Digital Educational Intervention Responses to Academic Stress: Investigating the Impact of Social Media Addiction in Higher Education Learning Environments

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***Abstract*—Academic stress is a critical issue in higher education, especially in digital learning contexts where constant connectivity blurs the boundaries between study and rest. This study examined the roles of peer attachment, healthy lifestyle, and social media addiction in predicting academic stress among 815 Indonesian university students. Using Partial Least Squares Structural Equation Modeling (PLS-SEM) and network analysis, the results showed that a healthy lifestyle significantly reduced academic stress, while social media addiction increased it and weakened the protective effects of both peer attachment and a healthy lifestyle. Theoretically, the study advances current models of academic stress by positioning social media addiction as not only a direct risk factor but also a moderator that undermines established protective mechanisms. Practically, the findings underscore the need for higher education institutions to implement digital wellness strategies, such as online counseling, self-regulation modules, and technology-based stress management tools. These interventions can help students balance academic demands with healthier digital engagement, thereby promoting sustainable mental well-being.**

***Keywords*—academic stress, digital educational intervention, student mental health, higher education, social media addiction, blended learning**

I. Introduction

Students are ideally in a developmental phase that is full of potential to grow as individuals who are independent, emotionally resilient, and skilled in completing academic and social tasks. At this stage, students are expected to be able to manage their time well, think critically, and establish healthy relationships with their surroundings [1–6]. They should also have a clear vision of the future and the skills to maintain a balance between academic and personal life [7–9]. These traits are part of the psychosocial maturity that is targeted in the higher education process [10–15].

However, the reality faced by many students shows the opposite picture. The onslaught of academic pressures, such as coursework, busy schedules, and parental expectations, often lead to a lot of stress [16]. This situation is exacerbated by the major transformation in the learning system that now relies on digital media. Since the pandemic, online learning has become the new normal, bringing with it a range of consequences, from decreased quality of social interactions to screen fatigue [17–19]. Several studies show that students tend to experience high levels of academic stress in digital-based learning systems, characterized by mental fatigue, sleep disturbances, and a constant feeling of being overwhelmed [20–22].

The transition to the digital learning era has dramatically reshaped the academic environment in higher education. Characterized by the widespread use of online platforms, virtual classrooms, and digital communication tools, this era offers increased accessibility and flexibility but also brings psychological and cognitive challenges for students. Studies have shown that although digital learning can enhance autonomy and efficiency, it is often accompanied by screen fatigue, reduced motivation, fragmented attention, and increased academic stress due to blurred boundaries between study and rest [23–25]. The lack of physical interaction and the persistent connectivity of digital devices further intensify students' exposure to academic pressure and digital distraction [26–29]. In Indonesia, the post-pandemic shift to blended or fully online learning continues to affect students' academic well-being and calls for a deeper understanding of the psychosocial implications of digital education [22].

Academic stress itself is a psychological reaction to pressures originating from the academic environment and students' perceptions of their inability to cope with these demands. In many cases, academic stress impacts on students' motivation to learn, focus, and mental and physical health [30–32]. If not dealt with appropriately, this condition can interfere with the learning process and the overall development of students' personalities.

There are a number of factors that are thought to influence students' academic stress levels. One factor that stands out is peer attachment. The quality of healthy, supportive and trustworthy social relationships is believed to be a source of psychological strength for students in dealing with academic pressure. Conversely, social isolation and weak interpersonal ties can actually exacerbate perceived stress [33–35]. Good friendships are not only a place to share emotions but also a source of reinforcement in making important decisions during college.

Another factor is the healthy lifestyle lived by students. A healthy lifestyle includes a nutritious diet, adequate physical activity, quality sleep, and the ability to manage emotions and build healthy social relationships [36–40]. Students who consistently maintain a healthy lifestyle tend to be more emotionally stable and have more resilience in dealing with academic pressure. In contrast, students who neglect a healthy lifestyle often become more vulnerable to stress, fatigue, and other mental disorders [41–43].

In a digital world, social media addiction is also one of the factors that can potentially increase academic stress. Students who use social media excessively tend to experience

impaired focus, disturbed sleep, and feelings of anxiety due to unhealthy social comparisons. They can lose a lot of productive time and experience additional stress from irrelevant or even anxiety-provoking information [44–46]. More than a stand-alone factor, social media addiction is also thought to have a role in influencing the strength of the relationship between other factors and academic stress.

Recent theoretical models of academic stress have largely focused on cognitive appraisal frameworks and self-regulation perspectives, where stress arises from a perceived imbalance between demands and coping resources [30]. Other frameworks emphasize the buffering role of social support, lifestyle habits, and digital behaviors in shaping stress responses [33, 36, 41]. However, most models examine these factors separately and do not address the interactive influence of digital addiction on protective mechanisms. For instance, cognitive behavioral approaches highlight the role of self-regulation but rarely consider the disruptive nature of compulsive digital engagement, while lifestyle-based models emphasize health behaviors but underestimate the moderating role of social media. Building upon these frameworks, our conceptual model positions social media addiction not only as a direct predictor of stress but also as a moderator that weakens the protective effects of peer attachment and healthy lifestyle. This integration surpasses earlier models by capturing the paradoxical role of digital engagement, in which sources of connection and coping resources may also turn into stressors through compulsive use. In doing so, the model contributes to advancing theoretical understanding of academic stress in the digital era and provides a foundation for the development of digitally informed interventions.

This study departs from the assumption that there is a relationship between peer attachment, healthy lifestyle, and social media addiction on college students' academic stress. In particular, social media addiction is thought to not only contribute directly to increased stress, but also weaken or strengthen the influence of social attachment and healthy lifestyle on academic stress. For example, students who have good social relationships may still experience high stress if they also experience social media addiction. Similarly, the positive effects of a healthy lifestyle may not be maximized if individuals are overexposed to excessive digital media use [21, 35, 47].

