation design to develop and validate the climate change anxiety scale (CCAS) among Egyptian university students, addressing the critical gap in Arabic-language assessment tools for climate-related psychological distress. Two independent samples from Al-Azhar University participated: 540 students completed exploratory factor analysis (EFA) and 977 students completed confirmatory factor analysis (CFA). Content validity was established through expert review (content validity indices (CVI)=.778-1.000), resulting in an 18-item scale. EFA revealed a three-factor structure explaining 53.981% of variance: cognitive-emotional impairment, functional impairment, and behavioral engagement. CFA confirmed excellent model fit (comparative fit index (CFI)=.944, root mean square error of approximation (RMSEA)=.067), significantly superior to a single-factor model. Internal consistency was robust across subscales (ω=.817-.907, α=.813-.906) and total scale (ω=.910, α=.909). Test-retest reliability demonstrated strong temporal stability (r=.714-.886). Convergent validity was supported through significant inter-dimensional correlations (r=.394-.710). The CCAS provides a psychometrically sound, culturally appropriate instrument for assessing multidimensional climate anxiety, enabling systematic identification of students requiring targeted mental health interventions within Egyptian higher education contexts.

Corresponding Author:

Mohamed Ali Nemt-allah
Department of Educational Psychology and Statistics, Faculty of Education, Al-Azhar University
Tafhna Al-Ashraf, Egypt
Email: mohamednamatallah.2026@azhar.edu.eg

1. INTRODUCTION

Climate change anxiety, often referred to as eco-anxiety, represents a multifaceted psychological response encompassing cognitive, emotional, and behavioral dimensions triggered by awareness of climate change and its far-reaching consequences [1]–[4]. This phenomenon manifests as persistent worry, fear, and distress related to environmental degradation, threats to future generations, and perceived inadequacies in global responses [1], [4], [5]. While moderate levels of such anxiety may catalyze adaptive behaviors like environmental activism, elevated intensity can lead to significant impairments in mental health and daily functioning [1], [6], [7]. As global climate crises intensify, the prevalence of climate change anxiety has risen sharply, particularly among younger demographics, underscoring the urgent need for standardized, reliable tools to measure and address this issue systematically.

University students emerge as a particularly vulnerable population to climate change anxiety, given their extended exposure to environmental threats, amplified media consumption, and heightened awareness of future uncertainties [2], [8], [9]. Empirical evidence indicates that individuals aged 16-25, especially those in higher education, report substantially higher levels of climate-related distress compared to older groups [10]–[12]. This vulnerability spans diverse cultural and geographical contexts, including European institutions, as well as universities in regions like Palestine, Afghanistan, and the Philippines [13]–[16]. Factors such as gender and media exposure exacerbate these effects, with female students and those with frequent access to climate information demonstrating greater anxiety [5], [17]–[20]. At this developmental stage, characterized by identity formation and future-oriented planning, university students' experiences of climate anxiety not only reflect broader societal trends but also necessitate targeted assessment tools to mitigate potential long-term impacts on mental health and academic performance [21], [22].

The escalation of climate change anxiety as a public health concern stems from the increasing frequency and severity of environmental crises, including rising sea levels, extreme weather events, and biodiversity loss, which amplify psychological distress across global populations [1], [23]. This distress is compounded by existential fears for future generations and dissatisfaction with institutional responses, leading to symptoms such as rumination, helplessness, and functional disruptions [9], [11], [19]. In this context, distinguishing between adaptive worry and pathological anxiety is crucial for effective intervention. Reliable measurement instruments are therefore essential to quantify prevalence, identify at-risk individuals, and guide public health strategies [2], [24], [25]. Without such tools, efforts to address climate-related mental health issues remain fragmented, highlighting the need for scales that are both psychometrically robust and culturally sensitive.

Among university students, climate change anxiety presents as a cluster of interrelated symptoms affecting emotional, cognitive, and functional domains. Emotionally, individuals often experience intense worry, fear, sadness, guilt, and helplessness in response to environmental threats [2], [5], [26]. Cognitively, this manifests as rumination, difficulty concentrating, and preoccupation with climate scenarios, which can hinder decision-making and goal attainment [2], [26]. Functionally, these symptoms disrupt sleep, academic engagement, and social interactions, potentially leading to reduced productivity and quality of life [15], [27], [28]. The development of the climate change anxiety scale (CCAS) addresses this by providing a comprehensive framework to assess these dimensions, enabling the identification of students who may require mental health support [2].

