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DOES RETRIEVAL PRACTICE HELP CRITICAL THINKING?

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ABSTRACT

Critical thinking is generally thought of as the long-lasting legacy of higher education, since a great deal of factual information learned in university courses may become outdated or be forgotten as time goes by. Yet, unclear are the conditions that foster critical thinking competencies among students with a didactic instructional past. Thus, the present study was concerned with the relationship between retrieval practice (as exercised by developing a study guide for a final exam) and critical thinking (as measured by scores on the final exam). Specifically, it examined whether retrieval practice would be related to more accurate subjective estimations of readiness for the final exam as well as enhanced performance. Selected were two general education courses devoted to developing critical thinking competencies either broadly (written scientific communication) or within a particular field of knowledge (psychology). Participants were female first-year undergraduate students with a didactic educational past. A few weeks before the end of the semester, they were asked to complete a study guide on the materials that the final exam would cover and then estimate their readiness for the exam. In this study, although baseline performance did not differ between students who completed and those who did not complete the study guide, the former obtained higher grades. Completing the study guide also tempered students' readiness evaluations, enhancing calibration. These findings suggest that retrieval practice exercises are useful tools for fostering critical thinking competencies, potentially fostering academic self-confidence and undermining memorization habits.

KEYWORDS: Retrieval Practice, Academic Attainment, Calibration.

1. INTRODUCTION

In university studies, learning demands the acquisition and retention of knowledge and the ability to integrate, utilize, and apply it (i.e., competencies). Retrieval practice, which refers to the recall or recognition of previously learned information, is known to improve long-term memory and thus learning outcomes in a variety of settings (Agarwal et al., 2021; Carpenter et al., 2022). A key learning outcome in higher education is critical thinking, which is a set of competencies through which facts and concepts are integrated into a broader and deeper network of knowledge and are used to solve problems in a variety of settings. It reflects mental operations that encompass active perception, analysis, synthesis, and evaluation of information, shaping decision-making and ensuing actions. Thus, although critical thinking operations rest on memory for facts and concepts, they require reflection (Kember et al., 1999). The attainment of this valued learning outcome also rests on learners' calibration, which refers to their understanding and awareness of the distance between assumed and demonstrated competencies (Alexander, 2013).

The development and exercise of critical competencies may be particularly challenging for women from a society emerging from patriarchy (Littrell & Bertsch, 2013; Waked et al., 2024). On one side, critical thinking is a valued commodity that is an unavoidable aspect of the exercise of professional endeavors (Abadzi, 2016). On the other side, it conflicts with past experiences based on a didactic approach to learning, whereby students' task is to assimilate and replicate the knowledge conveyed by instructors serving as the 'sage on the stage' (Aulakh et al., 2025; El Alaoui et al., 2019). This type of approach to learning fits the patriarchal model, whereby women are viewed as subservient and docile assimilators of knowledge. Knowledge is a fixed, quantifiable entity to be acquired and demonstrated at a later point in time through testing. Within this framework, demonstrations of knowledge tend to privilege verbatim repetition of memorized concepts and facts (Güneş, 2020). Women accustomed to didactic instruction are likely to perceive even mild criticism of instructional materials as an uncomfortable task and the uncertainties that instruction might generate as frustrating. By its very nature, instruction fostering the development of critical thinking operations (e.g., self-directed forms of learning such as inquiry-based learning and case-based learning; Pilotti et al., 2024; Tawfik et al., 2020) is likely to create uncertainties, such as dilemmas, problems to solve, and cognitive dissonance between old and new information. Women accustomed to didactic instruction may resist critical thinking practices by pleading with the instructor for immediate and certain answers (Keeley et al., 1995), thereby expressing uncertainty avoidance (Hassan, 2015). In this context of conflicting values, it is reasonable to ask whether retrieval practice exercises can aid not only memory retrieval but also critical thinking competencies.

