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An overlooked academic stressor: deadline anxiety among design students

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ABSTRACT

This study investigates the underexplored phenomenon of deadline anxiety among undergraduate design students, a unique form of academic stress caused by frequent and overlapping assignment deadlines. Unlike the well-researched test anxiety, deadline anxiety is particularly prevalent in design disciplines due to the emphasis on practical and technical courses, which require students to complete multiple comprehensive design projects. Utilizing a structural equation model, this study examines the roles of time management, self-efficacy, time efficacy, and psychological resilience in mitigating deadline anxiety. The results suggest that time monitoring is negatively associated with deadline anxiety, whereas self-efficacy and time efficacy do not show statistically significant direct associations. psychological resilience, however, emerges as a significant mediating variable, reflecting its potential role in shaping the relationship between self-related efficacy and deadline anxiety. The findings underscore the importance of structured time management training and resilience-building strategies to help design students manage their unique academic pressures effectively. Furthermore, enhancing psychological resilience allows students to view challenges as opportunities for growth, thus improving both academic performance and emotional well-being. Given the impact of deadline anxiety on creativity and long-term development, future research should explore additional mediating factors and develop targeted support strategies.

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1. INTRODUCTION

Academic stress is a psychological state triggered by academic scenarios, often influenced by individual cognitive patterns and personality traits, and is primarily characterized by persistent worry [1]. Among various forms of academic stress, test anxiety has received the most attention. It manifests through affective symptoms such as fear, cognitive distortions such as negative expectations or fear of failure, and maladaptive coping behaviors like procrastination or ineffective study strategies [2]. The consequences of test anxiety include impaired motivation, reduced academic achievement, diminished cognitive functioning (e.g., working memory and attention), and even long-term psychological disorders [3]–[5].

Although academic stress has long been a subject of extensive research [6], most studies treat it as a broad construct, paying limited attention to the specific psychological strain associated with deadline-driven tasks [7]. While motivational research has addressed procrastination and surface learning tendencies near

deadlines [8], few studies have examined the anxiety triggered by procrastination itself [9]. Deadline anxiety, a distinct yet often overlooked form of academic stress, is particularly salient in design disciplines, where students are frequently required to manage multiple intensive projects under strict time constraints. Compared to exam-based evaluations, project-based tasks pose more complex emotional and cognitive challenges, potentially exerting adverse effects on students' psychological well-being [10]. In this context, the present study focuses on deadline anxiety in design education and investigates the underlying psychological mechanisms through which it operates.

2. LITERATURE REVIEW

Unlike conventional academic programs in science or the humanities, design-related curricula are heavily centered on practical and technical courses [11]. As a result, students are often evaluated through comprehensive "final projects" that serve as a substitute for conventional final examinations [12], [13]. These projects demand not only technical proficiency but also a high degree of creativity and time investment, often leading to intense academic pressure as deadlines converge toward the end of the semester.

Previous studies have shown that students in industrial and interior design programs frequently experience high levels of stress due to poor time management and creative overload [14], [15]. In some cases, such stress may even inhibit creative performance and lead to physical and cognitive strain. However, some scholars have argued that project-induced stress may also foster team collaboration and problem-solving skills in studio-based learning environments [16]. Urban design programs, for instance, emphasize iterative project work over traditional exams to train design intuition [17].

Despite these educational innovations, the psychological consequences of repeated and overlapping deadlines have not been sufficiently examined. Most existing literature has focused on test anxiety, largely overlooking the stress dynamics faced by design students during project execution phases [18], [19]. As the semester progresses, students often encounter multiple deadlines simultaneously, which intensifies pressure and exacerbates anxiety [20].

To address this gap, the current study conceptualizes and measures "deadline anxiety" as a unique psychological phenomenon within the context of design education. It further investigates how four psychological constructs, time monitoring, time efficacy, self-efficacy, and psychological resilience, affect deadline anxiety through both direct and indirect pathways. A structural equation modeling (SEM) approach is employed to reveal the mediating mechanisms and to provide empirical evidence for future interventions.

2.1. Time management

An individual's voluntary effort to use time in an effective manner to achieve specific goals is known as time management [21], [22]. Psychology also views time management as the psychological and behavioural traits people display in their use and handling of time [23]. Wearden [24] and Grondin [25] introduced the concept of time perceptions, defined as an individual's perception and understanding of the value of time, reflecting how one views time as a resource. Additionally, Bandura and Perloff first introduced the concept of time monitoring in their self-regulation theory, which refers to the monitoring and management of time use by individuals [26]. This includes activities such as time allocation, progress tracking, and task completion supervision [27], [28]. Furthermore, Xie *et al*. [29], based on time management, proposed the concept of time efficacy, defined as an individual's belief in and confidence regarding their effective use of time, reflecting their self-assessment of time management abilities in completing tasks and achieving goals.

A substantial body of research shows that time management and perception are among the most critical issues students face in their learning [30]. Several studies indicate that students' academic stress and anxiety levels are highly correlated with their time management skills and styles [31]. High-level time managers are better at utilizing their time, effectively reducing anxiety [32]. Conversely, low-level time managers are more prone to anxiety. Alawad and Slamah [33] conducted a survey on student stress at King Abdulaziz University, finding that undergraduate students majoring in furniture design and interior design experienced significantly higher academic stress than those in other disciplines. The results suggest that the prevalent stress among design students is primarily caused by the tense environment of project-based learning, excessive design assignments, and career-related concerns.

Generally, there are two ways in which students' time management behaviors lead to changes in outcome variables: first, time monitoring behaviors directly alleviate negative experiences such as academic stress [34]; second, time monitoring behaviors reduce negative learning experiences by enhancing time efficacy [35]. Therefore, this study hypothesizes that, within the design learning environment, students can directly reduce "assignment anxiety" through reasonable planning and goal-setting as part of their time-monitoring behavior and indirectly reduce the anxiety about assignments by increasing their confidence in managing and controlling their time, thereby enhancing time efficacy. Therefore, the hypothesis is

proposed: H1: time monitoring directly influences deadline anxiety and indirectly affects deadline anxiety through time efficacy.

