Paper Title Can Learning Objectives Harness the Power of the Pretesting Effect? (Poster 4)

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Theoretical Framework and Purpose

Learning objectives (LOs), learning outcomes, and goals are all terms used to explicitly inform learners or users of the learning outcomes of an academic course, a lesson, a training, or a task. LOs can be defined as means that inform learners of what they are expected to gain after exposure to the specific task and the task's purpose (Mager, 1997; Rodriguez & Albano, 2017). In theory, LOs should be useful: they orient the learner to what is important to learn from an upcoming chapter or lesson. And yet they are often overlooked and ignored. In the present experiments, we draw upon the cognitive psychology literature of prequestions to consider how LOs might be augmented for student learning.

Instructors' and Students' Perspectives on LOs

While LOs are not always required of instructors, teaching guides and centers for teaching and learning often encourage instructors to use LOs to guide the design of their lessons, assignments, or assessments (Fink, 2003; Wolf & Stevens, 2007). In a survey by Mitchell and Manzo (2018), however, faculty from U.S. universities perceived LOs as not very useful, and that the LOs were created mainly for faculty or school administrators and less so for students. While the literature on students' perspectives on LOs is not extensive, there are some insights from the existing work. For example, some students reported seeing LOs as an accountable guide between them and the instructor that assists them to be more organized students (Simon & Taylor, 2009), other times they ignore LOs or fail to identify how they can guide their studying (Mitchell & Manzo, 2018). Nevertheless, LOs technically help guide learning outcomes from both instructors' and students' perspectives.

The Benefit(s) of Prequestions

Although not framed in terms of learning objectives, researchers have explored the benefits of prequestions—asking students to answer questions about content *before* they receive the lesson or complete a reading. In general, prequestion paradigms involve asking participants to answer a small set of questions, taken from the upcoming lecture or chapter. These are often questions that participants fail to answer correctly. Participants then engage in the lesson or read the chapter, and are tested on the content either immediately or with a delay. Both laboratory-based and classroom-based studies have reported benefits of prequestions, with a recent meta-analysis by St. Hilaire (2022) showing an average effect size of $g = 0.58$ for specific content.

One theory for why prequestions benefit learning emphasizes the way in which they direct learners' attention to specific content. The vast majority of prequestion studies have used specific prequestions—where answers are often found in just one or two sentences. In support of attention-based theories, learners eye-gaze is focused more on sentences that relate to the prequestions (Lewis & Mensink, 2012) and pretesting tends not to benefit learning of the non-prequestioned content (in their 2022 meta-analysis, St. Hilaire found an average effect size of $g = 0.04$ for general content). In fact, the focus on very specific isolative prequestions is a limitation of the existing work that poses a barrier to pragmatic use: To adequately cover all important upcoming concepts, teachers would have to administer many prequestions. This is unlikely to be a solution.

What is more likely to be a solution is to pose fewer questions that can encapsulate a broader range of concepts. In fact, St. Hilaire et al. (2019) found that when the prequestions are integrative (instead of isolative), a large pretest effect is obtained even for the non-prequestioned material, Cohen's $d = 0.60$. Lesson learning objectives may serve as a natural form of "integrative" prequestions.

A second theory for why prequestions benefit learning emphasizes the elaborative, semantic memory activation that learners engage in when they try to answer questions. Researchers have found that there is a benefit to the act of trying to answer questions. For example, asking students to answer prequestions leads to better learning than simply having them read the questions and highlight the answers (Richland et al., 2009; Sana et al., 2021). By making simple modifications to learning objectives—asking students to think about what they already know about the objectives—might yield learning benefits akin to the prequestion effect.

Augmenting Learning Objectives

While pretesting can positively influence memory recall, there are costs in using this approach: time. For teachers, there is a cost of generating prequestions. Learning objectives may be a way to harness the power of prequestions—drawing students' attention to the important content, and activating their prior knowledge networks to encode new information. By leveraging learning objectives, this addresses the limitation of the prequestion literature (the need for integrative questions), and addresses the pragmatic barrier for teachers—if they already need to create learning objectives, then minimum additional time is needed to turn them into prequestions.