Retrieval is the act of calling information to mind (Morano, 2019). If it is consistently repeated over time, it can become a practice. Retrieval practice can be exercised through means that probe the content of the learner's mind, such as tests, quizzes, flashcards, and clicker activities. It has been shown to indirectly benefit learning. For example, a practice test or quiz can inform learners about what they know and do not know (i.e, metacognition) so that they can make informed decisions about the quality and quantity of their studying (Roediger et al., 2011). Learners' awareness that frequent quizzes are embedded in a course is accompanied by greater time spent studying and class attendance (Roediger et al., 2011). Although students may engage spontaneously in retrieval practice exercises, such as using flashcards and submitting to self-quizzes, they often report that such exercises aim to determine how well they know particular information rather than to enhance learning (Carpenter et al., 2017; Rivers, 2021). As a result, retrieval practice exercises are often underused (Carpenter et al., 2017). Mixed evidence also exists about whether retrieval practice influences students' ability to transfer solutions to a problem from one domain or setting to another (Peterson & Wissman, 2018; Hostetter et al., 2018; Huang et al., 2023; Roediger & Butler, 2011), which is a key aspect of critical thinking. Furthermore, the majority of the work on retrieval practice comes from the Global North (Agarwal et al., 2021; i.e., WEIRD countries: western, educated, industrialized, rich, democratic countries; Rad et al., 2018) and from the laboratory. While informative, what works in the laboratory and for a particular student population may not necessarily work in the classroom of another population.

In the present study, we asked whether developing a study guide for an upcoming final exam (i.e., summative assessment) may benefit students' calibration (i.e., accurate self-assessment of readiness) as well as their performance on the exam. The study guide exercise, which was optional, required learners to define in their own words concepts and provide concrete examples that highlighted similarities and differences. Namely, it

offered learners the opportunity to call concepts to mind, examine their understanding of concepts in relation to one another, as well as to test their understanding via the generation of examples. As such, it could be conceptualized as a retrieval practice exercise embedded in the broader framework of self-directed learning, whereby students actively and largely independently identify what is needed for a given task, select resources, implement learning strategies, and assess outcomes (Charokar & Dulloo, 2022). Evidence exists that self-directed learning promotes autonomy, curiosity, and self-regulation, and is more effective than didactic learning in promoting undergraduate students' academic attainment (e.g., critical thinking) (Aulakh et al., 2025). Evidence also exists that to transfer learning to new situations and materials (e.g., the final exam), students have to actively process information, such as organizing it into coherent knowledge structures and integrating it with one's prior knowledge (Van Peppen et al., 2021).

The participants of the present study were undergraduate students of Saudi Arabian nationality. They were young women who had only recently emerged from patriarchy by having been granted legal rights and educational and professional opportunities similar to those once given only to men. Before university enrollment, their educational experiences were largely didactic (El Alaoui et al., 2019). They were purposely chosen for being first-year students, thereby making them the ideal testing ground for assessing the relationship between retrieval practice and critical thinking performance. In this study, we hypothesized that the execution of an optional exercise (i.e., developing a study guide), which would likely be viewed as valuable in light of the upcoming final exam, might underscore students' course engagement. It might also be helpful to performance if retrieval practice fostered knowledge transfer of learning to the final test. As such, students who completed the exercise were expected to be more engaged (as measured by attendance records; H1) and yield higher final exam performance than those who chose not to complete the activity (H2). Furthermore, the quality of students' work in the exercise was expected to be related to their performance (H3). If retrieval practice helped students not only to transfer knowledge to a different setting but also to accurately calibrate their learning activities, students' estimates of readiness for the final exam were anticipated to be more accurate after completing the exercise (H4). Baseline critical thinking performance at the start of the semester measured the critical thinking skills of students who would complete and those who would not complete the study guide. Baseline assessment was intended to determine whether equivalence existed between the two groups of learners.

2. METHOD

2.1. Participants

Participants included first-year undergraduate students: 275 enrolled in a scientific communication course and 293 enrolled in an introductory psychology course, both offered by an English-medium university. Arabic was their first language. English competency, assessed before enrollment through IELTS, varied from modest to competent. Their ages ranged from 18 to 26 years. All students were women who described their prior educational experiences as being largely didactic (El Alaoui et al., 2019).