2.2. Self-efficacy

Self-efficacy refers to an individual's judgement and expectation of their own ability to complete specific behaviours and tasks [36]. A substantial amount of research has demonstrated that self-efficacy is an important factor in the processes that influence students' anxiety and other psychosomatic responses [37], [38]. Students with high self-efficacy are better equipped to cope with the stress of exams, thereby reducing their risk of developing test anxiety [39], particularly in exam-oriented education. For example, a study found that time management training effectively enhances self-efficacy among English majors, which in turn reduces their test anxiety [14], [40]. Similarly, a study on a finance course showed that the use of online assessments lowered self-efficacy and positively influenced test anxiety [41]. Similarly, a study examining math ability and test anxiety discovered a negative correlation between math performance and math anxiety, and a positive correlation between math enjoyment and math self-efficacy [37]. Overall, self-efficacy negatively impacts test anxiety and serves as a mediating factor in the effects of various time management training programs on test anxiety. A similar relationship and correlation may also exist among students in design majors. Therefore, this study proposes the hypothesis: H2: self-efficacy is a mediating variable in the effect of time monitoring behavior and time efficacy on deadline anxiety.

2.3. Psychological resilience

Psychological resilience is a concept that emphasises the mental capacity to cope with and adapt to challenges, including emotional regulation, problem-solving, and maintaining a positive attitude in the face of adversity or stress [42]. A substantial body of research indicates that psychological resilience is a critical factor in shaping and influencing academic anxiety. For example, a study on anxiety among university student-athletes showed that psychological resilience significantly predicts their mental health, with higher resilience scores associated with fewer reported symptoms of depression and anxiety [43]. Similarly, a study on English language teaching found that both psychological resilience and mindfulness can predict academic anxiety and serve as effective tools for combating anxiety and other negative emotions [44]. Wadi *et al*. [45] developed the systematic assessment for resilience (SAR) framework to address medical students' academic stress and found that the SAR significantly strengthened medical students' psychological resilience, thereby reducing psychological distress and academic anxiety. Therefore, this study proposes the hypothesis: H3: psychological resilience is a mediating variable between time efficacy, self-efficacy, and deadline anxiety.

2.4. Hypothetical model development of deadline anxiety

Despite growing evidence on test anxiety, the distinct phenomenon of deadline anxiety, driven by overlapping "final projects" in design curricula, remains understudied. To fill this gap, we propose a single-paragraph chain-mediation model in which time monitoring directly alleviates deadline anxiety and boosts time efficacy, both of which strengthen self-efficacy; heightened self-efficacy then enhances psychological resilience, which further diminishes anxiety. This integrated framework simultaneously captures direct effects and sequential mediations among time management, self-efficacy, and resilience, offering a nuanced understanding of how structured planning and intrapsychic resources can mitigate deadline anxiety in undergraduate design students (Figure 1).

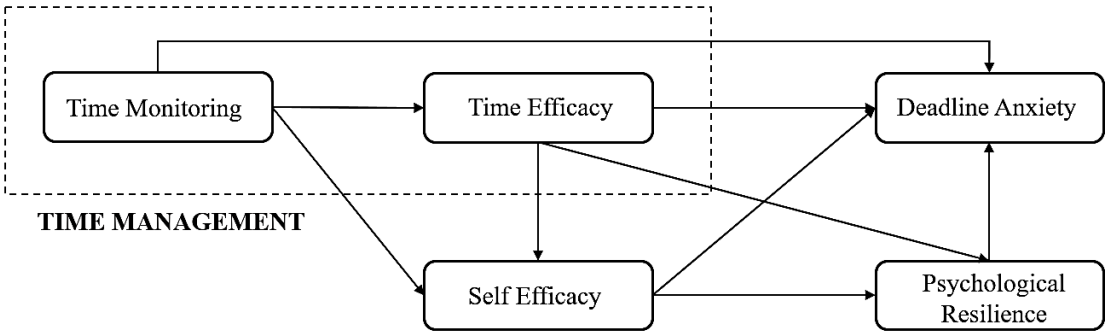

Figure 1. Hypothesis model of deadline anxiety

3. METHOD

In this study, we aim to explore the mechanisms influencing deadline anxiety among design students, using time monitoring, time efficacy, self-efficacy, and psychological resilience as multiple mediating variables to form a hypothetical model. SEM was used as the main statistical analysis method, with several undergraduate students from various design-related majors recruited as participants. Statistical analysis was conducted using SPSS 3.0 for correlation analysis, and Mplus 6.8 for SEM analysis.

Prior to the formal commencement of the study, ethical approval was obtained from the university's ethics review board to ensure that the research procedures complied with ethical standards and data privacy regulations. At the beginning of the questionnaire, a digital informed consent interface was implemented, clearly outlining the purpose of the study, the use of data, and measures to protect anonymity. Only participants who clicked "Agree to Participate" were allowed to proceed with the questionnaire.

3.1. Sampling

A total of 516 questionnaires were distributed for this study, and 512 responses were received. After removing incomplete or invalid entries, 438 valid questionnaires were retained for final analysis. These valid responses were obtained from undergraduate students in design-related majors, selected using a stratified random sampling technique to ensure representation across academic years and disciplinary backgrounds. The target population consisted of approximately 1,200 undergraduate students enrolled in eight design-related programs at the host university: architecture, interior design, product design, fashion design, animation design, software engineering, graphic design, and engineering design. Stratification was based on both academic year (sophomore, junior, and senior) and discipline to achieve proportional representation, as shown in Table 1.

To improve coverage and reflect variations in deadline stress across the semester, data were collected in two phases. The first round occurred in early April 2023, targeting sophomore and junior students in the mid-stages of their semester projects. The second round was conducted in mid-May 2023, focusing on final-year students approaching final project deadlines.

In both phases, data were collected through an online questionnaire distributed via official university email channels and learning management systems. The questionnaire was administered using two widely used Chinese survey platforms: Tencent Questionnaire and SoJump. These platforms ensured broad accessibility, data security, and mobile compatibility.

Table 1. Participant demographics by discipline

Discipline	N	Male (n)	Female (n)	Avg. age (years)
Architecture	58	32	26	19.77
Interior design	53	28	25	19.61
Product design	60	33	27	19.43
Fashion design	55	21	34	19.75
Animation design	50	29	21	19.62
Software engineering	54	37	17	19.87
Graphic design	56	29	27	19.12
Engineering design	52	29	23	19.82
Total	438	238	200	19.62

3.2. Research instruments

To quantify and measure the relevant variables in the hypothetical model, this study adapted relevant scales and instruments according to the teaching environment faced by design students. Self-efficacy was measured using the original version of the general self-efficacy scale (GSES) without modification. Based on related studies, we adapted other variables like time monitoring, time efficacy, and psychological resilience to better suit the context of undergraduate design students.

