The Academic Anti-Procrastination Approach: Combining Peer Motivation and Personalized Artificial Intelligence Reminders

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Abstract: Academic procrastination is a pervasive issue that significantly affects college students, leading to increased anxiety, stress, and reduced study efficiency and performance. Despite numerous studies exploring the causes and solutions to reduce procrastination, including the positive effects of peer motivation and technological interventions, the integration of artificial intelligence (AI) interventions through peer motivation and smart reminders remains underexplored. In this study, we conducted a systematic literature review on the causes of academic procrastination, the influence of social motivation, and technical interventions aimed at reducing procrastination. Our review revealed a significant research gap regarding the use of AI reminders and peer motivation to help students mitigate procrastination and enhance productivity. To address this gap, we propose an Academic Anti-Procrastination Approach that integrates peer motivation, social interaction, and AI-driven reminders. This approach utilizes the social networks of college students and incorporates AI tools to create a support system designed to reduce procrastination. We conducted an experiment to evaluate the effectiveness of this approach, using a mixed-methods methodology to analyze the results. Our findings suggest that the approach effectively reduces academic procrastination by harnessing the synergistic effects of peer motivation and AI-driven interventions. Quantitative results showed a p-value of 0.0017 in the experimental group, indicating a statistically significant decrease in procrastination scores after the intervention. Qualitative semi-structured interview results revealed that all participants found the personalized AI reminders helpful, with 87% stating that social motivation and interaction motivated them to complete tasks. Additionally, 80% of participants indicated that the concepts behind the approach would be useful in combating procrastination and expressed a willingness to use the approach and join a peer group to reduce their academic procrastination. This study offers practical contributions for combating academic procrastination in college environments. Students can utilize this method to create supportive peer groups and leverage personalized technological support, helping them overcome low efficiency and maintain focus on academic tasks.

Keywords: Procrastination, Peer motivation, Artificial intelligence, Reminders, Social Interaction, College students

1. Introduction

Procrastination is a common issue across the globe which affects most people regardless of occupation or social status. Avoiding procrastination is reported to be one of the top goals around the world. For instance, a meta-analysis by Professor Steel (2007) at the University of Calgary claims that 80 to 95 percent of college students procrastinate, particularly when it comes to doing their homework or coursework. He stated that procrastination can be defined and characterized as a self-regulatory failure leading to poor performance and reducing human well-being. Longitudinal studies have revealed that procrastination is positively associated with anxiety and negatively related to self-efficacy for self-regulated learning (Yerdelen et al., 2016).

Numerous studies have explored the internal and external causes of procrastination, including individual factors and influences from groups. Research on procrastination among college students reveals its negative relationship with self-esteem, self-efficacy, and motivation (Cuncolkar & D'Silva, 2020; Chen et al., 2016; Vij & Lomash, 2014). Social networks can trigger procrastination through persuasive design features (Alblwi et al., 2019), while group work with interdependence can decrease procrastination, especially for high trait procrastinators (Koppenborg & Klingsieck, 2022).

In the context of academic procrastination among college students, personal emotions and behaviors are mutually influenced by the encouragement and support from peers. College students' thoughts and behaviors are easily influenced by their peer groups. Peer attachment, motivation and support play crucial roles in mitigating academic procrastination (Jin et al., 2019).

Although substantial research has focused on identifying the causes of procrastination and proposing solutions, the potential of AI technology to enhance peer interaction and encouragement, thereby altering individual procrastination behavior, remains unexplored. This paper aims to design an approach to assist college students in overcoming academic procrastination by joining groups with common goals. By leveraging peer motivation

and personalized AI reminders, the approach seeks to reduce procrastination, provide timely encouragement throughout task completion, and ultimately improve productivity.