2.2. Materials and Procedure

Scientific communication and introductory psychology were selected for their enrollment of first-year students and their focus on critical thinking competencies in instruction and assessment. Three weeks before the end of the semester, students were asked to develop a study guide for the final exam (i.e., summative assessment). The task was an optional participation activity intended to foster students' active learning. It was described to students as a way for them to become aware of what they did and did not know for the upcoming exam, as well as a way to learn or relearn exam materials. They were given lists of concepts to be covered in the final exam. Their task was to define each concept in their own words and then provide an example for each. Thus, in this study, the operational definition of retrieval practice narrowly referred to students' active attempts to recall or recognize useful concepts, and then create for each one a definition in their own words and an example. Yet, emphasis was placed on developing definitions and examples that highlighted the differences between and among concepts. Before and after the study-guide activity, students were asked to estimate their readiness for the final test (0-100). Students' work was to be submitted to the instructor during the final week of classes.

The final exam entailed open-ended questions that required students to analyze practical applications of concepts and highlight their similarities and differences. According to the Reflective Thinking Model's taxonomy of Kember et al. (1999; Chan et al. 2002), these questions, at the very minimum, demanded the 'thoughtful action' level

(i.e., understanding), upon which reflective actions could be developed (i.e., evaluation and analysis). These types of information processing are considered elements of critical thinking operations. Thus, in this field study, retrieval practice through the development of a study guide involved conceptual knowledge and skills to retrieve, recognize, evaluate, and analyze such knowledge.

Attendance records were also collected up to the announcement of the study guide activity. Excused absences were counted as absences. In the initial month of each course, the first assignment was used to measure baseline critical thinking performance. In the scientific communication course, students' ability to compare and contrast the extant findings of a particular research question was used to measure performance. In introductory psychology, students' ability to compare and contrast theories of human dreaming activities was used for the same purpose. Data were anonymized before analyses were conducted. Data collection and treatment were approved by the Deanship of Research of the university that hosted the study. Procedures had been deemed to comply with the guidelines for educational research of the Office for Human Research Protections of the U.S. Department of Health and Human Services.

3. RESULTS

In the communication course, 70% of students submitted the study guide. In the psychology course, 63% of students submitted it. Course engagement was measured through attendance records, whereas activity-specific engagement was indexed by the quality of each student's submitted study guide. The latter was graded through the Reflective Thinking Model's taxonomy of Kember et al. (1999; Chan et al. 2002): repetitions with minimal thinking = 0.5; applications of existing knowledge = 1; and reflection including connections between concepts = 2. Two independent raters scored students' work, yielding an inter-rater reliability of 96%. Discrepancies were tackled by a third rater. If a student did not complete the study guide, a value of 0 was assigned.

In the first assignment, students' compare-and-contrast performance was measured to estimate critical thinking baseline performance on a 0-10 scale by the same independent raters. Scores were then translated into percentages for ease of comparison with the other data.

At the end of the semester, students' baseline performance in each course was organized into groups depending on whether the study guide assignment was completed or not. A one-way between-subjects ANOVA was conducted between the performance of students who later completed the study guide and the performance of students who did not complete the study guide. No group differences were uncovered in either the scientific communication course or the introductory psychology course (Fs < 1, ns).

Descriptive statistics are displayed in Table 1. In the table, completion of the study guide served to index students' exercise of retrieval practice before the final exam. All results of inferential statistics reported below were considered significant at the 0.05 level.

Table 1: Descriptive Statistics Organized by Whether the Study Guide Was Completed.

	Communication Course				**Psychology Course**			
	Not Completed		**Completed**		**Not Completed**		**Completed**	
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Baseline performance	71.48	(24.26)	70.88	(17.87)	69.08	(19.89)	70.69	(14.61)
Before est. prep. (%)			71.49	(17.53)			71.16	(14.55)
After est. prep. (%)			57.75	(19.74)			58.87	(18.40)
Final exam (%)	44.69	(29.71)	60.39	(20.15)	58.12	(20.18)	69.24	(23.14)
Attendance (%)	65.43	(24.42)	88.44	(14.66)	75.09	(20.20)	84.56	(15.59)
N	82		193		108		185	

3.1. Is the Choice of Retrieval Practice Reflected in Course Engagement and Performance?

A one-way between-subjects ANOVA was carried out on attendance records (i.e., course engagement; 0-100 scale). Students who completed the study guide had higher course attendance in both scientific communication [$F(1, 273) = 92.96$, $MSE = 327.96$, $p < 0.001$, partial $\eta 2 = 0.254$] and introductory psychology [$F(1, 291) = 20.17$, $MSE = 303.69$, $p < 0.001$, *partial* $\eta_2 = 0.065$].