In regions like Egypt, the demand for context-specific tools to measure climate change anxiety has grown in recent years, driven by the country's acute vulnerability to climate impacts such as desertification, rising temperatures, and water scarcity [28], [29]. This need became particularly evident in the early 2020s, as climate-related distress surged among university students and other demographics amid increasing public awareness and media coverage [30], [31]. Although international research on climate anxiety measurement began around 2020, with tools like those developed by Clayton and Karazsia [2] and Wullenkord *et al*. [5], Arabic-language scales tailored to Egyptian contexts only emerged in 2024 [30], [31]. This gap underscores the importance of culturally adapted instruments to capture nuances in expression and perception.

Despite the growing recognition of climate change anxiety as a significant mental health concern globally, Arabic-language assessment tools validated within Middle Eastern contexts remain critically scarce. While international instruments have been developed in Western contexts [2], [5], their direct application to Egyptian populations may overlook cultural nuances in anxiety expression, religious coping mechanisms, and collectivist values that shape psychological responses to environmental threats. The novelty of this study lies in developing the first comprehensive, psychometrically validated Arabic-language scale specifically designed for Egyptian university students, addressing both the linguistic gap and the cultural appropriateness of climate anxiety assessment in the region.

The novelty of this study extends beyond geographical adaptation to encompass three conceptual innovations. First, it empirically tests whether Western-derived factor structures—primarily distinguishing cognitive-emotional and functional dimensions [2], [5]—remain valid within Islamic cultural frameworks emphasizing environmental stewardship (*istikhlaf*) and collective responsibility, potentially producing distinct behavioral engagement patterns absent in secular contexts. Second, it addresses methodological limitations of existing Arabic adaptations [30], [31] that relied on direct translation without culturally informed item generation, risking construct underrepresentation. Third, validation within Egypt's centralized higher education system enables policy integration—standardized screening protocols, faith-based intervention frameworks, institutional mental health resource allocation—impossible with Western instruments developed for decentralized educational contexts with secular counseling paradigms.

This study aims to address the following research questions:

i) What is the underlying factor structure of climate change anxiety among Egyptian university students, and does it align with theoretical multidimensional models proposed in international literature?

ii) Does the CCAS demonstrate adequate psychometric properties, including internal consistency reliability, test-retest reliability, and construct validity?
iii) How do the dimensions of climate change anxiety interrelate, and what are the patterns of association among cognitive-emotional impairment, functional impairment, and behavioral engagement?
iv) Does a three-factor model provide superior fit compared to a unidimensional conceptualization of climate anxiety?

By answering these questions, this research provides a standardized tool for identifying at-risk individuals and informing targeted interventions, ultimately contributing to evidence-based strategies that support mental health in the face of escalating environmental challenges within Egyptian higher education contexts.

2. METHOD

2.1. Participants

Data were collected from two independent samples of university students at Al-Azhar University during the first semester of the 2025/2026 academic year. The first sample comprised 540 students from the Faculty of Education for Boys in Dakahlia and the Faculty of Education for Girls in Cairo, who participated in the exploratory factor analysis (EFA). Their ages ranged from 18 to 22 years (M=19.21, SD=1.21). The second sample consisted of 977 students from the same faculties who completed the confirmatory factor analysis (CFA). This sample's ages ranged from 17 to 22 years (M=19.25, SD=1.17). Additionally, a subsample of 211 students participated in the test-retest reliability assessment to establish the scale's temporal stability. Detailed demographic characteristics of both samples are presented in Table 1.

Table 1. Sample description statistics

Variable	Category	EFA sample (N=540)		CFA sample (N=977)	
		N	%	N	%
Academic level	First year	243	45.0	354	36.2
	Second year	99	18.3	186	19.0
	Third year	120	22.2	296	30.3
	Fourth year	78	14.5	141	14.5
Gender	Male	179	33.1	277	28.4
	Female	361	66.9	700	71.6
Residence	Urban	141	26.1	262	26.8
	Rural	399	73.9	715	73.2
Follow climate conferences	Yes	169	31.3	573	58.6
	No	371	68.7	404	41.4
Feel part of community and care about protection	Yes	361	66.9	622	63.7
	No	179	33.1	355	36.3

2.2. Instrument development

The CCAS was developed to assess climate-related psychological distress among university students. The initial version contained 20 items designed to capture the multidimensional nature of climate change anxiety. The scale was structured around three theoretical dimensions: cognitive-emotional impairment (reflecting persistent worry, sadness, and intrusive thoughts about climate change), functional impairment (assessing disruptions to academic performance, social activities, and daily functioning), and behavioral engagement (measuring guilt, personal responsibility, and environmental actions). Items were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating greater climate change anxiety. The scale items were translated from Arabic to English and back-translated by three specialized translators to ensure linguistic equivalence and cultural appropriateness. This bidirectional translation process helped maintain semantic consistency across both language versions while preserving the intended meaning of each item within the Egyptian cultural context.