2. Systematic Literature Review

Academic procrastination is a prevalent issue among college students, significantly impacting their academic performance and overall well-being. This literature review aims to fill this gap by providing a detailed overview of research on academic procrastination among college students, focusing on its causes, the influence of peer motivation, and the potential of technical interventions to mitigate procrastination. This literature review seeks to address the following research questions:

- What are the primary causes of academic procrastination among college students?
- How does peer motivation influence academic procrastination?
- What technical interventions have been proposed and evaluated to reduce academic procrastination in college students?

2.1 Method and Search Strategy

The purpose of a systematic review is to answer specific questions based on an explicit, systematic, and replicable search strategy, with inclusion and exclusion criteria identifying studies to be included or excluded (Gough, Oliver & Thomas, 2017). Data are then coded and extracted from included studies to synthesize findings and shed light on their application in practice, as well as on gaps or contradictions. An exhaustive search was conducted using Google Scholar, Semantic Scholar, Web of Science, Zotero, and Elicit. We used terms such as procrastination/anti-procrastination, academic procrastination, group work, social motivation, peer influence, study productivity, college students, and other similar terms. The search technique was designed to locate papers related to the three research topics and questions. In total, 30 articles were used on the topic of academic procrastination among college students.

2.2 Literature Review Findings and Discussion

Causes of Academic Procrastination in College Students

Internal Causes: we investigated the internal causes of academic procrastination of college students. The findings show that procrastination is often linked to poor self-regulation, where students struggle to manage their time and prioritize tasks effectively (Steel, 2007). Low self-esteem and self-efficacy are significant predictors of procrastination, as students with low confidence in their abilities are more likely to delay tasks (Guo & Chen, 2024). Intrinsic motivation and self-determined extrinsic motivation are negatively correlated with procrastination, whereas amotivation and external pressure contribute to higher procrastination rates (Deci & Ryan, 1985).

External Causes**:** We found that the external factors leading to academic procrastination are primarily focused on the challenge and difficulty of the tasks, as well as the disruptive elements of the external environment. The external factors leading to academic procrastination are primarily focused on tasks perceived as aversive or overly challenging and are more likely to be procrastinated (Blunt & Pychyl, 2000). Distractions in the environment, such as social media and other online activities, significantly contribute to procrastination (Guo & Chen, 2024).

Peer Influence on Academic Procrastination

Peer conformity can have both positive and negative effects on academic procrastination. Peers who engage in procrastination can reinforce this behavior in others, while supportive peers can help reduce procrastination through encouragement and accountability (Mackinnon et al., 2016). Group work has been shown to reduce procrastination by promoting accountability and shared goals. However, it can also increase feelings of guilt and shame if group members do not meet expectations (Wolters, 2003). Social motivation, including encouragement from peers, is a crucial factor in reducing procrastination. Social networks provide support and motivation, helping students to stay on track with their academic tasks (Schmitz & Wiese, 2006).

Technical Interventions for Reducing Procrastination

Nudge Theory was originated by Richard Thaler and Cass Sunstein in the book Nudge Theory. Nudges, such as reminders and prompts, have been effective in reducing procrastination by keeping students focused on their tasks (Thaler & Sunstein, 2008). Tools that facilitate social interaction and collaboration, such as online forums and study groups, can help reduce procrastination by providing social support and accountability (Hrastinski,

2009). Techniques such as goal setting (SMART goals), calendar integration, reminders, self-monitoring, and task motivation (commitment, rewards, milestones) are effective in managing procrastination. These strategies help students organize their tasks, stay motivated, and complete assignments on time.

2.3 Conclusion of the Findings and Research gap

Academic procrastination is a multifaceted issue influenced by internal and external factors, social motivation, and technological interventions. Addressing procrastination requires a comprehensive approach that includes enhancing self-regulation and motivation, leveraging peer influence positively, and utilizing technological tools to support students in managing their tasks effectively. By understanding and addressing these factors, educators and researchers can develop strategies to reduce procrastination and improve academic performance. Due to the research gap identified during the literature review, we proposed an approach to reduce academic procrastination among college students. Existing studies have not addressed how to use AI technology to combine peer motivation and personalized reminders to alter individual procrastination behavior. This unique contribution is the focus of our research.