A one-way between-subjects ANOVA was also carried out on the final exam grades (0-100 scale). In both scientific communication [$F(1, 273) = 25.91$, $MSE = 547.55$, $p < 0.001$, *partial* $\eta_2 = 0.087$] and introductory psychology [$F(1, 291) = 17.28$, $MSE = 488.27$, $p < 0.001$,

partial η_2 = 0.056], students who completed the study guide obtained higher grades than those who chose not to complete it.

Spearman correlation analyses were conducted on activity-specific engagement, as indexed by the quality of students' study guides (range: 0-2) and performance.

In these analyses, engagement predicted final exam grades in communication [rs = + 0.46, n = 275, p < 0.01] and in psychology [rs = + 0.52, n = 293, p < 0.01] (see Table 2). Unsurprisingly, more engaged students were more likely to participate in the retrieval practice activity and obtain higher final exam grades. Taken together, these findings supported H1, H2, and H3.

3.2. Does Retrieval Practice Help Calibration?

A one-way repeated measures ANOVA was carried out on the estimates of readiness for the students who completed the study guide. In both scientific communication [F(1, 192) = 235.45, MSE = 77.44, p < 0.001, partial η2 = 0.551] and introductory psychology [F(1, 184) = 154.13, MSE = 90.76, p < 0.001, partial η2 = 0.456], students became more cautious in their estimates of readiness after completing the study guide (see Table 2). Indeed, in both courses, the number of overestimations decreased and the number of underestimations increased after the retrieval practice activity.

Table 2: Percentage of Students Who Overestimated, Underestimated, or Correctly Estimated Their Final Exam Readiness.

	Communication Course: Final Exam Before-After		**Psychology Course: Final Exam Before-After**	
Underestimation	31%	53%	55%	81%
Correct Estimation	3%	5%	3%	3%
Overestimation	66%	42%	42%	16%

H4 was further supported by Pearson correlation analyses, which were computed between final exam grades (0-100) and estimates before and after the retrieval practice activity (see Table 3). Coefficients of determination (CoD) illustrated the percentage of variance in final grades accounted for by readiness estimates (see Table 3). These analyses demonstrated that the activity enhanced students' calibration, as demonstrated by the increased strength of the correlations between final exam grades and estimates after the completion of the retrieval practice activity.

Table 3: Correlation Coefficients (r) and Coefficients of Determination (CoD) Between Final Exam Grades and Estimated Readiness in Each Course.

	Communication Final Exam *r -CoD*		**Psychology Final Exam** *r -CoD*	
Before Estimated Prep.	0.38 *	14%	0.45 *	20%
After Estimated Prep.	0.56 *	31%	0.68 *	46%
Note: * = significant at the 0.05 level.				

4. DISCUSSION

The results of the present study can be summarized in two points: First, a retrieval practice exercise, carried out as a self-directed learning activity, separated students into two groups that differed in course engagement (i.e., attendance), calibration, and exam performance. Second, although the influence of course engagement (as an index of overall effort) and that of retrieval practice were difficult to separate, evidence of particular benefits emerged among the students who completed the study guide. Specifically, the quality of students' study guides (i.e., a measure of engagement pertinent to performance) increased with their final exam grades. Furthermore, completing the study guide activity tempered the earlier estimates of readiness for the final exam. These findings suggest that critical thinking, which may induce a sense of uncertainty, anxiety, and resistance in students with a didactic educational past, can be promoted by targeted activities, such as retrieval practice. As a self-directed learning activity, our findings regarding the retrieval practice exercise can also be viewed as consistent with those of the literature showing that self-directed learning effectively aids students' academic attainment (e.g., critical thinking; Aulakh et al., 2025) by fostering autonomy, curiosity, and self-regulation.