To ensure the reliability and validity of the questionnaire, multiple rounds of pilot testing and expert reviews were conducted prior to its official distribution. Initially, five experts in the field of design education were invited to evaluate the questionnaire content, thereby ensuring the content validity of each indicator. Subsequently, a pilot test was conducted in March 2023 with a sample of 60 informal participants, and the feedback collected was used to refine the structure and wording of the questionnaire. In the formal sample, the Cronbach's alpha coefficient was calculated to be 0.872, indicating good internal consistency. Furthermore, factor analysis was conducted to verify construct validity, yielding a KMO value of 0.826 and a significant Bartlett's test of sphericity ($p<0.001$), which further supports the applicability and psychometric soundness of the questionnaire.

3.2.1. Measurement of time monitoring and time efficacy

For the measurement of time monitoring and time efficacy, this study adapted the adolescence time management disposition scale (ATMD) proposed by Xie *et al*. [29]. The time monitoring section was based on the study by Adam and Blair [46], which explored the impact of time management on engineering design students. A study examined the impact of time management strategies on the academic performance of architecture students, which informed the time efficacy section. The scale utilized a 5-point Likert scale from the ATMD, where 1 equal "strongly disagree" and 5 equals "strongly agree". Both scales passed the internal consistency tests ($\alpha_{TM} = 0.86$, $\alpha_{TE} = 0.79$).

3.2.2. Measurement of self-efficacy

This study measured self-efficacy using the GSES developed by Schwarzer and Jerusalem [47]. The GSES is considered a classic scale for assessing self-efficacy and has demonstrated excellent reliability and validity across culturally and racially diverse samples. The scale consists of 10 items, scored on a 5-point Likert scale (1=strongly disagree to 5=strongly agree). A pilot study confirmed the internal consistency of the GSES (α=0.87).

3.2.3. Measurement of psychological resilience

To measure psychological resilience, this study employed the Connor-Davidson Resilience Scale (CD-RISC), developed Burns and Anstey [48]. A comprehensive review of the literature on psychological resilience measurement tools informed this choice, revealing that the CD-RISC simplifies the number of dimensions and items while maintaining a high level of reliability and validity, thereby reducing the cognitive load on participants. Given that participants in this study were required to complete multiple questionnaires, minimising the number of items per questionnaire was crucial to sustaining their attention and avoiding cognitive overload. As a result, this study used a version of the CD-RISC containing 10 items, rated on a 5-point scale (1=strongly disagree to 5=strongly agree). The CD-RISC demonstrated excellent internal consistency in this study (α=0.74).

3.2.4. Measurement of deadline anxiety

Due to the scarcity of research focusing specifically on the measurement of deadline anxiety, there are a few scales that are a perfect match for this purpose. Therefore, this study drew upon research related to test anxiety, which is similar to deadline anxiety, and adapted the cognitive test anxiety scale-revised (CTAR) as a prototype to better align with the academic stress experienced by undergraduates. The CTAR eliminates reverse-coded items, making the measurement simpler and clearer while maintaining internal consistency and structural validity, particularly for undergraduates. Additionally, a study on the impact of emotional intelligence and test anxiety on academic performance among university students demonstrated that the CTAR has excellent reliability for measuring deadline anxiety (α=0.96).

Based on this, the study adapted the CTAR into a version suitable for measuring deadline anxiety in design majors, termed the cognitive deadline anxiety scale (CDAC). In this study, the CDAC passed both confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) tests (χ^2=45.2, χ^2/df=1.036, root mean square error of approximation (RMSEA)=0.045, comparative fit index (CFI) =0.97, Tucker–Lewis's index (TLI) =0.96), and its internal consistency was considered acceptable (α >0.75).

4. RESULTS AND ANALYSIS

To minimize the potential for common method bias (CMB) during the questionnaire administration, this study implemented strict controls over the data collection process. For instance, data was collected anonymously to reduce response bias that might arise from social desirability or other external influences. Additionally, the questionnaire included several reverse-coded items to mitigate errors resulting from automatic responding or consistency bias. To further assess the presence of CMB, the study employed Harman's single factor test (HSFT).

4.1. Results of the correlation analysis

In this study, the average score for deadline anxiety among undergraduate design students was 29.833, with a standard deviation of 6.881. Notably, 67.4% of the students scored above 65% of the total possible score (M=32.27, SD=6.33), and 36.7% scored above 75% of the total score (M=37.70, SD=6.41). According to the scoring criteria of the classic test anxiety scale (TAS) developed by Sarason, a score above 50% of the total indicates a certain level of academic stress, while a score above 75% suggests a potential risk of developing anxiety disorders. Therefore, it is evident that design students face substantial academic pressure, primarily due to multiple course assignments.

As shown in Table 2, this study conducted a correlation analysis to explore the interrelationships among various psychological factors. Time monitoring was found to have a significant positive correlation with time efficacy (r=0.702, p<0.01), indicating that the effectiveness of time monitoring is closely related to individuals' sense of self-efficacy in time management. Moreover, time monitoring also showed a significant positive correlation with self-efficacy (r=0.371, p<0.001), further emphasizing the role of self-efficacy in time management. The positive correlation between psychological resilience and time monitoring (r=0.410, p<0.01) reveals the importance of psychological resilience in promoting effective time monitoring. Interestingly, a negative correlation was observed between deadline anxiety and time monitoring (r =-0.153, p<0.05), which may imply that individuals may feel anxious when facing tight deadlines, thereby affecting their ability to monitor time.

The positive correlation between self-efficacy and time efficacy (r=0.407, p<0.001) further confirms the role of self-efficacy in promoting time management. The positive correlation between psychological resilience and self-efficacy (r=0.339, p<0.001) indicates that individuals with higher psychological resilience are often better at managing self-efficacy. The negative correlation between psychological resilience and deadline anxiety (r=-0.494, p<0.001) reveals the potential role of psychological resilience in alleviating deadline anxiety. These results provide an initial perspective for understanding the complex relationships between time management, self-efficacy, psychological resilience, and deadline anxiety, and offer preliminary reference for subsequent studies to determine the complex key factors of time management and deadline anxiety.

Table 2. Results of the correlation analysis

No	Factors	M	SD	1	2	3	4	5
1	Time monitoring	15.116	5.532	/				
2	Time efficacy	11.555	4.564	0.702**	/			
3	Self-efficacy	15.443	4.505	0.371***	0.407***	/		
4	Psychological resilience	17.201	7.557	0.410**	0.455***	0.339***	/	
5	Deadline anxiety	29.833	6.881	-0.153*	-0.232**	-0.213***	-0.494***	/

Note: M=mean, SD=standard deviation, *p<0.05, **p<0.01, and ***p< 0.001.