3. Design

3.1 Design Science Research Methodology

We designed and built our artifact using the Design Science Research methodology, following the guidelines of the Information Systems research framework presented by Hevner et al. (2004), which offers a problem-driven approach to assist IS designers. Based on the Design Science Research (DSR) framework, we outline the environment, IT artifacts, and knowledge involved in developing an Academic Anti-Procrastination Approach. The figure emphasizes the relevance and rigor in connecting the environment, IT artifacts, and knowledge. The development process is cyclical, requiring ongoing evaluation and adjustments to refine the approach and enhance its effectiveness in combating academic procrastination. (Figure 1)

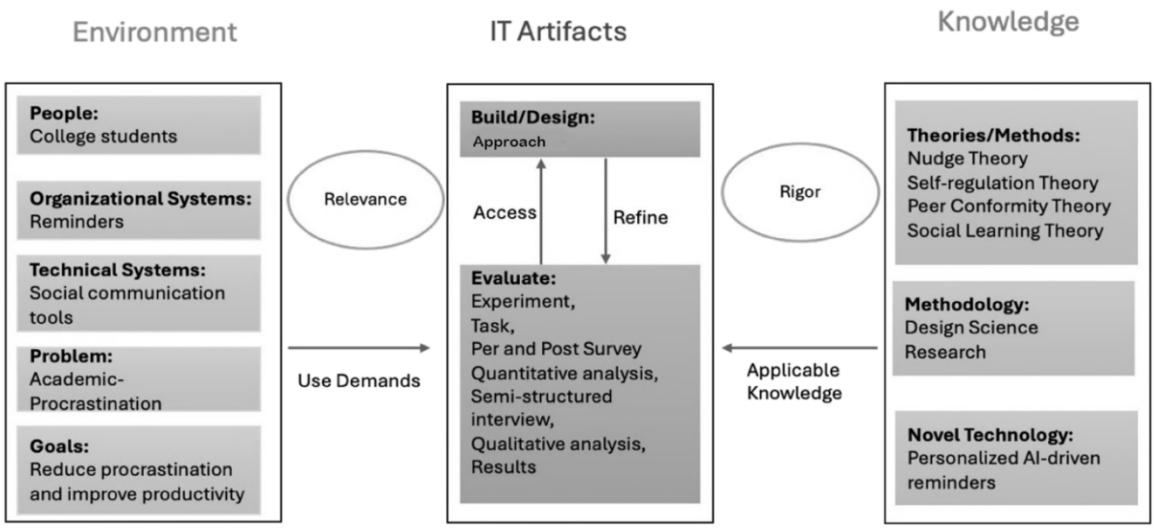

Figure 1: The Design Science Methodology applied in Academic Anti-Procrastination Approach

Environment: Based on the DSR model, our environment includes college students as the target population, digital reminders used during the learning process as the organizational systems, and social communication tools as the technical systems. The goal of this approach is to reduce academic procrastination and improve productivity.

IT Artifacts: The artifact is the "Academic Anti-Procrastination Approach," which integrates social motivation and AI-driven reminders. An experiment was designed to test the approach, including tasks, pre- and post-surveys for both experiment and control groups, and a mixed-methods approach involving quantitative analysis, semi-structured interviews, and qualitative analysis. The entire process is iterative, requiring continuous assessment and refinement.

Knowledge: To develop a robust approach for reducing academic procrastination, we integrated several foundational theories. Nudge Theory (Thaler & Sunstein, 2008) provided the basis for using subtle cues and reminders to steer students towards productive behaviors. Self-Regulation Theory (Schunk, 2012) emphasized

the importance of helping students manage their thoughts, emotions, and actions to achieve academic goals. Peer Conformity Theory (Laursen & Faur, 2022) highlighted the influence of peer behavior on individual actions, informing our approach to leverage peer motivation and social interaction. Lastly, Social Learning Theory (Brady, 2017) underpinned the framework's use of observational learning and modeling, encouraging students to learn from each other's successes and challenges. At the same time, we integrated cutting-edge AI technology into the process.