One of the limitations of our study is that it involved female first-year students, thereby questioning whether findings generalize to male students and to other educational levels. The optional nature of the study-guide activity represents another limitation, which questions whether a compulsory activity would produce the same outcomes. Yet, in women with a didactic past who are citizens of a country emerging from a strict version of patriarchy (Sultana, 2010), our findings suggest that resistance to the demands and uncertainties of critical thinking (Keeley et al., 1995) can be weakened by activities that students perceive as useful. Not surprisingly, during the last week of the semester, students who completed the study guide were less likely to inquire about the difficulty of the final exam and report concerns about course grades (5% versus 24%). In such informal exchanges, those who did not complete the study guide were likely to spontaneously share intense worries about their upcoming performance in the final exam (e.g., 'I am worried that I will fail') without any attempts to plan countermeasures intended to rectify potentially dreadful outcomes.

Notwithstanding the study's limitations, the current findings suggest that self-directed learning activities targeting particular cognitive operations, such as those involved in information retrieval, can be helpful opportunities for critical thinking practice. Self-directed learning activities differ from tasks in which the educator determines aims, required actions, and how performance is assessed (Robinson et al., 2020). In self-directed learning activities, each learner sets goals (e.g., preparing a study guide that serves one's particular needs), assesses progress in reaching set goals, defines the structure and sequence of the actions to take, identifies resources, and may even seek feedback. That is, the learner takes responsibility for acquiring information, materials, and skills. By doing so, self-directed learning activities become a tool for one's sense of autonomy. In social cognitive theory (Bandura, 2017), learners' sense of autonomy refers to their beliefs that personal actions can influence their lives within and outside the classroom. According to self-determination theory, autonomy is a fundamental human need that concerns a person's belief in being able to self-initiate and self-regulate one's own actions (Ryan & Deci, 2017). Learners' sense of autonomy defines their intrinsic motivation to be engaged and sustain involvement over time. It embodies an internal locus of causality, according to which self-initiated personal actions are thought to be responsible for ensuing outcomes. The findings of our study suggest that, instead of a broad-spectrum implementation of self-directed learning, which may lead to students' resistance and withdrawal (Robinson et al., 2020), instructors may consider selected self-directed learning activities, such as the development of study guides for upcoming exams, in their classrooms. Thus, even lecture-based courses can become loci for this type of pedagogy and perhaps a testing ground for broader implementations.

If self-directed learning activities are viewed principally as devices for learners' engagement, leading to desirable performance, retrieval practice can be regarded not only as an assessment tool but also as a tool for learning. According to Roediger et al. (2011), a particular type of retrieval practice exercise, testing, has several performance-related benefits. For critical thinking operations, specific benefits include improving the transfer of knowledge to new settings and the retrieval of information that was not tested. More global benefits encompass cognitive operations above and beyond those required by critical thinking and problem-solving tasks. The latter may comprise improved metacognition (i.e., monitoring what one knows and does not know), and feedback to learners so that adjustments can be made to the way studying is approached and carried out. In our study, developing a study guide may be assumed to display the same benefits if its adoption is spread across the entire semester, rather than being restricted to its end. Regretfully, most of the literature on the development of study guides refers to the instructor as the responsible party (e.g., Eltouny et al., 2020; Tutolo, 1977). Our study suggests that the responsibility of developing a study guide can be shifted to the students. Of course, if there are concerns about the high number and variety of concepts in the course materials that students need to review for an upcoming exam (BoJulaia et al., 2025), instructors need to increase their guidance on how to develop a study guide suitable for the exam. Guidance may focus on clarifying what concepts and cognitive operations are important and deserve concentrated study. Targeted operations may go beyond mere understanding, including demands for applications, analyses, and evaluations (Adams, 2015; Aheisibwe et al., 2021), and must reflect the demands of the upcoming exam questions. Instructors are responsible for gauging the right amount of guidance to be offered to their students.

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