To explain this relationship, the conceptual model shown in Fig. 1 was developed as the basis for the research framework.

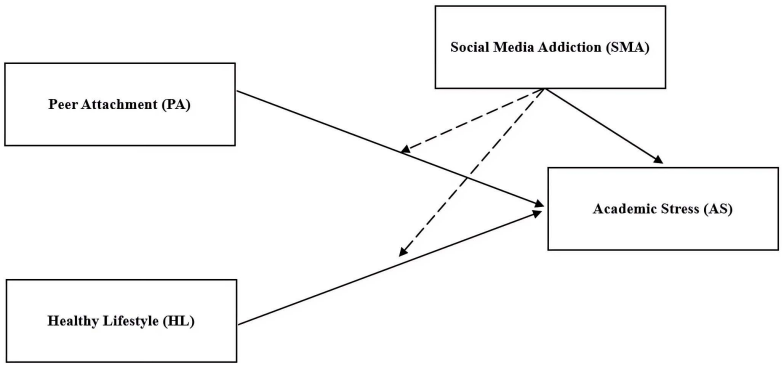

Fig. 1. Conceptual model.

H1: There is a negative and significant correlation between peer attachment and academic stress.

H2: There is a negative and significant correlation between healthy lifestyle and academic stress.

H3: There is a positive and significant correlation between social media addiction and academic stress.

H4: Social media addiction significantly moderates the correlation between peer attachment and academic stress.

H5: Social media addiction significantly moderates the correlation between healthy lifestyle and academic stress.

This study makes a novel contribution by examining the interaction between social media addiction and two protective factors in dealing with academic stress. The focus on the context of students in Indonesia who face the challenges of digital-based lectures makes this study relevant and important. Different from previous studies that mostly look at the influence of each variable separately, this research maps the interactive dynamics between variables in the context of everyday student life. The findings of this study are expected to provide a basis for the development of guidance and Educational Support Services that are more contextual and adaptive to changing times.

Building upon previous frameworks, this study contributes theoretically by integrating digital behavior into the understanding of academic stress. Unlike earlier models that treated social support, lifestyle, and digital use separately, our approach highlights the paradoxical role of social media addiction: a factor that simultaneously offers connection while weakening protective resources. This integration provides a more comprehensive model of academic stress in digital learning environments. From a practical perspective, the findings guide universities in designing context-specific digital interventions, including online counseling systems, digital literacy programs, and wellness applications, to help students regulate stress and manage technology use more effectively.

II. Literature Review

A. Academic Stress in the Digital Learning Era

Academic stress refers to the psychological response experienced by students when they perceive a mismatch between academic demands and their personal coping resources. In the digital learning era, academic stress has become increasingly complex as students encounter new challenges such as digital fatigue, reduced physical interaction, and blurred boundaries between study and rest. Recent studies have shown that digital learning environments

may intensify cognitive fatigue, lower motivation, and trigger emotional exhaustion [25, 48–50]. These issues are particularly pronounced among university students who are still developing effective strategies to adapt to the flexibility and self-regulation required in online education [51–54].

B. Peer Attachment and Student Wellbeing

Peer attachment plays an essential role in students' emotional development and academic engagement. Supportive and trusting social relationships are associated with improved emotional regulation, reduced anxiety, and stronger academic performance [51, 55, 56]. However, in digital learning environments, social connections are often mediated through digital communication, which may not provide the same emotional quality as face-to-face interaction. Some recent studies indicate that the protective role of peer attachment may be diminished in settings where in person support is limited [57–59].

C. Healthy Lifestyle as a Coping Resource

A healthy lifestyle, including balanced nutrition, regular physical activity, quality sleep, and stress management, is known to enhance students' psychological resilience. Those who maintain healthy habits tend to be more emotionally stable and better equipped to manage academic challenges [60–63]. In the digital context, however, these habits are often disrupted by long screen time, sedentary behavior, and irregular sleep patterns [64–67]. Therefore, it is necessary to reexamine the effectiveness of healthy lifestyle factors within the digital learning context.

Prior studies indicate that social media addiction is not only directly associated with higher stress levels but also indirectly influences lifestyle patterns. Excessive use of social media often disrupts sleep routines, reduces physical activity, and leads to irregular eating habits, which undermine the benefits of a healthy lifestyle [64, 66, 67]. Conversely, students who maintain healthier routines are more resilient to academic demands, yet this protective effect may be weakened when their daily habits are interrupted by compulsive social media use [65, 68]. In this sense, social media addiction and healthy lifestyle are closely intertwined, and their interplay substantially affects the extent to which students experience academic stress. Recognizing these interconnections strengthens the rationale for including social media addiction as a moderating factor in the current conceptual model.

D. Social Media Addiction and Academic Stress

Social media addiction has emerged as a significant psychosocial risk among university students. Excessive social media use is associated with poor sleep, diminished concentration, and heightened psychological stress, including academic stress [68, 69]. Although many students use social media as a means of coping or relaxation, overuse may lead to compulsive behavior that undermines academic focus and productivity [70, 71]. Furthermore, social media often exposes students to unhealthy social comparisons and digital pressure, which may further elevate their stress levels.

E. The Moderating Role of Social Media Addiction

Recent research suggests that social media addiction may not only directly influence academic stress but also moderate the effects of other protective factors. For instance, positive peer relationships may lose their effectiveness when students are heavily immersed in digital platforms [72]. Similarly, the benefits of a healthy lifestyle may be weakened when students experience disrupted routines due to excessive digital engagement [73]. Understanding this moderating effect is important in developing comprehensive interventions in higher education that address both personal and digital environmental factors affecting student wellbeing.