4.2. Subgroup analysis of deadline anxiety

To better understand how background variables influence students' experiences of deadline anxiety, subgroup analyses were conducted on a sample of 438 undergraduate students majoring in design-related disciplines. Results showed no statistically significant differences in deadline anxiety scores across academic year groups (sophomore, junior, and senior; F=0.78, p=0.460), indicating that academic progression does not appear to substantially affect anxiety levels. Similarly, no significant difference was found between students in art and design disciplines (e.g., graphic design, fashion, and animation) and those in engineering design disciplines (e.g., software engineering, architecture, product engineering) with regard to their reported anxiety (t=0.54, p=0.591), suggesting that project type does not meaningfully differentiate students' anxiety experiences as shown in Table 3.

Table 3. Comparison of deadline anxiety scores across subgroups

Subgroup variable	Category	Sample size (n)	deadline anxiety (M ± SD)	F/t value	p value
Academic year	Sophomore	140	29.72 ± 6.91	F=0.78	.460
	Junior	160	29.85 ± 6.74		
	Senior	138	29.93 ± 6.95		
Project type	Art and design	256	29.89 ± 6.84	t=0.54	.591
	Engineering design	182	29.76 ± 6.91		
Gender	Male	238	30.52 ± 7.04	t=2.31	.021*
	Female	200	29.01 ± 6.57		

Note: *p<0.05

However, a statistically significant difference was observed in relation to gender. Male students reported significantly higher levels of deadline anxiety compared to female students (t=2.31, p=0.021). This finding suggests that male students may experience more pronounced emotional strain when managing complex design projects under tight deadlines. As such, future interventions or support strategies aimed at reducing academic stress in design education may benefit from incorporating gender-sensitive approaches.

4.3. The impact mechanism of time management on deadline anxiety

A structural equation model analysis was conducted to examine the relationships between time monitoring, time efficacy, self-efficacy, psychological resilience, and deadline anxiety among design students. Since the model includes both manifest and latent variables, the Bootstrap method (with 5,000 resamples) was used to test the model.

Firstly, demographic data such as gender, age, discipline, and academic year were included as covariates to assess the direct effect of time monitoring on deadline anxiety. The results showed that the model fit was acceptable (χ^2/df=2.082, RMSEA=0.054, goodness-of-fit index (GFI)=0.859, adjusted goodness-of-fit index (AGFI)=0.834, comparative fit index (CFI)=0.921). Time monitoring behaviour was found to significantly negatively predict students' deadline anxiety (β=-0.275, t=3.152, p<0.001).

Secondly, to ensure an improved model fit, several items with suboptimal convergent validity were removed from the constructs of psychological resilience and self-efficacy. As shown in Figure 2, the revised model demonstrated a better fit than before (χ^2/df=2.029, RMSEA=0.038, AGFI=0.930, CFI=0.951). Self-efficacy significantly positively influenced psychological resilience (β=0.354, t=7.581, p<0.001), and psychological resilience significantly negatively predicted deadline anxiety (β=-0.640, t=14.772, p<0.001).

However, the negative predictive effect of time efficacy on deadline anxiety was not statistically significant (β=-0.291, t=-1.916, p=0.054), and similarly, the negative predictive effect of self-efficacy on deadline anxiety was not significant (β=-0.336, t=-1.765, p=0.076). This indicates that, within this model, the only direct factors in reducing deadline anxiety are time monitoring and psychological resilience.

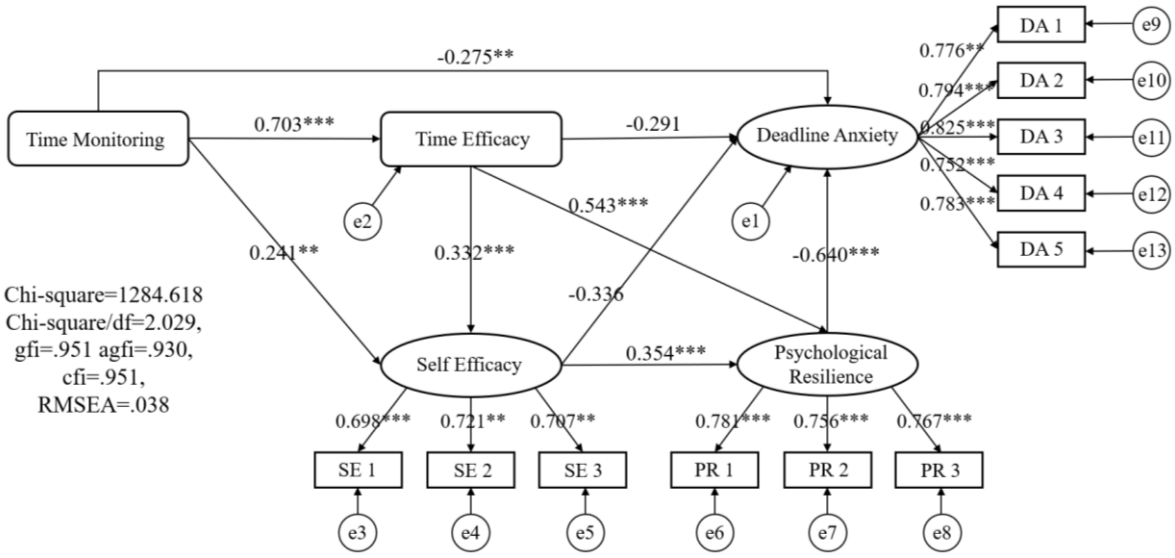

Figure 2. Results of a chain model for deadline anxiety

Finally, multiple mediation analyses were conducted for the significant pathways. As shown in Figure 2 and Table 4, time monitoring has a direct effect on deadline anxiety among undergraduate design students, with an effect size of -0.275 and a 95% confidence interval of [-0.312, -0.087], indicating that this direct effect is significant. The chain mediation effect of time efficacy and psychological resilience between time monitoring and deadline anxiety is also significant, with an effect size of -0.249 and a 95% confidence interval of [-0.326, -0.187] and an effect size of 1.028, demonstrating a strong mediating effect. Similarly, the chain mediation effect of self-efficacy and psychological resilience between time monitoring and deadline anxiety is significant, with an effect size of -0.053 and a 95% confidence interval of [-0.086, -0.021], and an effect size of 0.189. The chain mediation effect of time efficacy, self-efficacy, and psychological resilience between time monitoring and deadline anxiety is also significant, with an effect size of -0.047 and a 95% confidence interval of [-0.084, -0.026] and an effect size of 0.180.

