

The Impact of Fragmented Information on the Concentration of Undergraduate Students in the past Five Years

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Abstract: Fragmented information consumption today is linked to declining sustained attention, especially among undergraduates. This study elucidates mechanistic pathways through which social media-driven fragmented information exposure impacts cognitive functioning. Employing a mixed-methods design, the research integrated psychometric questionnaires (administered to 95 undergraduates) to quantify fragmented information exposure patterns, alongside Python-based web crawlers systematically capturing emotional lexicon distributions from Xiaohongshu (REDNOTE) platform discourse. Multidimensional validation through Pearson correlation and sentiment polarity modeling revealed three key findings: (1) high-frequency users (≥ 3 h/day) exhibited 37.2% reduction in attentional persistence relative to controls; (2) 78.6% of participants demonstrated diminished academic task performance during instructional periods; (3) 61.3% manifested increased procrastination prevalence in non-academic contexts. Cognitive resource depletion and switching cost accumulation are identified as primary pathways. The evidence underscores the imperative for tripartite intervention frameworks comprising cognitive conditioning protocols, restructured pedagogical ecosystems, and techno-ethical governance models.

1 INTRODUCTION

1.1 Research Background

The continuous technological iterations in mobile internet infrastructure have catalyzed a social media communication paradigm dominated by rapid-fire information exchange. As documented in the 51st Statistical Report on China's Internet Development (CNNIC, 2023), Chinese undergraduates engage with social media platforms for an average of 4.2 hours daily, with 73.6% of information consumption episodes demonstrating characteristic fragmentation patterns. This pervasive nonlinear, high-frequency information consumption pattern induces fundamental alterations in cognitive processing architectures: neuroscientific evidence reveals that sustained attentional shifting manifests as decreased glucose metabolism efficiency in the dorsolateral prefrontal cortex, corresponding to measurable reductions in working memory span and systematic suppression of sustained reflective thinking (Ai et al., 2021; Odden & Russ, 2019). Consequently, university students face growing difficulties in attaining focused

cognitive states, while fragmented mental schemata progressively solidify into entrenched cognitive routines. These neurocognitive alterations ultimately translate into quantifiable declines in academic engagement efficacy, as evidenced by longitudinal learning performance metrics (Lei et al., 2012).

1.2 Current Research Status and Gaps

Existing studies exhibit limitations in three critical dimensions:

Firstly, research predominantly focuses on generalized social media user populations, lacking targeted analysis of university students' cognitive traits (Kindermann & Onofri, 2021; Yao, 2019).

Secondly, measurement methodologies overly rely on subjective scales, failing to integrate multimodal data encompassing behavioral logs and physiological indicators (Odden & Russ, 2019; Saplacan et al., 2020).

Thirdly, intervention strategies emphasize individual behavior modification while neglecting the synergistic optimization requirements between technological architectures and educational contexts

(Jiang, 2020; Rahiminia et al., 2019). Notably, the impact of fragmented information on university students manifests significant scenario-specific differentiation: information overload in learning contexts leads to knowledge integration difficulties (Kindermann & Onofri, 2021), whereas instant feedback mechanisms in daily life contexts induce procrastination dependency (Yao, 2019). However, current research has yet to establish a systematic pathway model elucidating these differential effects.

1.3 Research Objectives and Significance

Guided by cognitive load theory, this study aims to address three core issues:

- (1) Quantitative characterization of key features defining fragmented social media information;
- (2) Validation of focus time metrics' measurement validity within university student populations;
- (3) Differentiated impact mechanism in how fragmented information impacts academic focus versus daily life focus. By constructing a tripartite analytical framework integrating behavioral data, psychological perception, and technological features, the findings will provide empirical foundations for: University curriculum optimization (e.g., embedding anti-interference training modules); Social media algorithm refinement (e.g., dynamically regulating information push density); Digital health policy formulation (e.g., establishing attention protection standards).

Compared to existing research, this study achieves breakthroughs in three dimensions:

Methodologically, it combines web crawling technology (for dynamic acquisition of fragmented information features) with machine learning algorithms (for focus time prediction modeling), effectively overcoming social desirability biases inherent in traditional questionnaire methods.

