

When Students Start Studying: Tracing Self-Regulated Learning and Exam Performance in Undergraduate Biology

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ABSTRACT: Self-regulated learning (SRL) theorists such as Zimmerman (1990) and Winne (1995) emphasize task definition and planning as crucial initial steps in the SRL cycle. These stages enable learners to identify what is expected of them, set goals, and allocate time and effort strategically to optimize performance. Within this framework, exam study guides function as essential resources that describe task demands, affordances, and constraints. They contain explicit learning objectives that operate as goals, guiding students to plan how and when to engage with exam preparation materials such as blueprints, practice tests, or lecture outlines. We conceptualize exam preparation in high-structure active learning STEM courses as a SRL task, in which learners' timing and frequency of study behaviors represent dimensions of planning and engagement. We investigated undergraduates' exam preparation behaviors in an introductory biology course to understand how planning and engagement relate to academic achievement. Most students delayed or avoided planning via study guide use. Timely planners engaged with more and more diverse learning resources than those who planned later or not at all.

Keywords: self-regulated learning; exam preparation; planning; academic performance

1 THEORY, RESEARCH AIMS, QUESTIONS, AND HYPOTHESES

Self-regulated learners (SRL) engage in stages of planning, goal setting, and enactment of strategies during learning, and monitor, self-evaluate and adapt according to those judgments, until a goal is met (Winne & Hadwin, 1998; Zimmerman, 1990). Engaging in SRL is frequently associated with academic success (Dent & Koenka, 2016). Researchers who study procrastination highlight that the timing of onset of learning behaviors has implications for success, and that intentionally delayed onset of learning behavior tends to be a problematic behavior (Miyake & Kane, 2022). Kitsantas (2002) and others proposed that test preparation provides a clear context for examining SRL because it requires goal setting, planning, time management, and strategic engagement. We aimed to model students' task definition and planning behaviors during exam preparation as indicators of SRL and examined how the timing of study onset and study behaviors relate to academic achievement. We hypothesized that students who accessed study materials earlier would demonstrate greater engagement and achieve higher final exam performance and used timestamped learning event data to derive the number of days prior to the exam when students first accessed study guides, allowing classification into groups of *advanced*, *timely* and *delayed planners* (leaving those who do not download as *non-planners*). Specifically, we address three research questions: (1) When do students begin exam preparation? (2) Does earlier planning lead to more and broader engagement with study materials? and (3) Does early and comprehensive preparation predict higher exam performance? These analyses can clarify how task definition (Winne & Hadwin, 1998) and forethought processes (i.e., Zimmerman, 1990) contribute to success in postsecondary coursework.

2 METHOD

2.1 Participants

Undergraduates (N = 884) enrolled in an introductory biology course at public university in the U.S. consented to share assessment data (including scores from four major exams and cumulative course grades) and event data from the learning management system (LMS) from the course. . All data were de-identified prior to analysis in compliance with research ethics protocols.

2.2 Procedure & Operationalization of SRL behaviours

Event-level data from the final 12 days after Unit 3 and prior to a cumulative Final Exam (Exam 4) were obtained from the LMS to capture students' final exam preparation behaviors. Participant-level demographic and performance data were merged with event records. For each participant, *first_access_days_prior*—was calculated to indicate the number of days before the final exam that the study guide was first accessed (Table 1). We tallied use of resources designed to support *planning* (i.e. reading the study guides) and *monitoring* (practice exam and exam key review), and derived *breadth of engagement* (count of distinct exam-related resources accessed), *study intensity* (total volume of interactions across 12 day exam preparation period) and *recency* of events (temporal proximity [in hours] between the final study interaction and the exam, with higher values indicating earlier completion of preparation). We then examined overall activity (Figure 1) and correlations of each activity with exam performance, per group (Figure 2).