As shown in Table 4, this study analyzed the total effects, mediation effects, and indirect effects. The overall indirect effect (Sum) was -0.349, with a 95% confidence interval of [-0.410, -0.187], further confirming the influence of time monitoring on deadline anxiety among undergraduate design students through different mediation pathways.

The difference in effect sizes between "TM → SE → PR → DA" and "TM → TE → SE → PR → DA" was 0.007, with a 95% confidence interval of [-0.026, 0.022], which means there was no important difference in the mediation effects between these two paths. In summary, there is a multiple chain mediation model between time monitoring and deadline anxiety among undergraduate design students, encompassing three mediation pathways, each demonstrating a significant mediation effect. Furthermore, different mediation pathways play distinct roles in influencing the relationship between time monitoring behaviours and test anxiety among design students.

Table 4. Comparative analysis of multiple mediating effects

Effect type	Paths	Estimate	Standard error	Effect size	95% CI
Direct effect	TP: TM → DA	-0.275	0.068	0.673	[-0.312, -0.087]
Mediation effects	P1: TM → TE → PR → DA	-0.249	0.043	1.028	[-0.326, -0.187]
	P2: TM → SE → PR → DA	-0.053	0.024	0.189	[-0.086, -0.021]
	P3: TM → TE → SE → PR → DA	-0.047	0.016	0.180	[-0.084, -0.026]
	Indirect effect (Sum)	-0.349	0.038	0.466	[-0.410, -0.187]
Comparative analysis	P1 vs P2	-0.196	0.037	/	[-0.220, -0.079]
	P1 vs P3	-0.202	0.034	/	[-0.200, -0.081]
	P2 vs P3	0.007	0.021	/	[-0.026, 0.022]

Note: TM=time monitoring; TE=time efficacy; SE=self-efficacy; PR=psychological resilience; DA=deadline anxiety; TP=total path; CI=confidence interval; and P=path.

4.4. Multi-group invariance test of mediation effects

Since this study recruited participants from eight different design disciplines (e.g., architecture, interior design, software engineering, and graphic design), a multi-group invariance test was conducted to determine whether the model maintains consistency and equivalence across different design disciplines. When conducting the multi-group invariance test, it is essential to first observe the p-value. If the p-value is not significant ($p>0.05$), it indicates model invariance. If the p-value is significant, it is necessary to examine the ΔCFI and ΔAGFI. If $\Delta CFI<0.01$ and $\Delta AGFI<0.05$, it suggests that the model differences are not statistically significant.

As shown in Table 5, all invariance tests, except for path invariance, are not significant, with p-values greater than 0.05. For path invariance, although the p-value is less than 0.05, the ΔCFI is -0.002, and the ΔAGFI is -0.004. Therefore, the model demonstrates cross-group invariance for students across different design disciplines, indicating that it is applicable to architecture, interior design, product design, fashion design, animation design, software engineering, graphic design, and engineering design.

Table 5. Structural model invariance test for different design disciplines

Invariance	$\chi2$	df	$\Delta\chi2$	Δdf	p	CFI	ΔCFI	AGFI	ΔAGFI
Configural invariance	210.235	82	/	/	/	0.951	/	0.930	/
Factor loading invariance	253.331	86	4.635	8	0.630	0.921	0.001	0.912	0.004
Intercept invariance	243.614	89	27.361	10	0.054	0.914	-0.002	0.909	-0.004
Path invariance	231.593	94	3.016	8	**	0.915	0.002	0.907	0.001
Structural residual invariance	257.364	102	11.008	5	0.050	0.917	-0.002	0.910	-0.001
Measurement residual invariance	265.312	105	14.896	11	0.113	0.911	-0.005	0.921	0.003

Note: **p<0.01

5. DISCUSSION

Based on the process model of time management, self-efficacy theory, and psychological resilience model, and considering the academic pressure caused by design assignments in design disciplines, this study proposed a model for deadline anxiety.

5.1. The underestimated harm of deadline anxiety

Compared to research on test anxiety, the perception of deadline anxiety among design students is significantly higher than the perception of test anxiety among students in conventional science and humanities disciplines. This suggests that deadline anxiety, which has been long overlooked, is actually having a serious impact on the mental health of design students.

Importantly, design students often require more creativity and divergent thinking to help them produce high-quality products and design solutions. As some studies have suggested, excessive academic pressure can lead to negative cognitive responses among design students [10]. Unfortunately, this overlooked deadline anxiety is far more severe than previously imagined, and it may be eroding their creative enthusiasm and suppressing creative thinking.

However, heightened levels of deadline anxiety may be associated with students placing greater emphasis on managing time constraints (i.e., completing design tasks within set deadlines). If deadline anxiety is not effectively managed over the long term, it may gradually diminish students' creative passion and adversely affect their long-term development in the design field.

5.2. The influence mechanism of time management and self-efficacy on deadline anxiety

In our structural model, time monitoring, a core facet of time management, directly and negatively predicts deadline anxiety in undergraduate design students. By segmenting projects into time-bound phases and estimating workloads, students bolster their self-efficacy, gain clearer insight into productivity, and thus alleviate anxiety.

Notably, neither self-efficacy nor time efficacy exerts a significant direct effect on deadline anxiety, unlike findings in test anxiety studies (e.g., Pérez-Fuentes *et al.* [49] on math exams; pandemic online-exam research; Kordzanganeh's work on academic burnout). This divergence suggests stronger moderators may intervene in design contexts. Highly self-efficacious students often impose rigorous standards on themselves; when instructor feedback falls short of these expectations, overconfidence may yield frustration. Without sufficient psychological resilience, negative feedback can exacerbate, rather than ease, deadline anxiety.

To clarify these dynamics, future research should incorporate in-depth interviews aimed at identifying key mediators such as resilience, feedback sensitivity, or perfectionism that shape the relationship between self-efficacy and deadline anxiety in design disciplines.

5.3. The impact of deadline anxiety on creativity

From the perspective of cognitive load theory, excessive anxiety can consume individuals' working memory resources, thereby impairing their capacity for deep processing and creative thinking [50]. Design education inherently requires students to engage in open-ended and divergent thinking. However, when students are under sustained time pressure, they tend to adopt conservative strategies to complete tasks, avoiding risk-taking and experimentation, which may suppress their creative potential [15]. Notably, the effect of anxiety on creative performance is not uniformly negative; rather, it is conditional on factors such as task type, contextual demands, and individual coping resources [51].