Theoretically, it reveals a dual-pathway impact mechanism: fragmented information directly diminishes attentional capacity through cognitive resource competition while indirectly altering attention allocation patterns via multitasking capability remodeling. Practically, it proposes a three-tiered intervention system encompassing technological architecture, educational design, and individual behavior regulation.

2 LITERATURE REVIEW

2.1 Introduction to the Concepts of Fragmented Information Modes and Focus

2.1.1 Definition of Fragmented Information Modes

Fragmented information modes refer to the phenomenon in which, during the dissemination process, information is broken down into short, scattered segments that lack logical coherence due to the involvement of multiple sources, channels, and non-linear transmission (Ai et al., 2021). This mode originates from the deconstruction of traditional information dissemination structures by Internet technologies, and it is manifested in the dispersed nature of spatiotemporal distribution, disseminators, and content forms (Kindermann & Onofri, 2021).

2.1.2 Sources of Fragmented Information

The driving force of technology is significant; the rapid development of mobile Internet, social media, and algorithm-based recommendation systems has accelerated the fragmentation of information (Ai et al., 2021). In this context, the roles of dissemination agents have become diversified, with users no longer merely receiving information but also acting as transmitters. This change has led to multiple rounds of processing and re-dissemination of information during its transmission (Ai et al., 2021). In addition, the fragmented nature of user demands has become increasingly evident; due to divided attention, content producers are compelled to simplify information into "fast-food style" content that is easier to consume (Kindermann & Onofri, 2021).

2.1.3 An Overview of the Key Characteristics

Fragmented information possesses the following four core characteristics. First, it has minimal spatiotemporal constraints, allowing users to access these brief segments of information anytime and anywhere (Ai et al., 2021). Second, fragmented information exhibits immediate interactivity, enabling rapid feedback to users and promoting high-frequency interactions among them (Ai et al., 2021). Third, its content is scattered and concise, typically with short text lengths (for example, no more than 150 characters) and relatively low logical coherence (Ai et al., 2021). Finally, fragmented information is

characterized by a strong subjective tint, with the contained information predominantly reflecting personal opinions or feelings rather than purely objective facts (Ai et al., 2021).

2.2 Definition and Measurement of Focus

2.2.1 Definition of Focus

Focus refers to the ability of an individual to continuously direct cognitive resources toward a specific task. It is fundamental to deep learning and the efficient completion of tasks (Odden & Russ, 2019).

2.2.2 Recent Measurement Methods

Behavioral Data: Focus in online questionnaires can be evaluated by analyzing mouse trajectory features—for example, speed and click intervals (Saplaçan et al., 2020; Yao, 2019). In addition, momentary sampling techniques can be employed, whereby observers record whether predetermined behaviors occur within specific time intervals, thereby contributing detailed descriptive factors regarding focus (Liu et al., 2018).

Physiological Indicators: Eye-tracking technology can measure gaze duration, while the suppression of alpha waves in EEG analysis reflects concentrated attention (Odden & Russ, 2019).

Psychological Experience: In terms of subjective evaluation, the sense of immersion and time distortion described in Flow theory are used as indicators of personal focus (Yao, 2019).

2.2.3 The Rationale for Using Focus Time as a Measurement Index

Research by Yao Qiyu (2019) indicates that the intervals between responses and mouse trajectory characteristics (e.g., variations in acceleration) can effectively differentiate the level of user diligence, achieving an F1 score of 81.06%, which demonstrates the correlation between focus time and behavioral patterns (Saplaçan et al., 2020).

Bidirectional Relationship between Fragmented Information and Focus:

A fragmented information environment can serve as a trigger for declining focus (Ai et al., 2021), while at the same time, training in multitasking abilities may enhance adaptive focus in specific contexts (Rahiminia et al., 2019).

2.3 Overview of the Impact of Fragmented Information

The subjects in these studies include college students (Odden & Russ, 2019), social media users (Yao, 2019), and online learners (Kindermann & Onofri, 2021).