3.2 Academic Anti-Procrastination Conceptual Approach

To address academic procrastination among students, we developed a comprehensive approach that integrates several foundational theories with cutting-edge AI technology. This approach leverages personalized AI-driven reminders, peer motivation, and social interaction to enhance self-regulation and reduce procrastination. The integration of these constructs creates a multi-faceted approach that targets the key factors influencing procrastination. (see Figure2)

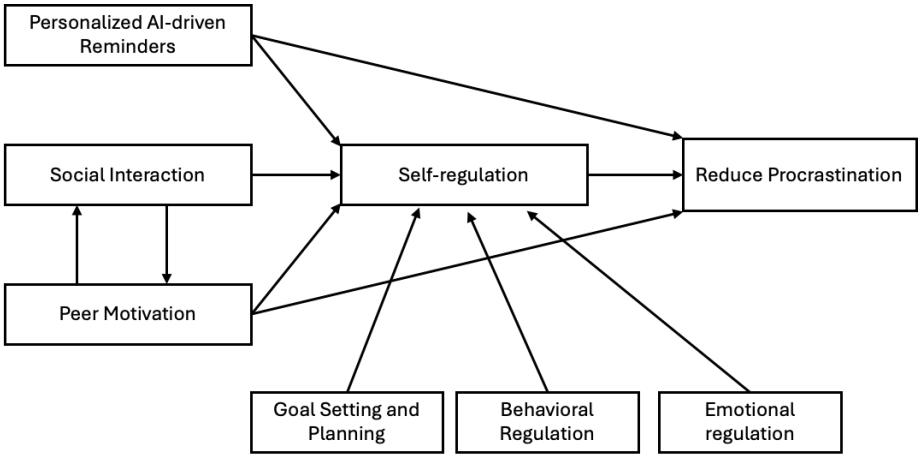

Figure 2: Academic Anti-Procrastination Approach

Variables in this Academic Anti-Procrastination Approach

Independent Variables*:* (a)Personalized AI-driven Reminders: tailored reminders generated by AI based on individual needs and preferences, aimed at keeping students on track. AI reminders provide timely cues and feedback to help students manage their tasks and time effectively. (b)Peer Motivation: encouragement provided by peers within the group which can foster a sense of community and mutual support, promoting motivation through social interactions. (c)Social Interaction: group discussions and collaborative activities designed to enhance engagement and motivation. Social communication can increase commitment to tasks through social support and interaction.

Dependent Variable: Reduction in Procrastination is the primary outcome of the approach, measured by the decrease in procrastination behaviors among students.

Mediator Variables: (a)Self-Regulation: the ability to manage one's thoughts, emotions, and behaviors in alignment with long-term goals. Acts as the central mechanism through which the independent variables influence the dependent variable. Enhanced self-regulation leads to reduced procrastination. (b)Goal Setting and Planning: establishing clear, achievable goals and creating structured plans to reach those goals. (c)Behavioral Regulation: controlling actions to avoid distractions and stay focused on tasks, using strategies such as time management and prioritization. (c) Emotional Regulation: managing stress and maintaining focus, such as mindfulness practices and relaxation exercises. Goal setting and planning, behavioral and emotional regulation directly contribute to self-regulation by ensuring effective self-management and focus on academic tasks.

4. Research Methodology

Our study employed a mixed-method approach within the Design Science Research (DSR) framework to develop and evaluate an Academic Anti-Procrastination Approach. We synthesized existing research on technological interventions and social motivation for reducing procrastination. Using DSR principles, we developed our approach integrating AI-driven reminders and peer motivation. We used Mixed-Method to evaluate this

approach, then synthesized quantitative and qualitative findings to comprehensively assess the approach's effectiveness.