However, existing research suggests that the relationship between academic stress and student creativity is not a simple negative correlation. Instead, it is often moderated by individual-level variables such as self-efficacy, time management skills, and psychological resilience [52]. As Amabile and Mueller [53] argue, the influence of stress on creativity is contingent on both personal traits and situational moderators. In some cases, moderate time pressure may even enhance task-oriented creativity, particularly in well-structured assignments [54]. However, when stress exceeds an individual's regulatory capacity or is compounded by a lack of contextual support, creativity is more likely to be inhibited.

Therefore, deadline anxiety does not necessarily undermine students' creativity. Its impact depends on whether individuals possess sufficient cognitive and emotional regulation resources, and whether they can maintain a constructive perception of time and task motivation. Future studies could adopt multi-time-point data collection methods to examine how such moderating mechanisms operate over time in the relationship between anxiety and creativity.

5.4. Institutional structures and instructional factors influencing deadline anxiety

In design education, project-based learning serves as a pedagogical core. Students are expected to complete ideation, sketching, iterative development, and final outputs within limited timeframes tasks that are inherently high in intensity and openness, thus carrying built-in psychological pressure [55]. When multiple courses impose overlapping final submission deadlines without institutional coordination, a "deadline stacking" effect emerges, forcing students to manage several major projects simultaneously and significantly increasing deadline anxiety. Moreover, the absence of structural buffers such as flexible submissions or staged progress assessments amplifies uncertainty throughout the project process, particularly for students with low self-efficacy or poor temporal perception [20].

The role of instructors in design education is equally critical. Unlike traditional classroom teaching, studio-based pedagogy heavily depends on personalized guidance, feedback pacing, and structured project framing. When instructors fail to clearly communicate evaluation criteria or frequently alter task requirements mid-project, students face not only creative pressure but also cognitive overload and emotional

volatility due to shifting expectations. Research further suggests that instructors who implement interim reviews, provide emotional scaffolding, or allow for deadline negotiations can help reduce students' "emotional thresholds" as submission approaches. Thus, in design education, instructors function not only as content facilitators but also as key mediators of temporal stress environments.

5.5. Limitation and future research

This study offers a theoretical and empirical contribution to understanding the psychological mechanisms underlying deadline anxiety in design education. However, several limitations should be acknowledged, which in turn point to valuable directions for future research.

First, the research is based on a cross-sectional survey design and adopts a SEM approach to examine students' perceptions of deadline anxiety and its associated predictors (e.g., time monitoring, time efficacy, self-efficacy, and psychological resilience). While the questionnaire was distributed in two waves to enhance temporal coverage, targeting students at mid-project and near-final submission stages, the data were not collected using a longitudinal or repeated-measures format. Therefore, the study does not capture within-subject temporal changes in anxiety levels across different phases of the semester. This is a methodological constraint inherent in the model design, which emphasizes structural relationships rather than time-based comparisons. Future studies are encouraged to incorporate longitudinal designs or experience sampling methods to dynamically track how deadline anxiety fluctuates over time, potentially identifying critical intervention windows during the academic calendar.

Second, although the sample includes a diverse range of majors and academic years, all participants were drawn from a single university in China. This institutional specificity may limit the external generalizability of the findings. Additionally, while subgroup analyses revealed no significant differences in deadline anxiety across academic year or project type, gender differences were observed, with male students reporting higher anxiety levels. Future work could explore whether this pattern holds in other cultural or educational contexts and whether it is moderated by factors such as teaching style, peer collaboration, or evaluation.

Third, the current model focuses on psychological and behavioral constructs but does not include other potentially important variables such as personality traits, perfectionism, or feedback sensitivity, which may shape how students interpret and respond to deadlines. Integrating these constructs into future models could enhance explanatory depth and lead to more targeted interventions.

In sum, future research should aim to: i) employ longitudinal or within-subject designs to capture temporal dynamics in anxiety; ii) expand sampling to multiple institutions or cross-national contexts; and iii) broaden the theoretical framework to include additional individual and contextual moderators. These steps would advance a more comprehensive and context-aware understanding of deadline anxiety in design education.

6. CONCLUSION

This study reveals the positive roles of time efficiency and self-efficacy in alleviating deadline anxiety faced by design students. The research findings indicate that when students feel confident in their time management skills, this confidence can translate into enhanced psychological resilience, effectively reducing their deadline anxiety. Similarly, self-efficacy, or students' belief in their ability to complete tasks, also appears to boost psychological resilience, helping them better cope with the academic pressures and challenges of design disciplines.

Moreover, psychological resilience plays a critical role in this process; it is not only an essential resource for students to handle academic stress but also a key factor in their personal growth and development. By cultivating and strengthening psychological resilience, students can manage stress more effectively and view challenges as opportunities for growth and learning, ultimately achieving better outcomes in both academic and personal life. In summary, enhancing time efficiency and self-efficacy not only strengthens students' psychological resilience but also helps them remain calm and efficient when dealing with the deadline anxiety brought on by various design tasks in their studies.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
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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

The authors declare that they have no competing interests.

DATA AVAILABILITY

All data related to this paper can be requested from the corresponding author, [ZD], upon reasonable request.

REFERENCES

[1] N. Reiss, I. Warnecke, A. N. Tibubos, T. Tolgou, U. Luka-Krausgrill, and S. Rohrmann, "Effects of cognitive-behavioral therapy with relaxation vs. imagery rescripting on psychophysiological stress responses of students with test anxiety in a randomized controlled trial," *Psychotherapy Research*, vol. 29, no. 8, pp. 974–985, 2019, doi: 10.1080/10503307.2018.1475767

[2] L. Fehm, T. Fydrich, and K. Sommer, "Prüfungsangst," (in German), in *Series: Fortschritte der Psychotherapie,* 2nd Ed. Hogrefe Verlag GmbH & Company KG, 2022, vol. 44, doi: 10.1026/03151-000.

[3] L. Tsegay, S. Shumet, W. Damene, G. Gebreegziabhier, and G. Ayano, "Prevalence and determinants of test anxiety among medical students in Addis Ababa Ethiopia," *BMC Medical Education*, vol. 19, no. 423, pp. 1–10, 2019, doi: 10.1186/s12909-019-1859-5.

[4] W. Zhang, A. De Beuckelaer, L. Chen, and R. Zhou, "ERP evidence for inhibitory control deficits in test-anxious individuals," *Frontiers in Psychiatry*, vol. 10, 2019, doi: 10.3389/fpsyt.2019.00645.

[5] H. Wei, T. P. Oei, and R. L. Zhou, "Test anxiety impairs inhibitory control processes in a performance evaluation threat situation: evidence from ERP," *Biological Psychology*, vol. 168, p. 108241, 2022, doi: 10.1016/j.biopsycho.2021.108241.