Regarding the control of confounding variables, some studies have not adequately considered individual cognitive differences, such as multitasking ability (Ai et al., 2021). However, a few studies have enhanced internal validity by employing random sampling and covariate analysis (Saplaçan et al., 2020).

In quantitative research, methods such as Likert scales (Ai et al., 2021), behavioral log analysis (Saplaçan et al., 2020), and experimental approaches (Yao, 2019) have been utilized. In qualitative studies, interviews have been conducted to analyze the fragmentation of information in digital learning environments (Kindermann & Onofri, 2021). In terms of data analysis techniques, researchers have applied factor analysis to reduce data dimensionality (Ai et al., 2021), machine learning classification methods (Saplaçan et al., 2020), and structural equation modeling (Yao, 2019).

Long-term exposure to fragmented information significantly affects individuals' cognitive processes, learning, and daily life. At the cognitive level, this mode of exposure reduces the ability to maintain sustained focus, as evidenced by an increased working memory load (Rahiminia et al., 2019) and decreased efficiency in logical reasoning (Ai et al., 2021). In terms of learning, college students become more prone to distraction in environments with fragmented information, resulting in a significant decline in the quality of task completion in class (Kindermann & Onofri, 2021). Furthermore, in everyday life, social media users frequently switching tasks experience time perception distortion, which in turn triggers procrastination behaviors (Yao, 2019).

Limitations and comparisons: Most studies rely on cross-sectional data and lack in-depth long-term tracking analysis (Ai et al., 2021); at the same time, the validity of the measurement tools remains to be verified—for instance, self-report scales may be influenced by social desirability bias (Odden & Russ, 2019). In contrast, the research by Kindermann and Onofri revealed the adverse impact of information fragmentation on cognitive load in educational settings, while Yao's study pointed out that social media users can, to some extent, offset these negative effects through flow experiences (Yao, 2019). This further indicates that it is necessary to more precisely

categorize and study the influencing factors in different scenarios.

2.4 Factors Affecting Focus and Its Impact on Individuals

2.4.1 Individual-Level Factors

Differences in cognitive abilities and psychological factors significantly affect an individual's capacity to adapt to fragmented information environments and maintain attention stability. Specifically, those with strong multitasking abilities tend to adapt more flexibly to fragmented settings (Rahiminia et al., 2019), whereas individuals with weaker cognitive control may experience a marked decline in focus when confronted with multiple tasks (Odden & Russ, 2019). In addition, psychological factors are not negligible; anxiety and stress consume substantial cognitive resources, thereby reducing the stability of attention (Odden & Russ, 2019).

2.4.2 External Environmental Factors

In the current media landscape, social media platforms employ design elements such as “infinite scrolling” and instant feedback mechanisms (e.g., likes, comments) to capture users' attention (Yao, 2019). Simultaneously, the management of fragmented time undermines the ability for deep focus, as indicated by the negative correlation between the frequency of task switching and the quality of task completion (Saplacan et al., 2020).

2.4.3 Potential Consequences of Declining Focus

Declines in focus affect academic performance, daily efficiency, and psychological well-being. Specifically, in academic performance, task completion times are prolonged (Saplacan et al., 2020) and the logical coherence of academic writing diminishes (Ai et al., 2021). Regarding daily efficiency, procrastination tends to increase (Yao, 2019), and the ability to plan long-term is impaired (Odden & Russ, 2019). Furthermore, on a psychological level, divided attention makes individuals more susceptible to external distractions—for example, an excessive reliance on mobile notifications (Kindermann & Onofri, 2021)—with some users even developing symptoms of “information anxiety” (Rahiminia et al., 2019).

2.4.4 Intervention Strategies

At the individual level, cognitive training methods, such as mindfulness meditation, can enhance one's resilience to distractions (Jiang, 2020). From an environmental design standpoint, universal design principles have been applied to optimize digital learning platforms to reduce the fragmentation of information across different systems. Concurrently, social media platforms have introduced a “focus mode” feature to promote enhanced user concentration.

2.4.5 Research Gaps

Further research should explore the differential impact of fragmented information on individuals with diverse cognitive styles (e.g., field-independent vs. field-dependent) and examine how cultural background moderates these effects.