Table 1: Planning distinct group

Planner group	Number of students	Mean of exam 4	SD of exam 4
Advanced Planners (10-12 d)	6	83.8	7.03
Timely planners (7-9 d)	26	77.8	12.2
Delayed (1-6 d)	114	76.7	12.4
Non-planners (No access of guides)	738	79.5	13.2

3 RESULTS

Of those who accessed the study guide during the final 12 days (16.5% of students), most initiated exam preparation within one week of the test (delayed) and some engaged 7-9 days in advance (Timely). A small subset of Advanced Planners (n=6) who initiated preparation more than 10 days in advance were excluded from analysis due to the sample size being too small to generalize. Mean differences in learning behavior metrics tended to benefit those who engaged earlier with planning resources (Figure 1; see brackets for statistically detectable differences. Although grades are statistically similar, the "pathway" to those grades differs significantly. Delayed Planners exhibited the highest Intensity and Monitoring scores, suggesting a "compensatory" strategy where they make up for late starts with high-pressure engagement right before the exam. Non-planners showed significantly lower Breadth and Intensity compared to the other groups. This suggests a large portion of the cohort is achieving decent grades while minimally engaging with the provided digital resources.

Timely and Delayed groups showed similar Breadth of Engagement, the Timely group exhibited a much stronger positive correlation between breadth and Exam 4 performance ($r = 0.43$) compared to others

(Figure 2). This suggests that early planning provides a unique advantage by allowing students to engage more productively with a diverse range of resources. Conversely, Recency (hours before exam) showed negative associations across all groups ($r = -0.04$ to $r = -0.20$), signaling the performance-reducing effects of last-minute cramming.

Figure 1: comparison of SRL behaviours across planning groups

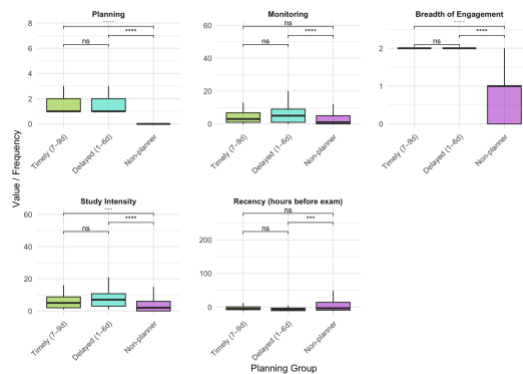
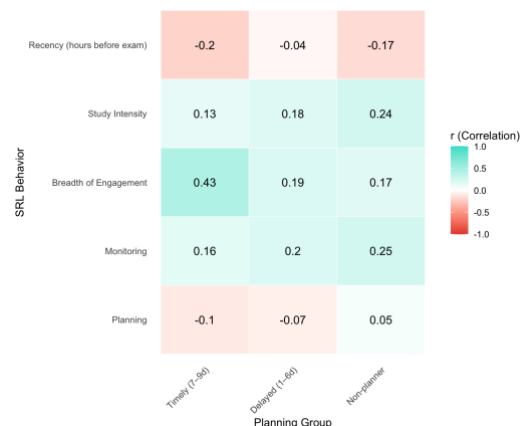


Figure 2: behaviours & Exam 4 grade Correlations



Note: Brackets indicate significance levels ((ns = not significant, * = $p < 0.05$, ** = $p < 0.01$)

4 IMPLICATIONS AND FUTURE DIRECTIONS:

The predominance of late preparation aligns with prior research in self-regulated learning (e.g., Wäschle et al., 2014), suggesting that while early planning may offer modest advantages, few engage in it. The additional self-regulatory processes reflected by strategy use and monitoring metrics may play a stronger role in academic performance in this context. The non-planner group—defined solely by lack of early engagement with the study guide within the Final Exam preparation period—requires future steps to understand. This will involve expansion of observation to include engagement during initial content units preceding final exam preparations, and multimodal methods to capture additional behaviors, overcoming limitations of unimodal behavioral detection of SRL.

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