To ensure content validity, the initial 20-item scale was submitted to a panel of nine expert judges who evaluated multiple aspects of the instrument. Judges assessed the appropriateness of each dimension to the overall construct, the relevance of individual items to their respective dimensions, the suitability of response options, clarity of wording, the scoring key, and the number of items. Each aspect was rated on a 3-point scale. Content validity indices (CVI) were calculated for each item and for the scale components overall. Based on expert feedback, two items were removed from the scale due to insufficient agreement among judges, resulting in a final 18-item instrument for empirical validation.

2.3. Data collection

Data were collected through Google Forms, allowing for efficient administration and data management. Participants accessed the online survey and completed the CCAS along with demographic questions about their academic level, gender, residence, engagement with climate conferences, and sense of community environmental responsibility. All participation was voluntary, and responses were collected anonymously to encourage honest self-reporting.

2.4. Data analysis

Statistical analyses were conducted using SPSS 29 and AMOS 27, following a rigorous validation procedure that included EFA to identify the scale's underlying structure and CFA to evaluate model fit using multiple indices (e.g., χ^2, comparative fit index (CFI), Tucker-Lewis index (TLI), normed fit index (NFI), root mean square error of approximation (RMSEA), root mean square residual (RMR), goodness of fit index (GFI), and adjusted goodness of fit index (AGFI)). Sampling adequacy was assessed via Kaiser-Meyer-Olkin (KMO) and Bartlett's test, while psychometric properties were examined through composite reliability (CR), average variance extracted (AVE), and maximum reliability (MaxR[H]). Internal consistency was evaluated using Cronbach's alpha (α), McDonald's omega (ω), and Guttman's lambda-2 (λ_2), with convergent validity assessed through inter-dimensional correlations and total scale scores. Test-retest reliability was confirmed through repeated measurements from a subsample of 211 students, demonstrating temporal stability.

3. RESULTS

The content validity assessment through expert review demonstrated strong agreement across all evaluated aspects of the CCAS. Nine expert judges evaluated the initial 20-item scale on multiple criteria, including the appropriateness of dimensions to the overall construct, the relevance of items to their respective dimensions, the suitability of response alternatives, clarity of item wording, the scoring key, and the total number of items. The CVI for the scale components ranged from .78 to 1.00, indicating excellent content validity. Specifically, the CVI for dimension appropriateness was 1.00, item relevance to dimensions was .78, response alternative suitability was .78, item clarity was 1.000, scoring key appropriateness was 1.00, and number of items was 1.000. At the item level, CVI ranged from .56 to 1.00 for individual items, with most items achieving CVIs above .78. Based on this evaluation, two items (Items 3 and 14 from the original 20-item pool) were removed due to insufficient expert agreement, resulting in an 18-item scale for subsequent psychometric analyses.

The EFA was conducted on the first sample (N=540) to examine the underlying factor structure of the 18-item CCAS. Preliminary analyses confirmed the appropriateness of factor analysis, with the KMO measure of sampling adequacy yielding an excellent value of .932, and Bartlett's test of sphericity reaching statistical significance (χ^2=5179.145, df=153, p<.001), indicating sufficient correlations among items for factor extraction. Two models were tested: a single-factor model and a three-factor model corresponding to the theoretical dimensions of the scale.

The single-factor solution extracted one factor with an eigenvalue of 7.562, accounting for 42.012% of the total variance before extraction and 39.031% after extraction using principal axis factoring. Factor loadings for this unidimensional model ranged from .527 to .782 for 11 items, while seven items failed to meet the minimum loading criterion of .50. Items from the cognitive-emotional impairment dimension showed loadings ranging from .668 to .777, functional impairment items loaded between .686 and .782, and only two items from the behavioral engagement dimension (Items 15 and 17) achieved acceptable loadings of .552 and .527, respectively. The remaining items from each dimension, particularly those from cognitive-emotional impairment (Items 1 and 2) and behavioral engagement (Items 13, 14, 16, and 18), demonstrated insufficient loadings on the single factor.