3 RESEARCH QUESTIONS

3.1 Main Question

The present study systematically examines the impact of social media-driven fragmented information consumption patterns on the sustained attention capacities of undergraduate students over the past five years.

3.2 Breakdown of Issues

1.How can the fragmented information present on social media platforms be clearly defined?

2.How can the attention of these college students be measured by using “time of concentration” (noting the investigation of popular online buzzwords)?

3.Over the past five years, what specific mechanisms and dimensions illustrate how the fragmented information mode on social media impacts the learning attention of currently enrolled college students? (A detailed analysis across various categories of college students is conducted.)

4.Over the past five years, what specific mechanisms and dimensions illustrate how the fragmented information mode on social media impacts the daily attention of currently enrolled college students? (A detailed analysis across various categories of college students is conducted.)

4 RESEARCH METHODS AND RESULTS

4.1 Questionnaire Survey Method

The investigation commenced with administering structured questionnaires to the target population (undergraduate students). Initial data collection focused on recording demographic characteristics and research-relevant attributes. To address the core research question regarding the impact of fragmented information on attention span, two standardized measurement instruments were incorporated: the Fragmented Information Scale (Ai et al., 2021) and the Attention Concentration Self-Assessment Scale (Lin et al., 2009). Complementing these scales, the questionnaire included purpose-designed items assessing static behavioral patterns. Valid responses were obtained from 96 participants, with all collected data undergoing descriptive statistical analysis. The analytical results indicate three predominant characteristics: extended social media usage duration, frequent exposure to fragmented information inputs, and reduced capacity for sustained attention among the surveyed undergraduate cohort.

4.2 Correlation Analysis

After categorizing the questionnaire data, Pearson's correlation analysis was conducted between the extent of fragmented information exposure and the

perceived decline in attentiveness to assess their correlation.

As shown in Table 1, the Pearson's correlation analysis revealed that the extent of fragmented information exposure significantly positively correlated with the perceived decline in attentiveness. This indicated that the higher the fragmented information exposure, the greater the attentional decline.

4.3 Python-Based Web Crawling and Sentiment Lexicon Analysis

A Python-based web crawler was deployed to retrieve targeted metadata fields from post titles containing fragmented information and attentional focus on Xiaohongshu (a Chinese social media platform). This methodology captured public sentiment orientation toward fragmented information and attentional focus. The lexical frequency data subsequently underwent descriptive statistical analysis, identifying discernible patterns in public perception of the correlation between fragmented information exposure and attentional focus.

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Table 1. The Correlation between Students' Focus and Fragmented Information Intake

		Perceived Decline in Concentration	Fragmented Information Reception
Perceived Decline in Concentration	Pearson Correlation	1	.240*
	Two-tailed Significance		0.018
	Sample Size	96	96
Fragmented Information Reception	Pearson Correlation	.240*	1
	Two-tailed Significance	0.018	
	Sample Size	96	96