Recent studies have highlighted the growing complexity of academic stress in digital learning environments. Zhao [21] demonstrated that social media addiction significantly impacts college students' academic performance through stress as a mediator, while Durmuş *et al.* [47] emphasized the role of hopelessness in linking social media addiction to loneliness. Similarly, Norabuena-Figueroa *et al.* [27] showed how digital teaching practices can increase stress among students, and Jameel *et al.* [68] identified insomnia as a mediator between social media use and psychological health. However, these studies have primarily examined digital behaviors or psychosocial factors in isolation. The present study is unique in simultaneously examining peer attachment, healthy lifestyle, and social media addiction, while also positioning social media addiction as a moderator that weakens the protective impact of these positive factors on academic stress.

III. Materials and Methods

A. Research Design

This study uses a quantitative approach with a survey method to examine the relationship between peer attachment, healthy lifestyle, social media addiction, and academic stress within the framework of a predetermined conceptual model. This design is confirmatory because it aims to test the strength of the relationship between variables that have been formulated theoretically, using the Partial Least Squares Structural Equation Modelling (PLS-SEM) analysis technique. The PLS-SEM method was chosen because it is able to handle complex models with many latent constructs, and is suitable for data with non-normal distributions and large sample sizes [74, 75]. This approach provides flexibility in evaluating instrument validity and reliability, as well as testing for direct effects and moderating interactions within the model structure.

B. Research Participants

The participants in this study were students of various universities in Indonesia at the Diploma, Undergraduate, and Postgraduate levels. The selection of participants was carried out using purposive sampling technique, which is a non-probability sampling technique that allows researchers to select respondents based on certain criteria relevant to the research objectives. In this context, the inclusion criteria included Indonesian students actively participating in digital-based lectures, and willing to complete the questionnaire online. This technique is considered appropriate in psychosocial research because it allows the selection of subjects who truly represent the target population [76].

The purposive sampling technique was adopted because it

allowed the researchers to specifically select participants who met the inclusion criteria, namely Indonesian university students who were actively involved in digital-based lectures and willing to complete the online survey. This approach was considered most appropriate to ensure that the respondents represented the target population of interest. Nevertheless, the reliance on purposive sampling and the restriction to Indonesian university students may limit the generalizability of the findings to broader populations. Future studies are encouraged to replicate the research using probability sampling techniques and more diverse student groups from different cultural and educational contexts to strengthen external validity. The following presents the demographic characteristics of all research respondents:

The data in the table shows that respondents come from diverse backgrounds, in terms of gender, age, education level, place of residence, region of origin, and duration of social media use per day. The majority of respondents are female (59.02%) who are in the age range of 21 to 23 years old (76.32%) and are studying at the Bachelor level. Most of them live in boarding houses or rented houses (55.21%) and come from the western part of Indonesia (75.46%). In terms of social media usage, 40.49% of students use social media for 4 to 6 hours per day, indicating a high intensity of digital interaction in their daily lives. As shown in Table 1, these characteristics provide an important context for understanding the dynamics of academic stress in university students in today's digital age [21, 44, 47].

Table 1. Demographics of research respondents

No.	Demographic Categories	Sub-Category	Total	Percentage
1	Gender	Male	334	40.98%
		Female	481	59.02%
2	Age	< 21 years old	149	18.28%
		21–23 years old	622	76.32%
		> 23 years old	44	5.40%
3	Education Level	Diploma	126	15.46%
		S1	606	74.42%
		Postgraduate	83	10.18%
4	Status of Residence	With parents	249	30.55%
		Dormitory	84	10.31%
		Boarding House/Contract	450	55.21%
		More	32	3.93%
5	Regional Origin	Western Indonesia	615	75.46%
		Central Indonesia	122	14.97%
		Eastern Indonesia	78	9.57%
6	Expenses per Month (IDR)	<1.000.000	122	14.97%
		1.000.000–2.000.000	413	50.67%
		2.000.001–3.000.000	207	25.40%
		>3.000.000	73	8.96%
7	Religion	Islam	687	84.29%
		Christianity	58	7.12%
		Catholic	25	3.07%
		Hindu	27	3.31%
		Buddhism	18	2.21%
9	Social Media Duration per Day	< 1 h	43	5.28%
		1–3 h	287	35.21%
		4–6 h	330	40.49%
		> 6 h	155	19.02%

C. Research Instruments

The instruments used in this study consisted of four psychological scales that have been widely used in international research and demonstrated high levels of validity and reliability. Each scale was carefully selected based on its suitability to the constructs being measured, and has gone through a cultural adaptation process to fit the context of students in Indonesia. The adaptation process was conducted using the forward and back translation method by two independent linguists, followed by a pilot test on a group of university students to ensure semantic clarity and measurement consistency. This procedure followed the international guidelines recommended by Beaton, which emphasize the importance of conceptual equivalence in cross-cultural adaptation of psychological instruments [77].

Table 2 is a summary of the instruments used in the study. All instruments were measured using a 5-point Likert scale. For constructs such as peer attachment, academic stress, and social media addiction, respondents were asked to rate from 1 (strongly disagree) to 5 (strongly agree). On the healthy lifestyle scale, some items were rated based on frequency of behavior, from 1 (never) to 5 (always). Higher scores on the peer attachment and healthy lifestyle scales indicate more positive qualities of each construct. In contrast, high scores on the social media addiction and academic stress scales indicate higher levels of problems.

To ensure the quality of the instruments before being used in the main data collection, the researcher conducted a pilot test of all scales. The test results show that all instruments have an average loading factor value above 0.90 and a high Cronbach's Alpha value, which indicates an excellent level of convergent validity and internal reliability [74, 78]. Details of the instrument pilot test results are presented in Table 3.

These results indicate that each construct in this study was measured with highly reliable and valid instruments. This provides assurance that the data collected accurately reflects the psychological reality being measured. Thus, the subsequent analysis process can be carried out with the confidence that the quality of measurement meets scientifically accountable standards [79].