The three-factor solution provided a more comprehensive representation of the scale's structure, as shown in Table 2. Principal axis factoring with Promax rotation extracted three factors, collectively explaining 61.644% of the total variance before extraction and 53.981% after extraction. The first factor had an eigenvalue of 7.562 and accounted for 42.012% of the variance before extraction (39.721% after extraction); the second factor had an eigenvalue of 2.371 before extraction, accounting for 13.172% of variance (1.873 after extraction, 10.405%); and the third factor had an eigenvalue of 1.163 before extraction, accounting for 6.461% of variance (.694 after extraction, 3.855%). Although the third factor's extracted eigenvalue fell below the conventional Kaiser criterion of 1.0, it was retained based on theoretical meaningfulness, strong factor loadings (.589-.709), substantial additional variance (3.855%), and alignment with international frameworks distinguishing behavioral engagement as a distinct component of climate anxiety. After rotation, the factors accounted for different amounts of variance (Factor 1=6.332, Factor 2=4.094, and Factor 3=5.714), though these values cannot be summed due to factor correlations.

The rotated pattern matrix revealed a clear three-factor structure with items loading predominantly on their theoretically predicted dimensions and minimal cross-loadings.

Table 2. EFA: comparison of single-factor and three-factor solutions

Item	Single-factor model	Three-factor model		
		Functional impairment	Behavioral engagement	Cognitive-emotional impairment
9. It is difficult to complete my tasks when thinking about the climate crisis	.747	.926		
10. My climate anxiety affects my relationships with others	.717	.878		
12. My personal plans are disrupted due to my climate change anxiety	.720	.855		
11. I feel unable to enjoy life because of my fears about climate change	.782	.807		
8. I avoid social activities due to preoccupation with climate issues	.686	.714		
7. My climate change anxiety negatively affects my academic performance	.759	.628		
14. I constantly change my daily habits to reduce my carbon footprint			.709	
16. I worry that my personal actions contribute to worsening climate change			.694	
15. I feel a great personal responsibility toward solving the climate crisis	.552		.687	
13. I feel guilty when I engage in behaviors that harm the environment			.609	
17. I participate in environmental activities to reduce my climate anxiety	.527		.595	
18. I feel stressed when I don't make enough effort to protect the environment			.589	
3. Climate change news causes me anxiety that is hard to control	.668			.816
4. I have difficulty sleeping due to my fears about the climate crisis	.725			.658
2. I feel deeply sad when I think about the future of planet Earth				.655
5. I feel hopeless when I think about my inability to stop climate change	.716			.609
6. My climate-related thoughts distract me from focusing on my studies	.777			
Eigenvalue	7.562	7.150	1.873	.694
% Variance explained	39.031	39.721	10.405	3.855
Total variance explained (%)	39.031		53.981	

Note: Loadings<.50 are suppressed. Dashes indicate loadings below the .50 threshold.

The three factors demonstrated moderate to strong intercorrelations, supporting the theoretical expectation that these dimensions represent related but distinct aspects of climate change anxiety. As presented in the factor correlation matrix, Factor 1 (functional impairment) correlated .394 with Factor 2 (behavioral engagement) and .710 with Factor 3 (cognitive-emotional impairment). Factor 2 (behavioral engagement) correlated .526 with Factor 3 (cognitive-emotional impairment). These correlations indicate that while the three dimensions are interconnected components of the overall climate change anxiety construct, each captures unique variance that justifies their treatment as separate subscales. The pattern of correlations suggests that cognitive-emotional symptoms are more strongly associated with functional impairment than with behavioral engagement, which may reflect the progression from internal distress to observable disruptions in daily functioning.

CFA was conducted on the independent second sample (N=977) to test the fit of both the single-factor and three-factor models identified in the exploratory phase. The single-factor model, which constrained all 18 items to load on a single latent factor, demonstrated poor fit to the data across multiple indices, as illustrated in Table 3. The Chi-square test was significant (χ^2=837.280, df=54, p<.001) with a ratio of χ^2/df=15.505, substantially exceeding the recommended threshold of 5.0. The GFI=.860 and AGFI=.797, fell below the acceptable criterion of .90, while the RMR=.075, was marginally acceptable. Incremental fit indices also indicated inadequate model fit, with the NFI=.875, RFI=.847, incremental fit index (IFI=.882), TLI=.856, and CFI=.882, all falling below the recommended .90 threshold. The RMSEA=.122 substantially exceeded the acceptable upper limit of .08, indicating poor approximate fit. For this model, CR was .921, AVE was .498, and MaxR[H] was .931.