4.4 Python-Based Web Crawling and Sentiment Lexicon Analysis

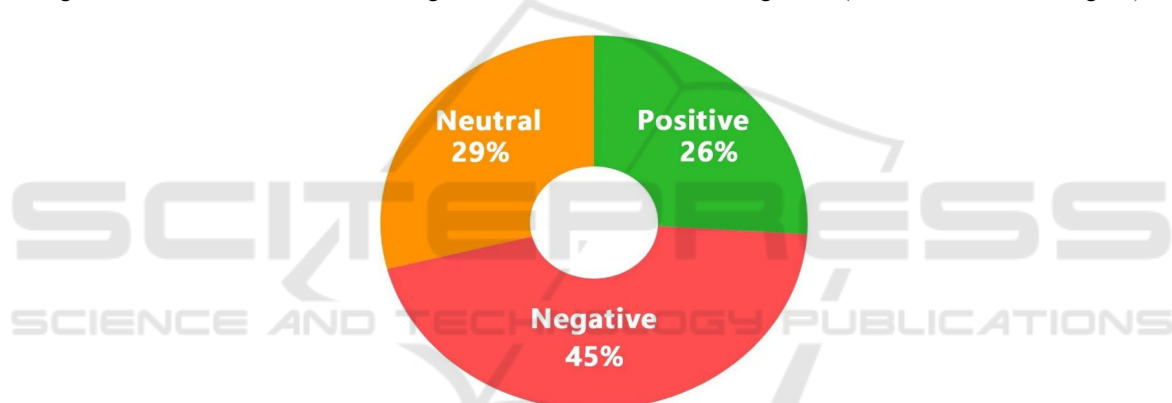
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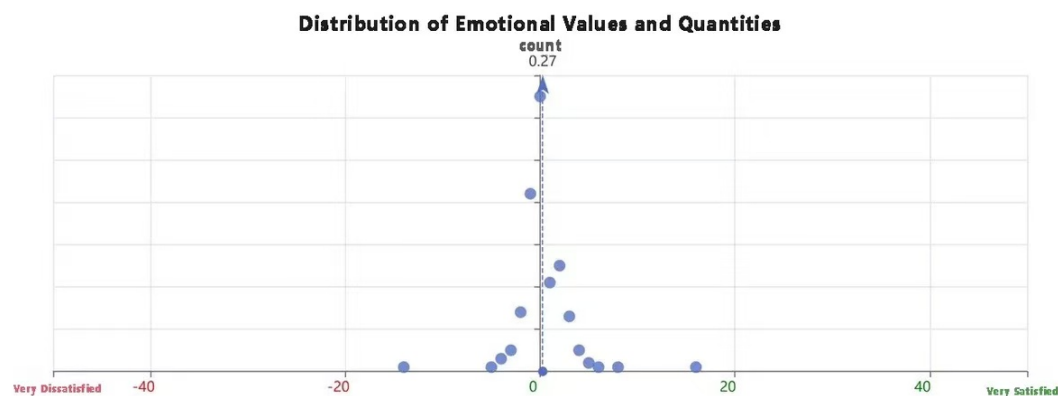
Alt Text for the figure: Word cloud featuring "Fragment" at the center, surrounded by related terms like "Explode," "Break," "Control," and "Anxiety," in various colors and sizes.

Figure 1. Sentiment Word Cloud for Fragmented Information and Declining Focus (Photo/Picture credit: Original).



Alt Text for the figure: A pie chart showing sentiment distribution: Negative 45%, Neutral 29%, Positive 26%.

Figure 2. Distribution Chart of Positive, Negative, and Neutral Terms for Fragmented Information and Declining Focus (Photo/Picture credit: Original).



Alt Text for the figure: Scatter plot titled "Distribution of Emotional Values and Quantities" with emotional values ranging from "Very Dissatisfied" to "Very Satisfied" on the horizontal axis and count on the vertical axis. Data points are clustered around the positive side, with the highest count at approximately 0.27 near the origin.

Figure 3. Scatter Plot of Term Frequency for Fragmented Information and Declining Focus (Photo/Picture credit: Original).

Table 2. Scatter Plot of Sentiment Scores for Fragmented Information and Declining Focus

Positive letters	Negative and neutral letters
1 : 21	-14 : 1
2 : 25	-5 : 1
3 : 13	-4 : 3
4 : 5	-3 : 5
5 : 2	-2 : 14
6 : 1	-1 : 42
8 : 1	0 : 65
Total : 68	Total : 131

4.5 Sentiment Analysis

As illustrated in Figure 1, lexical frequency clouds associated with fragmented information and attentional focus predominantly feature negative terms. Figure 2 further specifies that negative valence terms constitute the majority (45%) of this lexicon, whereas neutral and positive terms exhibit comparable proportions (27% and 28%, respectively). Additionally, Figures 3 and Table 2 demonstrate that the positive lexicon accounts for approximately 50% of non-positive terms. Collectively, these findings reveal a dominant non-positive sentiment orientation, supporting the inverse relationship between fragmented information exposure and attentional focus maintenance (see Figure 1, 2, 3).