By combining these methods, we aimed to provide a robust evaluation of our intervention's efficacy in reducing academic procrastination.

5. Evaluation and Results

5.1 Experimental Design and Implementation Process

To evaluate our approach, we conducted an experiment involving two groups: a treatment group and a control group. We utilized WhatsApp as the social communication tool for this experiment. A total of 34 participants, all university students from Claremont Graduate University, were randomly assigned to the two groups, with 17 participants in each group. The experiment comprised pre-surveys, post-surveys, completion of a specific academic task, and semi-structured interviews with the students in the treatment group. This approach enabled a comprehensive assessment of the approach's effectiveness in addressing academic procrastination.

The hypotheses for the experiment:

> *Null Hypothesis: Personalized AI-driven reminders combined with peer motivation and social interaction will not reduce procrastination.*
>
> *Hypothesis: Personalized AI-driven reminders combined with peer motivation and social interaction will reduce procrastination.*

Experiment Design: it was conducted over nine days (see Figure 4). On the first day, we sent the pre-survey to both groups and collected the responses by the end of the day. On the second day, we sent the "New Year's Study Planning Task" to both groups, giving them five days to complete it. During these days, based on each student's major, grade, and interests collected from the pre-survey of experiment group, we generated personalized AI reminders for each participant and encouraged the treatment participants to discuss and communicate about this task.

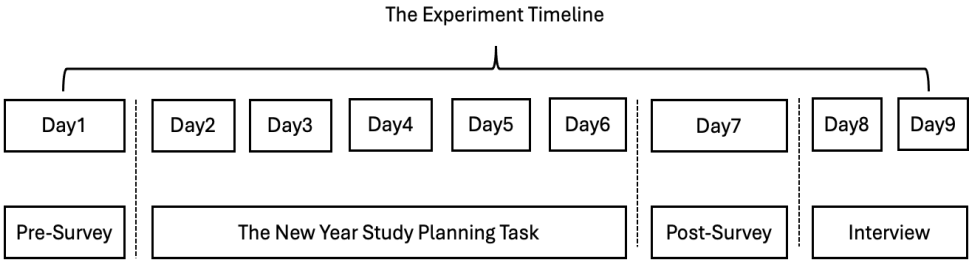

Figure 4: The Nine-Day Experiment Timeline

The pre and post survey: We used Qualtrics to distribute our surveys, which included both pre- and post-surveys for the control and experiment groups. The surveys, based on a 5-Point Likert Scale, consisted of four parts:

- Consent to Participate: it obtained participants' consent to take part in the study.
- General Procrastination Scale (GPS): The second part included the General Procrastination Scale (GPS), a reliable and validated measurement of procrastination containing 23 questions (Lodha et al., 2019).
- New Year Study Task and Attitudes: The third part consisted of four questions about the New Year study task and participants' attitudes toward peer motivation, social communication, and reminders during their study process.
- Personal Information: The final part concluded with personal questions about the participants' email address, major, grade, gender, interests, department, and school.

The task: named "New Year Study Plan," consisted of 10 open-ended questions about the past year's achievements and the new year's goals. Each student was given five days to complete this task. To measure the changes after the experiment, a post-survey, identical to the pre-survey, was administered. We will compare the General Procrastination Scale (GPS) scores before and after the task and analyze their attitudes toward peer motivation, social interaction, and AI reminders.

We began the experiment by adding the participants randomly into 2 groups, treatment and control. The participants in the treatment group could post in the chat. They also received reminders during the experiment. In contrast, the control group participants could not share anything and did not get any reminders during the experiment.