The three-factor model, which specified separate but correlated latent factors for cognitive-emotional impairment, functional impairment, and behavioral engagement, demonstrated substantially superior fit to the data, as shown in Table 3. The Chi-square statistic remained significant (χ^2=501.216, df=101, p<.001), which is common with large sample sizes. The GFI (.931) and AGFI (.907) both exceeded the .90 criterion, indicating good absolute fit, while the RMR (.058) was well below the .08 threshold. All incremental fit indices demonstrated excellent model fit: NFI=.932, RFI=.919, IFI=.944, TLI=.933, and CFI=.944, all surpassing the .90 benchmark. The RMSEA (.067) fell within the acceptable range below .08, indicating good approximate fit. CR for the overall scale was .855, AVE was .667, and MaxR[H] was .891. The comparison of fit indices between the two models clearly favored the three-factor solution, supporting the multidimensional conceptualization of climate change anxiety.

Table 3. Comparison of model fit indices between single-factor and three-factor models

Fit index	Single-factor model	Three-factor model
χ^2	837.280	501.216
df	54	101
p-value	<.001	<.001
RMR	.075	.058
GFI	.860	.931
AGFI	.797	.907
NFI	.875	.932
RFI	.847	.919
IFI	.882	.944
TLI	.856	.933
CFI	.882	.944
RMSEA	.122	.067
CR	.921	.855
AVE	.498	.667
MaxR(H)	.931	.891

The structural representation of the single-factor confirmatory model is presented in Figure 1, showing all 18 items loading on a single latent climate change anxiety factor. This model assumes that all manifestations of climate change anxiety can be explained by one underlying construct. However, the poor fit indices suggest that this parsimonious model does not adequately capture the complexity of climate change anxiety as measured by the CCAS. The model's inability to account for the distinct cognitive-emotional, functional, and behavioral components of climate anxiety resulted in substantial misfit, as evidenced by the elevated RMSEA and inadequate incremental fit indices.

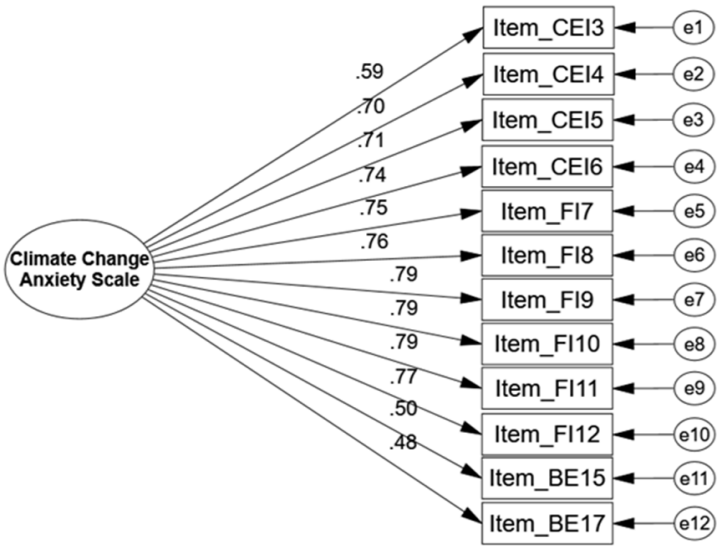

Figure 1. Single-factor CFA model

In contrast, the three-factor model's structural representation is depicted in Figure 2, illustrating the distinct but correlated latent factors of cognitive-emotional impairment, functional impairment, and behavioral engagement. This multidimensional structure provides a more nuanced understanding of climate change anxiety by acknowledging its various manifestations across cognitive, emotional, functional, and behavioral domains. The superior fit indices of this model confirm that climate change anxiety is best conceptualized as a multifaceted construct rather than a unidimensional phenomenon.

Internal consistency reliability was evaluated for each subscale and the total CCAS using multiple coefficients, including McDonald's omega, Cronbach's alpha, and Guttman's lambda-2. All subscales—cognitive-emotional impairment (ω=.817, α=.815, λ_2=.816), functional impairment (ω=.907, α=.906, λ_2=.907), and behavioral engagement (ω=.821, α=.813, λ_2=.820)—exceeded the acceptable threshold of .70, indicating adequate reliability. The total scale demonstrated excellent reliability (ω=.910, α=.909, λ_2=.914) with an average inter-item correlation of .380, supporting the scale's psychometric robustness and internal consistency.