Table 2. Outline of the research instrument

No.	Instruments	Indicators	*N* of Items	Source
1	Peer attachment scale	1. Trust between friends 2. Effective communication 3. Alienation from peers	9	Armsden & Greenberg [33]
2	Healthy lifestyle scale	1. Responsibility for Health 2. Physical activity 3. Nutrition 4. Spiritual growth 5. Interpersonal relationships 6. Stress management	18	Towsend *et al.* [41]
3	Social media addiction scale	1. Salience 2. Mood modification 3. Tolerance 4. Withdrawal 5. Conflict	5	Andreassen *et al.* [45]
4	Academic stress scale	1. Academic pressure 2. Emotional stress 3. Socio-academic engagement 4. Somatic impact	20	Putwain [30]

Table 3. Instrument pilot test results

Instrument	Average Loading Factor	Decision	Cronbach's Alpha	Decision
Peer Attachment	0.952	Valid	0.949	Reliable
Healthy Lifestyle	0.965	Valid	0.985	Reliable
Social Media Addiction	0.965	Valid	0.981	Reliable
Academic Stress	0.963	Valid	0.974	Reliable

D. Data Collection

To support the data collection process and provide a more engaging and contextually relevant assessment experience, this study utilized a custom-designed digital platform named DigiCons (Digital Counseling System). DigiCons was developed to simulate a counseling environment and deliver psychological questionnaires related to academic stress, healthy lifestyle, and social media addiction in a digital and user-friendly manner. The platform includes welcome features, self-assessment tools, and adaptive feedback modules that enhance students' reflective participation.

The use of DigiCons ensured that participants not only responded to items more naturally within a psychologically safe environment but also interacted with a system that mirrored actual Guided Educational Sessions in higher education settings. The platform was accessible via smartphones and computers, and integrated privacy protection and consent features in accordance with ethical research standards. Fig. 2 below illustrates several key User Interface (UI) screens of the DigiCons application used in this study.

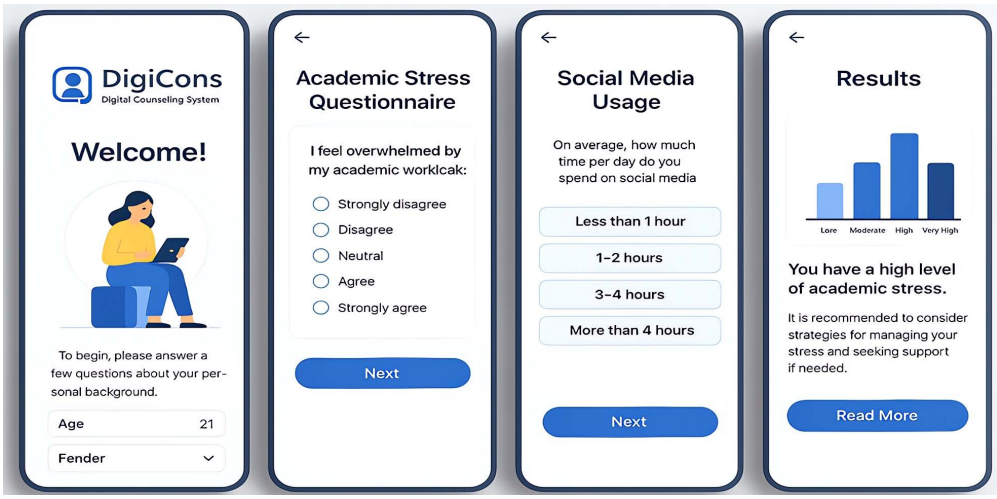

Fig. 2. DigiCons user interface for online academic stress assessment.

As shown in the Fig. 2, DigiCons guided participants through a structured flow starting from demographic data collection, followed by standardized self-report scales, and concluding with real-time visual feedback on stress levels. The interface was designed to be intuitive, minimalistic, and mobile-responsive, ensuring accessibility for participants across different devices and regions. Notably, the feedback screen provided tailored messages encouraging students to seek coping strategies and utilize available support services when high stress levels were detected.

By embedding the psychological instruments into a simulated Digital Educational Intervention tool, the research process aligned closely with the evolving nature of guidance and mental health services in digital learning contexts. This

also supports the integration of technological innovations into pedagogical and counseling practices, a core value emphasized by modern educational frameworks.

E. Data Analysis

Data analysis in this study used the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach with the help of the latest version of SmartPLS software. This approach was chosen because it has the advantage of handling complex research models with many latent constructs, and is suitable for data that is not always normally distributed. PLS-SEM is carried out through two main stages, namely outer model and inner model evaluation. Outer model evaluation aims to assess the quality of indicators in representing the measured constructs, through convergent validity, discriminant validity, and internal reliability tests. Meanwhile, inner model evaluation is used to test the relationship between latent constructs through hypothesis testing, path coefficient values, and R-square values to assess the predictive ability of the model [74, 79, 80]

Model fit evaluation is performed with reference to several key indicators, such as the Standardized Root Mean Square Residual (SRMR) value and d_ULS (squared Euclidean distance), both of which are widely recognized as important indicators in model fit assessment in PLS-SEM. The SRMR value is used to measure the extent to which the observed correlation matrix is close to the correlation matrix predicted by the model. The smaller the SRMR value, the better the fit of the model to the data. Meanwhile, d_ULS also shows a measure of the global fit of the model and is often used as a complement in assessing the feasibility of the tested model structure. Table 4 presents the results of the fit model evaluation based on these two indicators:

Table 4. Fit model evaluation

Fit Index	Saturated model	Estimated model
SRMR	0.033	0.155
d_ULS	0.188	4.125
d_G	7.163	n/a
Chi-square	12387.558	9245.872
NFI	0.713	0.785

SRMR values below 0.08 and low d_ULS values indicate that the model built in this study has a good level of fit to the field data. These findings strengthen the validity of the conceptual model used and provide a strong basis for proceeding to the next stage of analysis. Therefore, all constructs and relationships between variables in the model are considered suitable for further analysis through outer and inner model tests [74].