[6] N. Idoiaga-Mondragon, M. Gaztañaga, I. Yarritu, and E. Pascual-Sagastizabal, "Academic anxiety in Spanish higher education: a systematic review," *Behavioral Sciences*, vol. 15, no. 2, 2025, doi: 10.3390/bs15020192.

[7] E. Yulina, I. K. Dewi, and D. M. G. S. Lubis, "The relationship between academic stress and mental health of Medan Area University students," *JCS - Journal of Comprehensive Science*, vol. 4, no. 7, pp. 2284–2291, 2025.

[8] P. Hernandez Sibo, D. A. Gomez Celis, and S. Liou, "Exploring the landscape of cognitive load in creative thinking: a systematic literature review," *Educational Psychology Review*, vol. 36, no. 1, 2024, doi: 10.1007/s10648-024-09866-1.

[9] C. Y. A. Ko and Y. Chang, "Investigating the relationships among resilience, social anxiety, and procrastination in a sample of college students," *Psychological Reports*, vol. 122, no. 1, pp. 231–245, 2019, doi: 10.1177/0033294118755111.

[10] J. Hilliard, K. Kear, H. Donelan, and C. Heaney, "Students' experiences of anxiety in an assessed, online, collaborative project," *Computers & Education*, vol. 143, 2020, doi: 10.1016/j.compedu.2019.103675.

[11] R. K. Sawyer, "Teaching creativity in art and design studio classes: a systematic literature review," *Educational Research Review*, vol. 22, pp. 99–113, 2017, doi: 10.1016/j.edurev.2017.07.002.

[12] S. Chekurov, M. Wang, M. Salmi, and J. Partanen, "Development, implementation, and assessment of a creative additive manufacturing design assignment: interpreting improvements in student performance," *Education Sciences*, vol. 10, no. 6, 2020, doi: 10.3390/educsci10060156.

[13] J. A. Watson and L. L. Pecchioni, "Digital natives and digital media in the college classroom: assignment design and impacts on student learning," *Educational Media International*, vol. 48, no. 4, pp. 307–320,2011, doi: 10.1080/09523987.2011.632278.

[14] W. Chen, "Preliminary study on the learning pressure of undergraduate industrial design students," University of Cincinnati, pp. 91–104, 2019, doi: 10.7945/C2NM3M.

[15] D. Smith and L. Lilly, "Understanding student perceptions of stress in creativity–based higher education programs: a case study in interior architecture," *Journal of Interior Design*, vol. 41, no. 2, pp. 39–55, 2016, doi: 10.1111/joid.12072.

[16] L. Gomez-Lanier, "The role stress has on the creative process of problem-solving projects: a case study of individuals and collaboration," *International Journal of Social Science Studies*, vol. 6, 2018, doi: 10.11114/ijsss.v6i5.3234.

[17] K. Smatanová and J. Urban, "Outcomes of the experimental assignment in studio project I-urban design," *World Transactions on Engineering and Technology Education*, vol. 16, no. 2, pp. 115–120, 2018.

[18] N. Cross, *Engineering design methods: strategies for product design, 5th ed*. John Wiley & Sons, 2021.

[19] M. Gutai and G. Palaiologou, "Pavilions in architecture studio assessment of design-build approach in architecture education," *Architecture*, vol. 1, no. 1, pp. 38–55, 2021, doi: 10.3390/architecture1010005.

[20] M. Hills and K. Peacock, "Replacing power with flexible structure: implementing flexible deadlines to improve student learning experiences," *University of Calgary Journal Hosting*, vol. 10, 2022, doi: 10.20343/teachlearninqu.10.26.