Convergent and test-retest reliability analyses provided strong evidence for the psychometric robustness of the CCAS. Pearson correlations among the three dimensions and with the total score were all statistically significant ($p<.01$), indicating substantial interrelationships and supporting construct validity. Cognitive-emotional impairment correlated moderately with functional impairment (r=.640) and behavioral engagement (r=.496), while functional impairment and behavioral engagement showed a moderate association (r=.471). Each dimension also demonstrated strong correlations with the total score (ranging from .785 to .877), confirming their contribution to a unified construct. Temporal stability was assessed through test-retest reliability with a subsample of 211 students, revealing high consistency across administrations: cognitive-emotional impairment (r=.886), functional impairment (r=.714), behavioral engagement (r=.734), and total score (r=.846). Cross-time correlations between dimensions further supported the scale's stability, affirming its suitability for longitudinal research and repeated assessments.

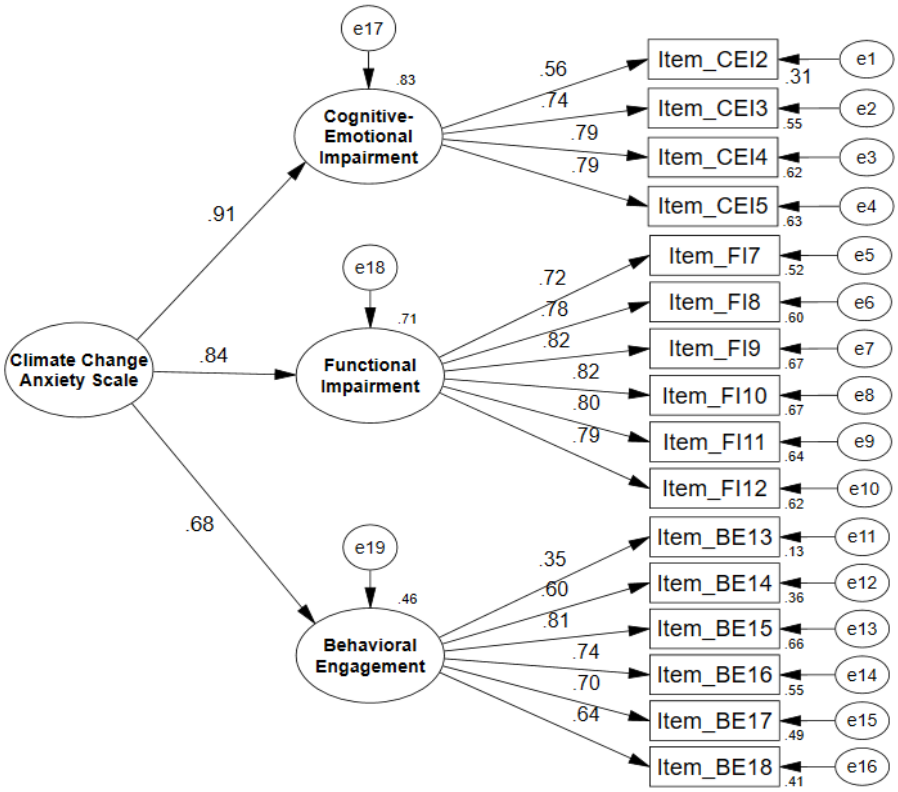

Figure 2. Three-factor CFA model

4. DISCUSSION

The psychometric validation of the CCAS demonstrated robust measurement properties among Egyptian university students. The three-factor structure—comprising cognitive-emotional impairment, functional impairment, and behavioral engagement—emerged as superior to a unidimensional model, explaining 53.981% of total variance. CFA on an independent sample (N=977) confirmed excellent model fit (CFI=.944, RMSEA=.067), while internal consistency coefficients exceeded acceptable thresholds across all subscales (ω=.817-.907). The moderate intercorrelations among dimensions (r=.394-.710) indicate distinct yet related components of climate anxiety, with cognitive-emotional symptoms showing stronger associations with functional impairment than behavioral engagement. This pattern suggests a progression from internal psychological distress to observable disruptions in daily functioning, supporting the theoretical conceptualization of climate anxiety as a multidimensional construct requiring differentiated assessment approaches.

The institutional context of Al-Azhar University warrants particular attention when interpreting these findings. The validation of CCAS within an Islamic educational setting revealed that religious and cultural frameworks may moderate the expression and intensity of climate anxiety dimensions. The relatively strong emergence of behavioral engagement as a distinct factor (despite its lower eigenvalue) may reflect Islamic teachings emphasizing environmental stewardship (*istikhlaf*) and accountability before God for

protecting creation. Students in this context may experience climate anxiety not only as psychological distress but also as a moral imperative rooted in religious obligations. This contextual influence aligns with research suggesting that religious coping mechanisms and collective moral narratives can both amplify environmental concern and provide meaning-making frameworks that buffer against existential anxiety. Future research should explicitly examine how religious identity, theological interpretations of environmental responsibility, and institutional religious climate moderate the relationships among CCAS dimensions and their associations with mental health outcomes.