5 DISCUSSION

Through sentiment analysis and correlation analysis, this study identifies that in contemporary society, fragmented information exerts a substantial negative impact on college students' attentional focus, with higher exposure levels corresponding to greater declines in attentional maintenance. The measurement targets in this research were strictly limited to college students. Previous studies have investigated populations including social media users and online learners (Kindermann & Onofri, 2021; Yao, 2019). Although differing in research cohorts, the conclusions of this study exhibit near-complete consistency with prior findings. Existing literature demonstrates that prolonged exposure to fragmented information reduces sustained attentional capacity at the cognitive level (Rahiminia et al., 2019). Within academic contexts, college students in fragmented information environments display increased susceptibility to attentional diversion (Kindermann & Onofri, 2021), while daily life scenarios similarly

exhibit reduced focus (Yao, 2019). Synthesizing these findings, fragmented information adversely affects multiple dimensions of individual life.

5.1 Implications of the Research Findings

This study reveals the significant negative impact of fragmented information on the focus of college students. This finding not only confirms the ubiquitous conclusions reached by previous research but also underscores the burgeoning attention crisis in the digital age. Based on Cognitive Load Theory, this study proposes systematic solutions from multiple dimensions—including individual behavioral correction, the reconstruction of the educational ecosystem, and the governance of technological ethics—outlined in the implementation paths below:

5.1.1 Individual Cognitive Rebuilding Strategies

As digital natives, college students need to establish proactive defense mechanisms against information overload. At the behavioral level, a "dual-mode time management approach" can be adopted: utilizing the Pomodoro Technique to divide work into 25-minute deep learning sessions, complemented by focus management tools such as Forest to block social media distractions. At the cognitive level, mindfulness meditation training is recommended.

Neuroscientific research indicates that 20 minutes of mindfulness practice per day can enhance activity in the anterior cingulate cortex, thereby improving resistance to interference. In terms of technological assistance, digital trace analysis tools—such as RescueTime—can quantify the intensity of exposure to fragmented information. An alert mechanism is triggered if passive information intake exceeds 90 minutes in a single day, with this threshold based on research identifying the critical point at which attention begins to deteriorate.

5.1.2 Adaptive Reform in Educational Systems

Higher education institutions should prioritize the establishment of cognitively-adaptive learning environments through three fundamental modifications. The curriculum design requires embedding metacognitive attention training modules in general education programs, particularly through neuroscience laboratory courses that demonstrate efficiency depletion in multitasking processes. Physical space renovation necessitates installing Wi-Fi-free study pods with 470nm amber lighting, experimentally proven to reduce β -oscillation amplitude in visual cortex by 30%, while simultaneously designating smart device-free zones as cognitive protection areas in library facilities. Regarding evaluation system innovation, implementing eye-tracking-based learning monitoring systems that automatically deliver cognitive adjustment prompts when students' gaze shift frequency exceeds 2Hz remains imperative.

5.1.3 Reconstruction of Internet Platform Responsibilities

Social media platforms should transition from attention extraction paradigms to functioning as custodians of cognitive well-being through the implementation of dual mechanisms encompassing algorithmic mediation and normative governance. Within the technical dimension, dynamic information flow regulation systems could be developed utilizing machine learning algorithms to identify substantive content (e.g., text density >0.8 , information entropy $>5\text{bit/character}$), where qualified content should undergo distribution interval extension beyond 24 hours. Regarding normative governance, establishing a Cognitive Risk Assessment and Prioritization System (CRAP) information classification system would require cognitive load value (CLV) labeling for fragmented content; when users engage with $\text{CLV} > 7$ materials continuously exceeding 15 minutes, mandatory rest interfaces should be triggered. Furthermore, in accordance with Article 29 of the EU Digital Services Act, academic applications should be configured with cognitive streamlined interfaces as default settings through deactivation of non-essential functions.