In addition to the Partial Least Squares Structural Equation Modeling (PLS SEM) approach, this study also employed a complementary network analysis to further refine the understanding of relationships among variables. Network analysis allows for the visualization of the strength and structure of associations between constructs in a multidimensional space, making it particularly useful for exploring the centrality and interconnectedness of variables within complex psychological frameworks [81]. Using the R package qgraph, we constructed a graphical network that mapped direct and indirect links between peer attachment, healthy lifestyle, social media addiction, and academic stress. This approach complements traditional path analysis by offering an intuitive and data driven representation of the psychological landscape experienced by university students in the digital era. It also provides insights into which variables hold the most influence in the network, which may guide future interventions and counseling practices [82].

IV. Result

A. Outer Model Evaluation

Evaluation of the outer model is carried out to ensure that the constructs in this study are measured validly and reliably. This process includes three main aspects, namely convergent validity, discriminant validity, and internal reliability. Convergent validity is assessed through the loading factor value of each indicator on the latent construct. A loading factor value above 0.70 indicates that the indicator significantly represents the construct. Meanwhile, discriminant validity refers to the ability of a construct to distinguish itself from other constructs, with the Fornell-Larcker criterion as a reference. Finally, internal reliability is tested with Cronbach's Alpha and Composite Reliability, where values >0.70 are considered adequate [74, 75].

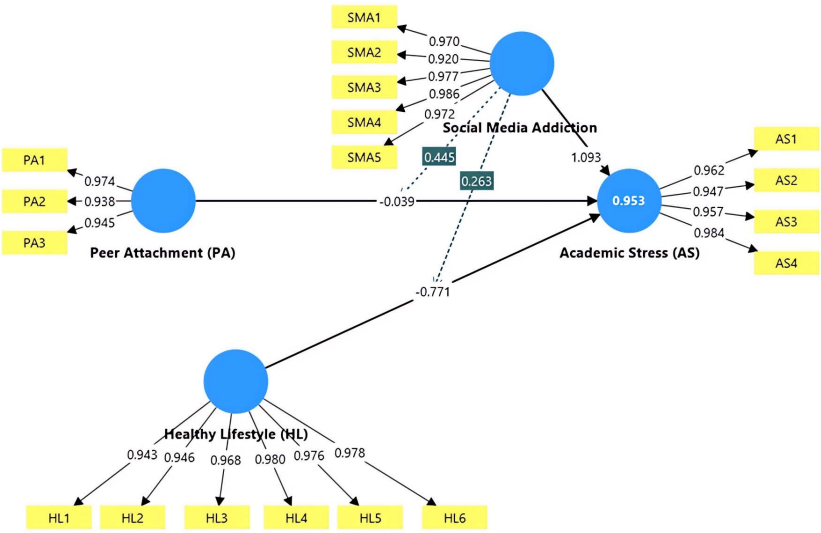

Fig. 3. Conceptual model evaluation.

The following conceptual model, shown in Fig. 3, illustrates the relationships among the constructs in this study, namely Peer Attachment, Healthy Lifestyle, Social Media Addiction, and Academic Stress, including two moderating interactions. This model was developed based on the theoretical framework and shows the direction of the relationships tested in the structural model.

1) Convergent validity

Convergent validity is confirmed by looking at the loading factor value of each indicator on the latent construct [74]. The analysis results show that all indicators have a loading factor value above 0.90, which indicates that each indicator strongly contains the intended construct.

As shown in Table 5, the high loading factor values on all indicators indicate that the constructs used in this study have excellent convergent validity. This provides confidence that each construct is accurately measured through its indicators [74].

Table 5. Convergent validity test results (loading factor value)

Indicator	Academic Stress (AS)	Healthy Lifestyle (HL)	Peer Attachment (PA)	Social Media Addiction
AS1	0.962			
AS2	0.947			
AS3	0.957			
AS4	0.984			
HL1		0.943		
HL2		0.946		
HL3		0.968		
HL4		0.980		
HL5		0.976		
HL6		0.978		
PA1			0.974	
PA2			0.938	
PA3			0.945	
SMA1				0.970
SMA2				0.920
SMA3				0.977
SMA4				0.986
SMA5				0.972

2) Discriminant validity

Discriminant validity is tested using the Fornell-Larcker criterion, where the square root value of AVE (Average Variance Extracted) on the diagonal of the table must be higher than the correlation between other constructs [74]. These values indicate that each construct has a unique identity and does not overlap conceptually.

The Table 6 shows that all constructs meet the Fornell-Larcker criteria. Thus, each construct in the model can be empirically distinguished from other constructs. These results indicate that the discriminant validity in the model has been met [78].

Table 6. Discriminant validity test results (fornell-lacker criteria)

Construct	Academic Stress (AS)	Healthy Lifestyle (HL)	Peer Attachment (PA)	Social Media Addiction
Academic Stress (AS)	0.963			
Healthy Lifestyle (HL)	−0.960	0.966		
Peer Attachment (PA)	−0.934	0.944	0.953	
Social Media Addiction	0.967	−0.987	−0.962	0.965

3) Reliability

The internal reliability of the construct is assessed through the Cronbach's Alpha and Composite Reliability (rho_c) values. Values above 0.70 indicate that the construct has high internal consistency, while AVE values above 0.50 indicate an adequate proportion of variance in construct indicators.

As shown in Table 7, the Cronbach's Alpha values range from 0.949 to 0.985, while the Composite Reliability values are between 0.967 and 0.988. All AVE values also exceed the recommended minimum limit of 0.50. This indicates that all constructs have excellent reliability and convergent validity, and are suitable for use in structural model testing [79].