There remains, however, a second barrier: answering prequestions, especially integrative ones, might take up time that students may be unwilling to invest. In the present experiments, we, therefore, created two versions of active learning objectives, comparing each to the control condition. In our prequestions condition, we turned learning objectives into prequestions by asking participants to attempt to write down what they know about each statement. In our metacognitive judgments condition, we simply ask participants to rate how confident they were in each statement. In this way, we draw their attention to the concepts and ask them to covertly activate relevant prior knowledge, without requiring the time and explicit effort of writing down answers.

Research Questions

Whether they are being ignored by students or being perceived as irrelevant by instructors, LOs are *not* being used optimally. The purpose of our experiments is to start exploring how LOs can be used to better guide self-regulated learning with minimal costs. In each of the two experiments, we compared three different variants of learning objectives: prequestions, metacognitive judgments, and control.

RQ1. Does modifying learning objectives to engage learners more actively increase subsequent learning from a text passage?

RQ2. What do learners report about how they used the learning objectives in the present studies, and more generally?

Methods

Participants and Design

Three hundred and eight participants (Experiment 1) and three hundred and two participants (Experiment 2) were recruited from the United States and Canada via Prolific.co and compensated with $9 for their time (see Table S1 for full participants' descriptives). Participants were randomly assigned to one of three conditions: 1) control, 2) metacognitive judgments, and 3) prequestions. In Experiment 1, the learning objectives were presented only at the beginning, before participants began the reading. In Experiment 2, the learning objectives were not only presented before the reading but the relevant learning objectives were also presented at the top of each page.

Learning Objectives and Text Passage

Participants were presented with three-page reading (2810 words) about decision-making in Psychology adapted from the psychology textbook *The Thinking Animal* by Daniel T. Willingham and Cedar Riener. The reading involved three subsections (decision-making and reasoning; mental processes and shortcuts for decision-making; prior knowledge and decision-making). Each subsection was placed on a different page and the content of each was aligned to a learning objective:

1. Explain, with examples, how people use value and utility theories to make decisions and understand normative theories,
2. Explain, with examples, how heuristics and biases impact decision-making
3. Explain, with examples, how prior knowledge can be integrated with new information to impact decision-making.

Procedure

Participants were told that they were going to read a passage about decision-making and then tested on their understanding of the content, especially as it related to the learning objectives. In the control condition, participants were simply told to read the learning objectives and check a box indicating that they had read and understood them. In the metacognitive judgment condition, participants were asked to rate on a 1-10 scale how confident they were in each learning objective. In the prequestions condition, participants were presented with a textbox underneath each learning objective and asked to type in as much as they could about each statement. Participants then moved to the reading (self-paced).

Before the final test, participants engaged in a brief two-minute distractor task (trivia questions). The final test consisted of 12 questions (Experiment 1) and 15 questions (Experiment 2) in a multiple-choice format and with a mixture of fact-based and applied questions.

After the final test, participants were asked about how they used the learning objectives in the experiment in an open-ended format (“How did you use the presented learning objectives throughout the reading?”, Experiment 1). In Experiment 2, we asked the same question in a “check all that apply format” with options created based on the responses from Experiment 1 (“I used the learning objectives presented to me to guide my reading and focus on the key points of the passage/to create a mental summary of the key points of the reading/to connect the materials of the reading with the points described in the learning objectives, I did not use the learning

objectives throughout the reading of the passage but I used the headings and bolded words presented in it instead, I wanted to use them to help guide my reading but I forgot the learning objectives as I was reading the passage, I did not use the learning objectives at all"). They answered four questions about how they used the learning objectives in the experiment (e.g., "For this reading, the learning objectives encouraged me to think more about the content while reading.", adapted from Prinz-Weiß & Köing, 2022), and two items about their views on LOs more broadly ("In general, I often skip the learning objectives.", self-created). All six items were rating on a scale of 1-6 (1 = strongly disagree, 6 = strongly agree).

Results

RQ1. Does modifying learning objectives to engage learners more actively increase subsequent learning from a text passage?

We conducted a linear mixed effects regression analysis, predicting the final test score by condition (control, metacognitive judgments, prequestions; reference level = control) and learning objectives (1, 2, or 3; reference level = 1). Participant ID was entered as a random effect. The full results of the analysis are presented in Table S2 and Figure S1.