[21] C. J. Koch and M. Kleinmann, "A stitch in time saves nine: Behavioural decision-making explanations for time management problems," *European Journal of Work and Organizational Psychology*, vol. 11, no. 2, pp. 199–217, 2002, doi: 10.1080/13594320244000120.
[22] R. Gafni, and N. Geri, "Time management: procrastination tendency in individual and collaborative tasks," *Interdisciplinary Journal of Information, Knowledge, and Management*, vol. 5, pp. 115–125, 2010, doi: 10.28945/1127.
[23] C. A. Wolters and A. C. Brady, "College students' time management: a self-regulated learning perspective," *Educational Psychology Review*, vol. 33, no. 4, pp. 1319–1351, 2021, doi: 10.1007/s10648-020-09519-z.
[24] J. Wearden, *The psychology of time perception*. Palgrave Macmillan London. Springer, 1st Ed. 2016, doi: 10.1057/978-1-137-40883-9.
[25] S. Grondin, *The perception of time: Your questions answered*. New York, Routledge, 1st Ed. 2019, doi: 10.4324/9781003001638.
[26] A. Bandura and B. Perloff, "Relative efficacy of self-monitored and externally imposed reinforcement systems," *Journal of Personality and Social Psychology,* vol. 7, no. 2, pp. 111–116, 1967, doi: 10.1037/h0024974.
[27] G. Mioni, S. Grondin, S. N. McLennan, and F. Stablum, "The role of time-monitoring behaviour in time-based prospective memory performance in younger and older adults," *Memory*, vol. 28, no. 1, pp. 34–48, 2020, doi: 10.1080/09658211.2019.1675711.
[28] H. Wang, M. P. Kwan, M. X. Hu, J. H. Qi, J. M. Zheng, and B. Han, "Time allocation and the activity-space-based segregation of different income groups: a case study of Nanjing," *Land*, vol. 11, no. 10, p. 1717, 2022, doi: 10.3390/land11101717.
[29] J. Xie *et al*., "Time management disposition and related factors among nursing managers in China: a cross-sectional study," *Journal of Nursing Management*, vol. 28, no. 1, pp. 63–71, 2020, doi: 10.1111/jonm.12890.
[30] X. Li, W. H. Tan, X. L. Zheng, D. Dou, Y. T. Wang, and H. J. Yang, "Effects of digital monitoring and immediate feedback on physical activity and fitness in undergraduates," *Education and Information Technologies*, vol. 30, pp. 3743–3769, 2025, doi: 10.1007/s10639-024-12990-8.
[31] H. Jenaabadi, N. Nastiezaie, and S. Jalalzaei, "The effect of time management training on student's test anxiety," *Journal of Nursing Education*, vol. 14, no. 5, pp. 12–22, 2016.
[32] K. Rowa, S. Waechter, H. K. Hood, and M. M. Antony, "Generalized anxiety disorder," in *Psychopathology: History, Diagnosis, and Empirical Foundations*, 3rd Ed. 2017, ch. 4, doi: 10.1002/9781394258949.ch4.
[33] A. A. Alawad and A. A. Slamah, "The prevalence of stress among interior design and furniture students," *European Scientific Journal,* vol. 10, no. 23, pp. 60–72, 2014.
[34] H. U. Rahiman, N. Panakaje, A. Kulal, Harinakshi, and S. R. Parvin, "Perceived academic stress during a pandemic: mediating role of coping strategies," *Heliyon*, vol. 9, no. 6, p. e16594, 2023, doi: 10.1016/j.heliyon.2023.e16594.
[35] H. Galindo-Domínguez and M. J. Bezanilla, "Promoting time management and self-efficacy through digital competence in university students: a mediational model," *Contemporary Educational Technology*, vol. 13, no. 2, p. ep294, 2021, doi: 10.30935/cedtech/9607.
[36] A. Bandura, "Self-efficacy: Toward a unifying theory of behavioral change," *Psychological Review*, vol. 84, no. 2, pp. 191–215, 1977, doi: 10.1037/0033-295X.84.2.191.
[37] M. Živković, S. Pellizzoni, E. Doz, A. Cuder, I. Mammarella, and M. C. Passolunghi, "Math self-efficacy or anxiety? The role of emotional and motivational contribution in math performance," *Social Psychology of Education*, vol. 26, no. 3, pp. 579–601, 2023, doi: 10.1007/s11218-023-09760-8.
[38] A. A. Hayat, H. Choupani, and H. F. Dehsorkhi, "The mediating role of students' academic resilience in the relationship between self-efficacy and test anxiety," *Journal of Education and Health Promotion*, vol. 10, no. 1, 2021, doi: 10.4103/jehp.jehp_35_21.
[39] K. Etherton, D. Steele-Johnson, K. Salvano, and N. Kovacs, "Resilience effects on student performance and well-being: the role of self-efficacy, self-set goals, and anxiety," *The Journal of General Psychology*, vol. 149, no. 3, pp. 279–298, 2022, doi: 10.1080/00221309.2020.1835800.
[40] B. Behnam, S. Jenani, and S. Ahangari, "The effect of time-management training on test-anxiety and self-efficacy of Iranian intermediate EFL learners," *Iranian Journal of Language Teaching Research*, vol. 2, no. 1, pp. 45–61, 2014, doi: 10.30466/IJLTR.2014.20423.
[41] E. Blondeel, P. Everaert, and E. Opdecam, "Does practice make perfect? The effect of online formative assessments on students' self-efficacy and test anxiety," *The British Accounting Review*, vol. 56, no. 4, p. 101189, 2024, doi: 10.1016/j.bar.2023.101189.
[42] D. Fletcher and M. Sarkar, "Psychological resilience: a review and critique of definitions, concepts, and theory," *European Psychologist*, vol. 18, no. 1, 2013, doi: 10.1027/1016-9040/a000124.
[43] B. Drew and J. Matthews, "The prevalence of depressive and anxiety symptoms in student-athletes and the relationship with resilience and help-seeking behavior," *Journal of Clinical Sport Psychology*, vol. 13, no. 3, pp. 421-439, 2019, doi: 10.1123/jcsp.2017-0043.
[44] Y. F. Shen, "Mitigating students' anxiety: The role of resilience and mindfulness among Chinese EFL learners," *Frontiers in Psychology*, vol. 13, 2022, doi: 10.3389/fpsyg.2022.940443.
[45] M. M. Wadi, M. S. B. Yusoff, M. H. Taha, S. Shorbagi, N. A. Z. N. Lah, and A. F. A. Rahim, "The framework of systematic assessment for resilience (SAR): development and validation," *BMC Medical Education*, vol. 23, no. 1, p. 213, 2023, doi: 10.1186/s12909-023-04177-5.
[46] R. V. Adams and E. Blair, "Impact of time management behaviors on undergraduate engineering students' performance," *Sage Open*, vol. 9, no. 1, 2019, doi: 10.1177/2158244018824506.
[47] R. Schwarzer and M. Jerusalem, "The general self-efficacy scale (GSE)," *Anxiety, Stress, and Coping*, vol. 12, no. 1, pp. 329–345, 2010.
[48] R. A. Burns and K. J. Anstey, "The Connor–Davidson resilience scale (CD-RISC): testing the invariance of a uni-dimensional resilience measure that is independent of positive and negative affect," *Personality and Individual Differences*, vol. 48, no. 5, pp. 527–531, 2010, doi: 10.1016/j.paid.2009.11.026.
[49] M. del C. Pérez-Fuentes, A. Núñez, M. del M. Molero, J. J. Gázquez, P. Rosário, and J. C. Núñez, "The role of anxiety in therelationship between self-efficacy and math achievement," *Psicología Educativa*, vol. 26, no. 2, pp. 137–143, 2020, doi: 10.5093/psed2020a7.
[50] R. J. Daker, I. V. Viskontas, G. F. Porter, G. A. Colaizzi, I. M. Lyons, and A. E. Green, "Investigating links between creativity anxiety, creative performance, and state-level anxiety and effort during creative thinking," *Scientific reports*, vol. 13, no. 1, 2023, doi: 10.1038/s41598-023-39188-1.
[51] V. Tritsaroli and O. Miraka, "Stress and creativity: the mediating role of anxiety and depression," Linnaeus University, 2019, doi: 10.13140/RG.2.2.22289.40801.

[52] K. Byron, S. Khazanchi, and D. Nazarian, "The relationship between stressors and creativity: a meta-analysis examining competing theoretical models," *Journal of Applied Psychology*, vol. 95, no. 1, pp. 201–212, 2010, doi: 10.1037/a0017868.
[53] T. M. Amabile and J. S. Mueller, "Studying creativity, its processes, and its antecedents: an exploration of the componential theory of creativity," in *Handbook of organizational creativity*, Psychology Press, 1st Ed. 2024, pp. 33–64
[54] R. R. Rocío, D. L. Andrés, B. S. L. Ignacio, and J. R. Jesús, "The impact of emergency remote teaching on students' stress and satisfaction in project-based learning experiences," *International Journal of Engineering Education*, vol. 37, no. 6, pp. 1594–1604, 2021.
[55] Y. Y. Fu *et al*., "Unlocking academic success: the impact of time management on college students' study engagement," *BMC Psychology*, vol. 13, no. 323, 2025, doi: 10.1186/s40359-025-02619-x.

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