Table 7. reliability test results

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Academic Stress (AS)	0.974	0.974	0.981	0.927
Healthy Lifestyle (HL)	0.985	0.986	0.988	0.932
Peer Attachment (PA)	0.949	0.951	0.967	0.907
Social Media Addiction	0.981	0.984	0.985	0.931

B. Inner Model

After the measurement model (outer model) is confirmed valid and reliable, the next step is testing the structural model (inner model). This evaluation includes hypothesis testing through the path coefficient value, t-statistic value, and p-value of the bootstrapping results. This test aims to determine the significance of the relationship between constructs in the research model.

1) Hypothesis test

As presented in Table 8, the results of hypothesis testing show that only one of the five hypotheses is rejected (H1), namely the relationship between Peer Attachment and Academic Stress is not significant. In contrast, Healthy Lifestyle and Social Media Addiction are proven to have a significant effect on Academic Stress. In addition, both Social Media Addiction moderating interactions were also

significant, indicating the important role of social media addiction in influencing the strength of the relationship between protective factors and academic stress [21, 47].

Table 8. Hypothesis test results

Path Relationship	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	*p*-values	Decision
Peer Attachment (PA)→Academic Stress (AS)	−0.039	−0.039	0.037	1.052	0.293	H1 Rejected
Healthy Lifestyle (HL) → Academic Stress (AS)	−0.771	−0.775	0.047	16.380	0.000	H2 Accepted
Social Media Addiction → Academic Stress (AS)	1.093	1.092	0.061	17.834	0.000	H3 Accepted
Social Media Addiction × Peer Attachment (PA) → Academic Stress (AS)	0.445	0.448	0.039	11.339	0.000	H4 Accepted
Social Media Addiction × Healthy Lifestyle (HL) → Academic Stress (AS)	0.263	0.262	0.037	7.024	0.000	H5 Accepted

2) R^2 value

The R^2 value indicates how large a proportion of the variance of the endogenous construct (Academic Stress) can be explained by the exogenous constructs in the model. As shown in Table 9, the R^2 value of 0.953 indicates that 95.3% of the variability of academic stress can be explained by Peer Attachment, Healthy Lifestyle, Social Media Addiction, and two moderating interactions.

Table 9. R-Square Values

Endogenous Construct	*R*-square	*R*-square adjusted
Academic Stress (AS)	0.953	0.953

The very high R^2 value indicates that the model has a very strong predictive power of the Academic Stress construct. This shows that the factors analyzed in this study are very relevant in explaining the phenomenon of academic stress in college students [78].

C. Indicator-Level Network Analysis

To deepen the understanding of the internal structure of each psychological construct, this study conducted a network analysis at the indicator level. This approach allows for the visualization of how specific items (indicators) within each latent variable are interconnected and how they contribute to the overall structure of academic stress. Indicator-level network analysis is particularly useful for identifying central items that may serve as key targets for interventions, refining measurement tools, and revealing potential redundancies or indirect effects across constructs [81].

As illustrated in Fig. 4, the analysis included all 18 indicators representing four major constructs: academic stress (AS1–AS4), social media addiction (SMA1–SMA5), healthy lifestyle (HL1–HL6), and peer attachment (PA1–PA3). A directed network model was created using a shell layout to visually separate indicators by construct. Nodes were color-coded based on their latent group, and arrows were added to show the directional strength of relationships. Edge thickness indicates the magnitude of partial correlations between indicators, while edge labels present the numeric strength of the relationships.

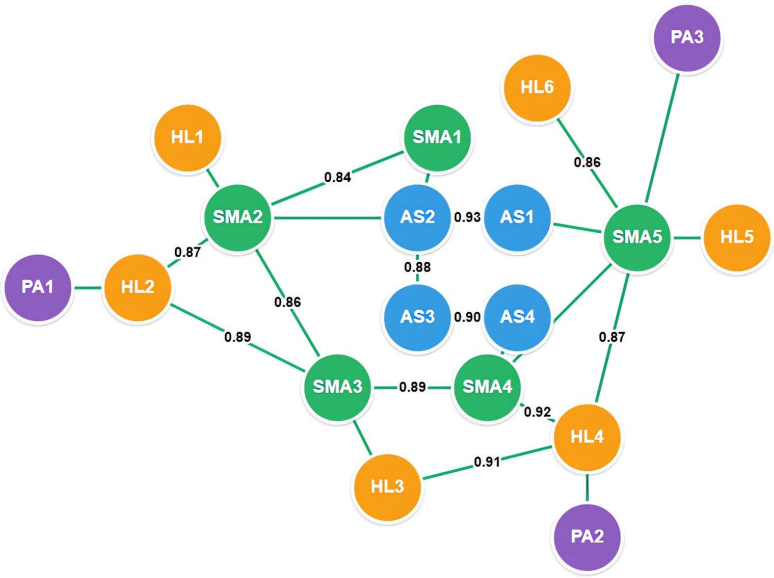

Fig. 4. Directed network of psychological indicators by construct.

To complement the visual representation of the indicator network, a centrality analysis was conducted to quantitatively assess the influence of each indicator in the system. This analysis produced three metrics for each item: strength, closeness, and betweenness. Strength indicates the total magnitude of direct connections a node has with others; closeness reflects how efficiently a node can connect to all other nodes in the network; and betweenness measures how often a node lies on the shortest path between other nodes, highlighting its role as a bridge. These values offer insight into which indicators serve as central drivers within their respective constructs and the broader academic stress network. The results are presented in Table 10.

The results show that AS1 (Academic Stress item 1), SMA4 (Social Media Addiction item 4), and HL3 (Healthy Lifestyle item 3) possess the highest strength values in the

network. This suggests that these items are particularly influential within their respective constructs and may also bridge connections across constructs. For instance, SMA4 likely plays a dual role by capturing compulsive digital behavior and linking it to symptoms of stress and poor self-regulation. Similarly, HL3 appears central in maintaining positive health behaviors that buffer against academic stress.