In general, being asked to engage more actively in the learning objectives led to better test performance. In both experiments, the metacognitive judgments condition led to marginally better than the control condition, scoring 6-7 percentage points higher (*d*s = 0.28 and 0.38). The prequestions condition led to significantly better performance than the control condition only in Experiment 1, scoring 9 percentage points higher ($d = 0.31$). However, these effects were found only for LO1, and disappeared for LO2 and LO3.

RQ2. What do learners report about how they used the learning objectives in the present experiments, and more generally?

Table S3 shows the coding for the open-ended question of how participants used the three LOs in Experiment 1. We used the coded responses to create a "check all that apply" question for participants in Experiment 2. In general, they reported using the LOs to guide their reading, to connect materials, and to create a mental summary of the LOs throughout the reading. Participants also rated LOs as being useful, both for the present reading and in general (Figure S2). One-way analyses of variance showed that there were no significant differences among the three conditions in usefulness ratings of the LOs for the present reading or in general, *p*s > 0.17.

Conclusion and Significance

Our experiments show an initial step to highlight simple adaptations of learning objectives that benefit performance. Participants in our experiments reported using LOs to guide their reading and that they were useful. They may need guidance, however, on how best to use them (e.g., engaging in brief metacognitive reflections). Further studies are needed to examine whether effects can be sustained beyond the first page and across time. Another promising finding is that metacognitive judgments can lead to benefits that are just as large as prequestions, however, they did not require one of the prequestions' barriers: time.

Word Count: 1981

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Supplemental Materials

Table S1

Participants' Descriptives Experiments 1 & 2

Demographic Variable	Variable Subcategories	Experiment 1	Experiment 2
Age Mean (*SD)*	-	25.28 (3.68)	25.59 (3.32)
Gender	Female	46%	42%
	Male	50%	54%
	Non-Binary	3%	3%
	Preferred not to answer	1%	1%
Race/Ethnicity	White	61.3%	62.9%
	Asian	15.6%	13.6%
	Black or African American	15%	14.9%
	Hispanic, Latino, or Spanish Origin	9%	13.2%
	Middle Eastern or North African	4%	1.7%
	American Indian or Alaska Native	1%	0.3%
	Native Hawaiian or Other Pacific Islander	0.3%	0.3%
	Multi-Racial	2.6%	1.7%
	Other	0.3%	0.3%
Education	Less than High school diploma	2%	0.7%
	High School or GED	16%	15.2%
	Vocational or technical degree	1.7%	2.3%
	Some College	24%	20.9%
	Associates degree	7%	8.3%
	Bachelor's degree	39%	43.4%
	Master's degree	9.6%	8.3%
	Professional degree (e.g., PhD, JDD, etc.)	1%	1%

Table S2

Linear Fixed Effects Regression for For Final Test Score Prediction by Condition

	Experiment 1				Experiment 2			
	β	SE	t-value	p-value	β	SE	t-value	p-value
Control	.35	.03	12.75	< .001	.22	.02	9.25	<.001
Metacognitive Judgments	**.07**	**.04**	**1.80**	**.07~**	**.06**	**.03**	**1.93**	**.054~**
Prequestions	**.09**	**.04**	**2.25**	**.03***	.02	.03	.74	.46
LO2 Test Score	.19	.04	5.23	< .001	.36	.03	12.75	<.001
LO3 Test Score	.20	.04	5.46	< .001	.28	.03	9.83	<.001
Metacognitive Judgements x LO2 Test Score	-.05	.05	-1.045	.3	-.07	.04	-1.67	.10
Prequestions x LO2 Test Score	-.07	.05	-1.31	.19	-.09	.04	-2.12	.03*
Metacognitive Judgements x LO3 Test Score	-.07	.05	-1.30	.19	-.04	.04	-.90	.37
Prequestions x LO3 Test Score	-.10	.05	-1.84	.07~	-.02	.04	-.46	.65