Personalized AI reminders: We sent educational, motivational, and recognitional AI reminders to the treatment group participants (see Table 1). The personalization of these reminders was achieved through a rule-based AI system that utilized individual student data collected from the pre-survey. The system followed these steps:

- Data Collection: The system gathered each student's major, grade level, and interests from the pre-survey responses.
- Reminder Template Selection: Based on the day of the experiment, the system selected appropriate reminder templates (educational, motivational, or recognitional).
- Content Customization: The AI then customized the content of each reminder by inserting relevant details such as the student's major, year of study, or specific interests into predefined placeholders within the templates.
- Timing Optimization: The system determined the optimal time to send reminders based on general student activity patterns and any time preferences indicated in the pre-survey.
- Adaptive Scheduling: The AI adjusted the reminder schedule based on task completion status, ceasing reminders once a student completed the task.

The treatment participants received personalized AI reminders each day. On the first day, each student received an educational reminder. From the second day to the fifth day, students received a mix of educational and motivational reminders randomly, at least one per day. Upon task completion, students received a recognitional reminder and no further reminders. The control group did not receive any reminders or encouragement posts, and there was no peer interaction within this group.

Table1: Personalized AI reminders Demo

Day	Educational Reminder	Motivational Reminder	Recognitional Reminder
Day 1	"Dear [Participant], next year is your [year] year at university, and your major is [major]. Start your study plan by reviewing your syllabus and your main tasks for the coming year. You will do your best!"		
Day 2	"Dear [Participant], set specific, measurable goals for each of your [major] subjects to keep your studies on track for your [year] year."	"Dear [Participant], remember, the future belongs to those who believe in the beauty of their dreams. Keep dreaming big!"	"Dear [Participant], you're doing amazing! Your effort today is a step towards success in [major]."
Day 3	"Dear [Participant], use active learning techniques like summarizing and questioning to enhance your understanding of [major] concepts."	"Dear [Participant], stay focused and stay strong. You're capable of achieving great things in your [year] year!"	"Dear [Participant], well done! You're halfway through your plan. Keep pushing forward in your [major] studies."
Day 4	"Dear [Participant], break down your tasks into manageable chunks to avoid feeling overwhelmed with your [major] coursework."	"Dear [Participant], believe you can and you're halfway there. Keep going!"	"Dear [Participant], your hard work is paying off. Great job staying dedicated to your [major] study plan."
Day 5	"Dear [Participant], review and adjust your study plan based on your progress to ensure you're on the right track in your [year] year of [major]."	"Dear [Participant], success is not final, failure is not fatal: It is the courage to continue that counts. You're almost there!"	"Dear [Participant], congratulations on completing your study plan! Celebrate your achievement and get ready for a successful year in [major]."

On the seventh day, we sent a link for the post-survey to both groups and collected the responses by the end of the day. Lastly, we conducted semi-structured interviews with the treatment group participants over the final two days. This structured approach allowed us to rigorously test the approach's impact on academic procrastination, providing both quantitative and qualitative data for a thorough evaluation.

5.2 Quantitative Evaluation

For the control group, 15 participants completed the pre-survey, 13 completed the task, and 13 completed the post-survey. In contrast, all 17 participants in the treatment group completed the pre-survey, the task, and the post-survey, resulting in a 100% completion rate. The completion rate for the control group was 76%. We performed t-tests using SPSS within the groups and between the groups, the statistics results as below:

Paired Samples T-Test for Experiment Group (N=16)

Paired Samples Statistic				
	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Pre-Test	65.12	17	7.98	1.94
Post-Test	59.35	17	7.31	1.77

Paired Samples Test					
	Mean	Std. Dev.	t	df	P value
Pre-Post	5.76	5.23	4.53	16	<0.001

Paired Samples T-Test for Control Group (N=11, matched pairs only)

Paired Samples Statistic				
	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Pre-Test	61.14	14	8.59	2.30
Post-Test	61.86	14	10.63	2.84

Paired Samples Test					
	Mean	Std. Dev.	t	df	P value
Pre-Post	-0.71	10.76	-0.25	13	0.808

Independent Samples T-Test (Comparing changes between groups)

Group Statistics				
	Mean	N	Std. Deviation	Std. Error Mean
Change Experiment	5.76	17	5.23	1.27
Control	-0.71	13	10.76	2.88

Independent Samples Test				
Change	t	df	P value	Mean Dif.
Equal Var. assumed	2.63	29	0.013	6.48

For the Experiment group, there's a significant decrease in procrastination scores (mean difference = 5.76, t (16) = 4.53, $p < 0.001$). For the Control group, there's no significant change in scores (mean difference = -0.71, t (13) = -0.25, $p = 0.808$). The pre and post scores are more strongly correlated in the experiment group than in the control group ($p = 0.013$), suggesting more consistent changes in the experiment group.