Table 10. Centrality indices of observed indicators

Indicator	Strength	Closeness	Betweenness
AS1	0.93	0.00	0.00
SMA4	0.92	0.09	0.01
HL3	0.91	0.08	0.02
AS3	0.90	0.08	0.01
PA2	0.90	0.06	0.00
SMA2	0.86	0.07	0.00
HL2	0.87	0.07	0.01
HL4	0.85	0.07	0.01
SMA3	0.86	0.06	0.00
AS2	0.88	0.06	0.00
HL1	0.87	0.06	0.01
SMA1	0.84	0.05	0.00
HL5	0.85	0.06	0.00
SMA5	0.84	0.05	0.00
HL6	0.88	0.07	0.01
PA1	0.86	0.05	0.00
PA3	0.86	0.05	0.00
AS4	0.90	0.06	0.00

Conversely, PA2 (Peer Attachment item 2) and several peripheral items showed lower centrality, indicating more localized or construct-specific relevance. These insights are critical for researchers and practitioners, as they offer empirical guidance for refining psychological scales and designing targeted interventions.

By combining network visualization with quantitative centrality analysis, this study provides a comprehensive and nuanced understanding of how psychosocial indicators relate to academic stress among university students in the digital learning era.

The centrality results shown in Table 10 can be better understood through the lens of digital wellbeing and stress theories. For example, the prominence of compulsive social media use indicators reflects the principle that digital wellbeing depends on balanced engagement with technology rather than sheer usage time. Excessive salience, withdrawal, and conflict dimensions identified in the network analysis align with theoretical models that describe how digital behaviors disrupt self-regulation and increase psychological strain. Similarly, the high centrality of lifestyle-related indicators, such as nutrition and physical activity, supports stress theories which argue that protective routines buffer against academic strain by enhancing resilience and emotional stability. By integrating these theoretical perspectives, the network analysis does not only highlight statistical connections but also provides empirical support for models of digital wellbeing that view stress regulation as a function of healthy lifestyle choices and controlled digital engagement.

V. Discussion

These findings extend the discussion beyond recent studies conducted in similar contexts. For instance, Zhao [21] and Jameel *et al.* [68] confirmed that social media addiction is directly associated with stress and related mental health issues, yet they did not explore its interactive influence on protective psychosocial factors. Meanwhile, Durmuş *et al.* [47] and Norabuena-Figueroa *et al.* [27] emphasized the negative outcomes of digital behaviors but treated healthy lifestyle or peer relationships separately. In contrast, our study demonstrates that social media addiction not only predicts stress but also moderates the beneficial roles of peer attachment and healthy lifestyle. This dual mechanism highlights the paradox of digital engagement, where tools that provide connection and coping resources may simultaneously erode resilience through compulsive use. Such integration contributes a more comprehensive and timely framework for understanding academic stress in the digital era.

The findings of this study must be interpreted within the context of the rapidly evolving digital learning environment that characterizes higher education today. The widespread integration of technology into classrooms, particularly in the post-pandemic era, has transformed not only how students access information but also how they engage with academic responsibilities. While digital tools offer unprecedented flexibility and access, they also introduce new challenges, such as increased screen time, distractions, and social comparison through online platforms, all of which may exacerbate students' psychological burden. As highlighted in recent studies, academic stress in the digital era is not solely a function of coursework but also shaped by students' digital habits, social media use, and self-regulation capacities [50, 83, 84].

In this regard, understanding academic stress requires a broader view that incorporates students' experiences with digital technologies, including how they navigate online learning, manage time, and cope with information overload. The current study's emphasis on social media addiction and healthy lifestyle as predictors and moderators of academic stress aligns with recent educational research that advocates for digital wellbeing as an essential dimension of academic success [85–87]. Institutions must therefore not only promote academic excellence but also design supportive ecosystems that foster digital discipline, healthy screen behaviors, and psychosocial resilience. These findings contribute to ongoing debates about the need for holistic, tech-informed approaches to student mental health and success in digitally mediated educational settings.

This study aims to understand the dynamics of academic stress in university students in a digital context by examining three main factors, namely peer attachment, healthy lifestyle, and social media addiction. The results provide an interesting picture and, in some aspects, differ from initial expectations.

The first hypothesis (H1) that examined the relationship between peer attachment and academic stress was found to be insignificant. This finding is surprising because it contradicts the assumptions of many previous studies which state that strong social attachments can serve as a protective barrier against academic stress. Armsden and Grrenberg [33] mentioned that warm and supportive relationships with peers can strengthen emotion regulation and promote students' psychological well-being. However, in the context of this study, it seems that social attachment is not effective enough in reducing academic stress, especially in the era of

digital-based learning, where forms of social support change and are not always physically present. It is likely that digital social interactions no longer have the same emotionally reinforcing effects as face-to-face interactions, making the role of peers less significant in reducing stress.

In contrast to H1, the second hypothesis (H2) received strong support. The results of the analysis show that a healthy lifestyle is significantly negatively correlated with academic stress. This means that the better students live a healthy lifestyle, such as maintaining a diet, getting enough sleep, exercising, and managing time, the smaller the level of academic stress they experience. This finding is in line with the research of Townsend *et al.* [41] and Hoying *et al.* [43], which emphasize the importance of a healthy lifestyle in maintaining the emotional stability and mental endurance of university students. In the Indonesian context, a healthy lifestyle may be a much-needed natural coping mechanism in the midst of increasing academic pressure and digital noise.

The third hypothesis (H3) also proved significant, indicating that social media addiction is positively correlated with academic stress. The higher the intensity or involvement of students in social media, the greater the level of academic stress felt. This finding is consistent with the research of Andreassen *et al.* [45] and Arslantas and Gul [46], who found that excessive use of social media can lead to impaired concentration, disturbed sleep, and increased anxiety due to unhealthy social comparisons. For many students, social media is not only a place to socialize, but also a new source of pressure that adds to the psychological burden beyond the academic pressure itself.