$p < .05$ *. $p < .01$**, $p < .001$ ***

Figure S1

Bar Graphs of Final Test Scores by LOs and Conditions Experiments 1 and 2

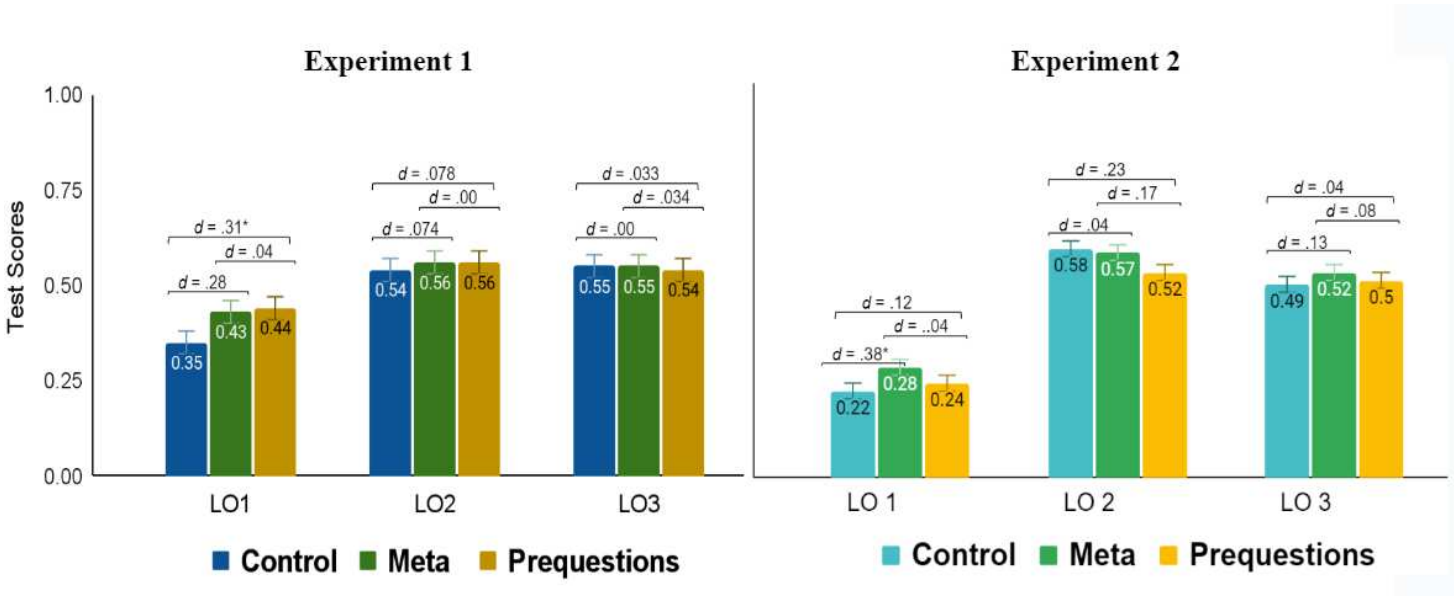

Table S3

Qualitative Analysis of How Participants Reported Using the LOs

		Experiment 1 (Qualitative Item)			Experiment 2 (Quantitative Item)		
Code	Example Response	Control	Metacognitive Judgments	Pre-questions	Control	Metacognitive Judgments	Pre-questions
Guide reading	*"I **used the learning objectives to dictate what information I should pay closer attention to** while reading and memorize those few selections."*	47%	46%	40%	52%	76%	65%
No use of LOs	***"Didn't really use the learning objectives. Moreso read it as a causal read"***	17%	19%	21%	6%	3%	6%
Forgot LOs	*"I tried to use them but **forgot them** midway through the reading."*	9%	8%	11%	27%	29%	15%
Connecting to materials	***"Yes i tried to use them. i kept them in mind as i read and tried to make connections"***	8%	6%	1%	40%	48%	48%

Focus on bolded words	***"Whenever I saw a bolded word the passage would usually provide its own example so I would try to create my own example along with it to help me understand it more."***	6%	2%	3%	13%	8%	6%
Mental summary of LOs	***"I attempted to memorize and keep in mind the learning objectives as I read"***	4%	6%	5%	38%	47%	48%

Note. Experiment 2 used common themes of Experiment 1's data to create a quantitative item. Percentages should be interpreted within conditions context rather than experiments.

Figure S2

Bar Graphs of LOs Utility by Conditions Experiments 1 and 2