These findings align with international climate anxiety research while revealing contextually relevant patterns. Similar to studies conducted in European institutions, Palestine, Afghanistan, and the Philippines, Egyptian university students demonstrated substantial climate-related distress across cognitive, emotional, and functional domains. The three-factor structure parallels Clayton and Karazsia [2] theoretical framework identifying cognitive-emotional symptoms and functional impairment as core anxiety dimensions. However, the emergence of behavioral engagement as a distinct factor extends previous measurement approaches by capturing guilt-driven environmental actions. The gender distribution showing higher female participation (66.9%-71.6%) reflects documented patterns of elevated climate anxiety among female students, though future research should explicitly examine gender differences in scale scores to confirm these demographic patterns within Egyptian populations.

The validated CCAS addresses critical gaps in Arabic-language climate anxiety assessment, providing mental health professionals and researchers with a culturally appropriate tool for identifying students requiring targeted interventions. The scale's multidimensional structure enables practitioners to distinguish adaptive environmental concern from clinically significant distress, facilitating early identification of individuals whose anxiety compromises academic performance, social functioning, and psychological well-being. For university counseling centers, subscale profiles can inform tailored interventions addressing specific manifestations—cognitive restructuring for rumination, behavioral activation for functional impairment, or channeling behavioral engagement toward productive climate action. The instrument also supports institutional policy development by quantifying climate anxiety prevalence across student populations, justifying resource allocation for mental health services, and evaluating intervention effectiveness through repeated measurements, thereby bridging assessment and actionable support.

The CCAS findings align with international validations while revealing contextual distinctions. The three-factor structure explaining 53.981% variance compares favorably with French (48.7%) [26], German [5], and Australian (52.3%) [25] validations, while internal consistency (ω=.817-.907) matches benchmarks from Clayton and Karazsia [2], Cosh *et al*. [24], and exceeds earlier Arabic adaptations [30]. Inter-dimensional correlations (r=.394-.710) parallel patterns in network analyses [27] and cross-cultural studies across China, India, Japan, and the United States [19]. The emergence of behavioral engagement as a distinct factor extends Western frameworks [2], [5] that subsume environmental actions under coping [12], [20], potentially reflecting Islamic stewardship (*istikhlaf*) integration. Gender participation patterns mirror global trends showing elevated female climate anxiety [17], [18], [21], while test-retest reliability (r=.714-.886) surpasses other Arabic validations [31].

The findings carry significant implications for educational practice and policy within Egyptian higher education. Universities should integrate CCAS into routine mental health screenings to identify at-risk students requiring early intervention. Counseling centers can develop targeted supports based on subscale profiles: cognitive-behavioral therapy for cognitive-emotional impairment, structured environmental activism for behavioral engagement, and academic accommodations for functional impairment. Institutional policies should establish climate mental health task forces coordinating student services, environmental programs, and religious affairs offices to create culturally responsive frameworks. Faculty development programs should train instructors to recognize climate anxiety manifestations and balance crisis education with solution-focused pedagogy, emphasizing collective efficacy to mitigate distress while maintaining engagement.

Despite rigorous validation, several limitations warrant consideration. The sample consisted exclusively of Al-Azhar University students, potentially limiting generalizability to other Egyptian institutions with different religious orientations, socioeconomic compositions, or geographic locations. The convenience sampling approach and reliance on self-report measures introduce potential response biases, including social desirability effects and subjective interpretation variability. The cross-sectional design precludes causal inferences about relationships between climate anxiety dimensions and external variables. Additionally, while test-retest reliability was established over a brief interval with 211 students, longer-term stability remains unexplored. The online data collection method may exclude students with limited internet access, potentially underrepresenting rural or economically disadvantaged populations. Finally, the scale's focus on university students limits applicability to broader Egyptian populations experiencing climate anxiety through different developmental and socioeconomic lenses.

Future research should extend validation across diverse Egyptian universities, including public and private institutions, to establish measurement invariance across educational contexts and socioeconomic

strata. Longitudinal studies examining predictive validity could elucidate relationships between baseline climate anxiety scores and subsequent mental health outcomes, academic trajectories, and environmental behaviors. Investigating clinical utility by comparing CCAS scores among students with and without diagnosed anxiety disorders would establish discriminant validity and clinical cutoff scores. Cross-cultural validation studies comparing Egyptian students with international samples could identify universal versus culturally specific manifestations of climate anxiety. Researchers should also explore moderating variables—including religiosity, climate change exposure, media consumption patterns, and perceived self-efficacy—that may influence anxiety expression within Egyptian contexts. Developing intervention studies using CCAS as an outcome measure would demonstrate practical utility for treatment evaluation.