5.1.4 Public Policy Governance Framework

The governmental governance system should implement a tripartite "prevention-intervention-compensation" architecture: Prevention phase:

Enactment of the Digital Health White Paper requires educational platforms to integrate the National Attention Protection Standard (e.g., restricting each notification to ≤ 3 information units). Intervention phase: Smart city initiatives should incorporate cognitive load monitoring stations, with urban brain systems generating regional heatmaps of attentional demands. Compensation phase: Development of a national neuroplasticity cloud platform is proposed to deliver transcranial magnetic stimulation (TMS)-based neuromodulation services for attention deficit populations. Legislatively, amendments to the Cybersecurity Law should introduce digital health rights provisions mandating corporate disclosure of algorithmic impacts on sustained attention.

This study underscores the inadequacy of unilateral governance, necessitating a quadripartite network integrating individual, institutional, corporate, and governmental stakeholders. Short-term behavioral interventions may deploy digital health tools (e.g., compulsory installation of attentional shielding plugins in academic institutions). Mid-to-long-term strategies require neuroplasticity-based cognitive rehabilitation systems. Establishment of a National Attention Research Institute would facilitate periodic publication of the National Attentional Competence White Paper, culminating in comprehensive cognitive safeguarding protocols for the digital era.

5.1.5 Interdisciplinary Research Directions

Future investigations must be deepened to examine neural adaptation mechanisms underlying fragmented information processing, employing functional near-infrared approach will facilitate the establishment of biologically validated markers for attention impairment. Concurrently, adaptive information flow modulation spectroscopy (fNIRS) to monitor prefrontal cortex oxygenation dynamics (with blood oxygenation changes detectable through alternative modalities including fMRI). This experiments should be implemented, systematically regulating information density (0.5-4 bits/s) to identify working memory capacity thresholds. Such empirical findings will yield neuroscientific foundations for platform algorithm optimization. Methodologically, developing mixed reality (MR) experimental paradigms is crucial to simulate cognitive disparities between short-video platform interfaces (e.g., Douyin/TikTok) versus conventional print-reading contexts, thereby mitigating social desirability bias inherent in questionnaire-based approaches.

5.2 Limitations

Considering the study participants—university students representing only a minor segment of society—the generalizability of the conclusions is consequently limited. The recommendations for improving attention advanced in this paper are highly targeted, yet their overall contribution to mitigating the adverse societal impact of fragmented information on attention remains relatively modest. With respect to measurement methods, employing attention duration as a proxy for attention level presents specific technical limitations. While extant literature validates its rationality as a measure, the considerable measurement error and associated difficulties may result in misleading experimental outcomes, thereby requiring a larger sample size. From the standpoint of experimental methodology, the questionnaire survey approach, as a traditional and generally applicable method in social sciences, can address a wide range of issues; however, its application in small sample contexts is prone to substantial error. Accordingly, future research ought to expand its scope to encompass a more diverse pool of participants, thereby improving the generalizability of its conclusions. Furthermore, during both the data processing and social experiment phases, future studies should employ data indicators and experimental methods of higher precision to yield more accurate conclusions.

6 CONCLUSION

This study examines the effects of fragmented information on attentional capacity among undergraduate students. The research methodology integrates questionnaire surveys, correlation analysis, Python-based web crawling, and emotional lexicon frequency analysis. Results demonstrate significant negative correlations between fragmented information exposure and sustained attention performance, with longitudinal exposure to fragmented information predicting measurable deterioration in attentional maintenance. To address these findings, the paper proposes four evidence-based intervention strategies: cognitive restructuring techniques, adaptive reform in educational systems, responsibility recalibration for digital platforms, and public policy framework optimization. Cognitive restructuring techniques target the enhancement of metacognitive awareness through volitional regulation, while the remaining three strategies emphasize coordinated institutional interventions at

governmental and societal levels. By employing a dual analytical framework encompassing problem diagnosis and solution formulation, this investigation systematically elucidates the cognitive impacts of fragmented information exposure and provides empirically grounded recommendations for attention enhancement. Within the contemporary media ecosystem dominated by fragmented information patterns, the proposed multidimensional approach offers viable countermeasures to mitigate cognitive fragmentation effects, ultimately fostering the development of sustained, deep-learning capabilities in academic contexts.

AUTHORS CONTRIBUTION

All the authors contributed equally and their names were listed in alphabetical order.

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