5.3 Qualitative Evaluation

After the treatment group completed their task and post-survey, we conducted semi-structured interviews with all 17 participants. Each participant answered seven questions. Using Atlas.ti for our qualitative analysis, we found that all participants considered the personalized AI reminders helpful. Additionally, 87% of participants felt that group communication and interaction motivated them to complete the task. Moreover, 80% appreciated the anti-procrastination approach and expressed interest in joining social groups to reduce procrastination in the future.

6. Conclusion

The Academic Anti-Procrastination Approach, which integrates peer motivation and personalized AI reminders, has demonstrated a significant impact on reducing procrastination among college students. The results from our mixed-methods approach provide robust evidence supporting the approach's efficacy. The quantitative analysis revealed a statistically significant decrease in procrastination scores within the experimental group. The paired samples t-test showed a mean difference of 5.76 ($t(16) = 4.53$, $p < 0.001$), indicating that the participants experienced a marked reduction in procrastination behaviors after the intervention. This significant decrease highlights the effectiveness of combining personalized AI reminders with peer motivation in tackling procrastination. The qualitative data from semi-structured interviews further validates the approach's success. All participants in the experimental group reported finding the personalized AI reminders helpful. 80% of the participants expressed a positive reception towards the anti-procrastination approach and showed interest in joining similar social groups to reduce procrastination in future academic endeavors. These findings underscore the practical applicability and user acceptance of the approach.

7. Limitations and Future Research

While our study shows promise in improving academic habits and potentially reducing procrastination, several limitations must be acknowledged: 1) Sample Size and Cultural Context: The experiment was conducted with a relatively small sample size of 34 participants from a single university in specify region/country. This limited sample size and specific cultural context may affect the generalizability of the findings. Cultural variations in understanding time management, peer support, and academic expectations could influence the effectiveness of our approach in different settings. 2) Task Design: The "New Year Study Plan" task, while useful for measuring procrastination reduction, may not fully represent the complexity and variety of typical academic assignments. The task's relevance may vary across cultures with different academic calendars or goal-setting practices.3) Time Constraints: The nine-day duration of the experiment limits our ability to fully evaluate the long-term effectiveness of the Academic Anti-Procrastination Approach. The differences in long-term planning and goal persistence could impact the approach's efficacy over extended periods. 4) Mediator Variables: The study did not explicitly test mediator variables such as self-regulation, goal setting, and emotional regulation, which play crucial roles in the approach and may be influenced by cultural factors.

To build on these findings and address limitations, future research should consider: a) Expanding the sample size and diversity, involving multiple universities across different cultural contexts to enhance generalizability. b) Designing longer-term experiments with more complex academic tasks that reflect various cultural academic environments. c) Exploring advanced AI functionalities that can adapt to cultural nuances in time management and academic expectations. d) Incorporating measures for mediator variables while considering their cultural relevance and interpretation.

By addressing these limitations and exploring research directions that consider cultural differences, this approach can be tailored to suit specific academic contexts, such as midterm or final exams, qualifying exams, and other high-level tasks. These scenarios often require enhanced peer motivation and AI technology to help students reduce procrastination and achieve their study goals. While our current findings are promising, further research is needed to develop a more robust and adaptable tool that can effectively support students in diverse cultural contexts. Ultimately, this approach has the potential to improve self-regulation skills, reduce procrastination, and contribute to better academic outcomes and overall well-being.

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