5. CONCLUSION

The CCAS represents a psychometrically sound instrument for assessing multidimensional climate anxiety among Egyptian university students, addressing a critical measurement gap identified in recent Arabic-language mental health research. The three-factor structure captures cognitive-emotional distress, functional impairment, and behavioral engagement as distinct yet interconnected components of climate-related psychological responses. With excellent reliability coefficients, strong construct validity, and temporal stability, the CCAS enables systematic identification of students experiencing clinically significant climate anxiety requiring intervention. Future research could strengthen these findings by employing longitudinal designs to examine the predictive validity of CCAS scores and track changes in climate anxiety over time, as well as experimental designs to evaluate the scale's sensitivity to change following therapeutic interventions. Additionally, mixed-methods approaches combining quantitative CCAS assessments with qualitative interviews could provide deeper insights into the lived experiences of climate anxiety among Egyptian students and validate the cultural appropriateness of the identified dimensions. As environmental threats intensify and psychological impacts proliferate across vulnerable populations, validated assessment tools become essential for evidence-based mental health practice, targeted resource allocation, and evaluation of therapeutic approaches. This validation establishes foundational psychometric evidence supporting the CCAS as a reliable research instrument and clinical screening tool within Egyptian higher education contexts.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Bassam M. A. Makram	✓	✓	✓	✓	✓	✓		✓		✓		✓	✓	✓
Mohamed Sayed Abdellatif		✓				✓		✓		✓	✓	✓	✓	✓
Ahmed Abdelhalim Elnhal	✓		✓			✓	✓			✓	✓			
Mohamed Ali Nemt-allah	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	

C : **C**onceptualization
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R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

Authors have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The study protocol was approved by the Research Ethics Committee of the Faculty of Education, Al-Azhar University, Egypt (Ref. No. EDU-REC-2025-157).

DATA AVAILABILITY

The data are available from the corresponding author, [MAN-a], upon reasonable request.

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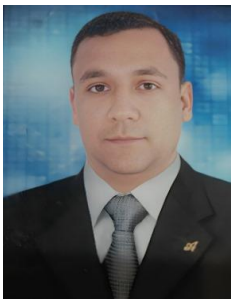
BIOGRAPHIES OF AUTHORS

Bassam M. A. Makram is an assistant professor in the Department of Computer Science at Prince Sattam bin Abdulaziz University's College of Arts and Sciences in Wadi Al-Dawaser, Saudi Arabia. Specializing in solid-state physics, he previously served as a lecturer in the Physics Department at Al-Azhar University in Egypt from 2012 to 2019. His expertise bridges theoretical physics and computational applications, fostering innovative educational initiatives. He can be contacted at email: b.makram@psau.edu.sa.

Mohamed Sayed Abdellatif is an assistant professor of the Department of Psychology at the College of Education in Al-Kharj, Prince Sattam Bin Abdulaziz University, Alkharj, Saudi Arabia. His academic work focuses on psychological research and education within the Saudi higher education system. Dr. Abdellatif contributes to understanding psychological processes and their applications in educational settings. His research addresses contemporary challenges in psychological education and practice. He can be contacted at email: m.heby@psau.edu.sa.



Ahmed Abdelhalim Elnhal is a lecturer in Educational Psychology at the Faculty of Education, Tafhna Al-Ashraf, Dakahlia, Al-Azhar University. Appointed as a teaching assistant in 2012, he earned his master's degree in 2018 focusing on constructivist learning strategies for developing geographical thinking skills among secondary students. In 2022, he earned his Ph.D. with honors, examining a training program grounded in spiritual intelligence to enhance psychological well-being among university students. His research contributions include published work on mental motivation and its relationship with psychological well-being. He can be contacted at email: ahmedelnhal.2026@azhar.edu.eg.

Mohamed Ali Nemt-allah is a lecturer at the Department of Educational Psychology and Statistics, Faculty of Education, Al-Azhar University, Tafhna Al-Ashraf, Egypt. His expertise centers on the intersection of psychology and education, emphasizing statistical method applications in educational research and practice. His professional responsibilities encompass teaching, research, and academic development of students in educational psychology and statistics. Dr. Nemt-allah contributes to advancing quantitative methodologies in educational research, helping bridge theoretical psychological concepts with practical educational applications through rigorous statistical analysis and interpretation. He can be contacted at email: mohamednamatallah.2026@azhar.edu.eg.