Furthermore, the fourth hypothesis (H4) tested the moderating role of social media addiction in the relationship between peer attachment and academic stress. The results showed that social media addiction significantly strengthened this relationship. That is, for students who are highly attached to peers, but also have high levels of social media addiction, the effects of stress tend to increase. This phenomenon shows that although students feel socially connected, addiction to digital platforms can disrupt the quality of these relationships or even change the function of social relations into a source of stress. This is in line with Allahverdi's [44] view that social media can be paradoxical: providing a space for connection, but also creating feelings of alienation and inadequacy.

The fifth hypothesis (H5) was also supported by the data, where social media addiction was shown to moderate the relationship between healthy lifestyle and academic stress. The protective effect of a healthy lifestyle tends to weaken when students also have high levels of social media addiction. This makes sense, because even if one maintains a healthy lifestyle, excessive social media presence can disrupt sleep quality, study focus, and even cause disruptions to time management, all of which can trigger stress. These findings reinforce those of Durmus *et al.* [47] that digital addiction can undermine promotive efforts towards college students' mental health.

The moderation effects identified in H4 and H5 gain further meaning when interpreted in the cultural and digital learning context of Indonesian students. As a society with collectivist values, peer attachment is generally seen as a protective factor against stress because students rely on group belonging and social support. However, when mediated through compulsive social media use, these relationships can shift, as online comparison, distraction, and interpersonal conflicts weaken the protective role of peer ties. Similarly, the buffering role of a healthy lifestyle, such as maintaining regular routines and physical activity, is increasingly challenged in a digital environment where extended screen time and online academic demands disrupt sleep and activity patterns. In this sense, the moderating role of social media addiction reflects how cultural reliance on social connection and the digitalization of education converge to create new stressors that alter traditional protective mechanisms.

The findings in this study suggest that social media addiction is not only a direct predictor of stress, but also plays a role in weakening or strengthening the influence of other factors. This indicates that in the digital era, self-management of social media use is an important key in maintaining students' mental balance. Educational Guidance in higher education needs to take this aspect more seriously, for example by integrating healthy digital literacy and strengthening self-management in the Educational Support Services offered.

These findings suggest the need for educational institutions to develop structured Digital Educational Intervention programs and online psychoeducational modules aimed at enhancing students' digital self-regulation skills. For instance, university counseling centers could implement digital-based interventions such as asynchronous video guidance, online group counseling, or chatbot-assisted stress management platforms, which are accessible, anonymous, and adaptable to students' schedules. These educational tools not only address stress and media addiction but also align with modern teaching practices that integrate technology to support student well-being. Incorporating these services into curriculum-linked guidance programs can help bridge the gap between academic demands and mental health support.

Preliminary feedback from the pilot use of DigiCons indicated that students perceived the platform as accessible, user-friendly, and effective in providing immediate feedback on their stress levels. Many participants reported that the visualized feedback enhanced their self-reflection and motivated them to adopt healthier routines. Building on these insights, universities could extend DigiCons into institutional services by embedding digital wellness modules into learning management systems, delivering short online workshops on stress self-regulation, and offering chatbot-assisted guidance for students who prefer flexible, technology-based support.

The study offers important implications for teaching and educational support services in higher education. Lecturers and academic advisors can integrate preventive counseling content into blended courses, addressing stress triggers and digital overload through classroom-based discussions or reflective assignments. In addition, Learning Management Systems (LMS) can embed micro-learning modules on digital wellness and mental health, while academic counseling units can offer virtual workshops targeting social media self-regulation and academic resilience.

VI. Conclusion

This study reveals that university students' academic stress

in the digital age is significantly affected by healthy lifestyle and social media addiction, while peer attachment shows no significant direct relationship. A healthy lifestyle proved to be a strong protective factor, but its positive effects can be disrupted when students have high levels of social media addiction. Similarly, peer attachment is a potential source of stress when influenced by excessive intensity of social media use. The very high R^2 value obtained in this study is reasonable because of the large and diverse sample size as well as the use of reliable and validated instruments, which together provide strong predictive power for the model. The statistical results in Table 8 are consistent with everyday experiences, where students who maintain healthy routines tend to cope better with academic demands, while those who are heavily engaged in social media often face fatigue, loss of focus, and increased stress. These findings emphasize the importance of managing social media use in a healthy way and strengthening a balanced lifestyle as key strategies for reducing students' academic stress. Therefore, educational institutions and counseling guidance services need to respond to this challenge with interventions based on digital wellness and the enhancement of students' coping capacity.

In addition to these insights, the study suggests concrete strategies that can be implemented by higher education institutions. Universities can integrate digital wellness modules into existing learning management systems to provide students with regular reminders and micro-learning content on stress management and healthy routines. Mobile health applications that monitor sleep, nutrition, and physical activity can be recommended to support students in maintaining a balanced lifestyle. Platforms such as DigiCons, developed in this study, may also serve as a model for providing online counseling, self-assessment, and personalized feedback on academic stress levels. By adopting these software-based tools, institutions can transform the study's findings into actionable interventions that directly help students regulate stress in their daily academic lives. From an implementation perspective, DigiCons is highly feasible due to its smartphone compatibility, privacy safeguards, and adaptability across academic contexts. This makes it scalable for broader institutional adoption, either as a stand-alone platform or integrated within existing counseling and student support systems. Future studies should further evaluate the long-term effectiveness of DigiCons through larger trials and assess its impact on academic outcomes and digital wellbeing.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

L.P. conceptualized the research framework, designed the DigiCons digital platform, and led the writing of the abstract, introduction, and discussion. A. conducted the literature review, developed and adapted the research instruments, and ensured their validity. Y.S. managed data collection, organized the respondent database, and processed demographic profiling. The fourth author performed the PLS-SEM statistical analysis and network visualization. D. revised the manuscript, ensured journal compliance, and coordinated correspondence with the editorial team. All authors reviewed and approved the final version of the manuscript.

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