Scaling Beliefs about Learning to Predict Performance and Enjoyment in an Online Course

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ABSTRACT

Previous research suggests that metacognitive learning strategies and beliefs may predict success in online learning, but little research has explored specific belief scales for this context. This paper examines how students' beliefs about learning predict course performance, satisfaction, and openness to feedback in both a massive open online course and an online experiment. An abbreviated Learning Beliefs scale based on previous scales was developed and tested. Study 1 found that Learning Beliefs significantly predicted 125 participants' positive attitudes towards an online cognitive task, as well as their perception that feedback on their performance was helpful. Study 2 tested the Learning Beliefs scale in an online course with 171 participants, finding that Learning Beliefs predicted course performance and enjoyment. These studies suggest that even a brief metacognitive scale can provide meaningful information about online learners. These findings highlight the benefits of understanding how online students' learning beliefs impact their course success.

Author Keywords

Learning beliefs; motivation; self-regulated learning; metacognition; mastery orientation, grit, education, course enjoyment, online learning

INTRODUCTION

Massive open online courses present a unique opportunity to provide rich educational opportunities to millions of people unable to access formal education [22]. Many online courses are free or low cost, agnostic to geography, and allow learners to adapt with disparate schedules or other constraints. However, for online education to match its promise of great impact, it must ensure that large numbers of learners persevere to completion [1, 30]. Little is known about what attributes predict student success in online learning [14, 23]. Are there identifiable characteristics that predict online learners' performance? What distinguishes

the enrollees who complete online courses from the much larger population who do not?

Decades of achievement and education research in Psychology provide strong evidence that students' *beliefs* about how learning works—independent of their content knowledge or more general intellectual abilities—are predictive of engagement and motivation, academic success, and depth learning [11, 14, 16, 17, 18, 24, 25, 35, 37, 38, 39]. This research introduced metacognitive learning strategies and beliefs such as *Self-Regulated Learning*, *Mastery Orientation*, and *Grit*. *Self-Regulated Learning* is directly orchestrated by the metacognitive, motivational, and behavioral actions of learners [12, 36, 37]. *Mastery Orientation* is motivated by the pursuit of depth knowledge and intrinsic mastery of material rather than being motivated by the desire to demonstrate a performance to others or to achieve an extrinsic reward such as a letter grade. *Grit* is trait-level perseverance and dedicated commitment to long-term goals. All of these attributes have emerged as strong predictors of academic success and resilience in the face of academic challenge [e.g., 15, 18]. Educational interventions that seek to develop these attributes in students have produced long-term beneficial outcomes such as higher achievement and motivation [4, 33, 38].

Learning Beliefs in Online Education

Adaptive learning beliefs are likely critical to achievement in online education systems. Successfully navigating online education systems requires users to exercise high levels of self-regulated learning. Self-regulated learners actively calibrate their attention and motivational resources in order to study and learn more efficiently, actively adjusting these strategies for different educational contexts. Highly self-regulated learners plan their study sessions, notice when their attention is waning, and monitor whether they comprehend novel content. Online, self-regulation may be required for learners to continue to engage in lectures and monitor their own consumption of material in the absence

of a physical classroom with its mandated schedule of lecture attendance. Further, online education environments provide few external performance incentives. Learners who are high in Grit and Mastery Orientation may be more intrinsically invested in the long-term goals of learning and course completion required to persevere through an online course. Nevertheless, very little research has examined the impact of learning beliefs online [8, 22, 23]. It is possible that learning beliefs may provide useful predictive cues for the probability that a learner will complete an online course.

Previous research suggests that Self-Regulated Learning can predict student achievement and retention in online education [e.g., 20, 21, 27, 31]. In one study, 815 students enrolled in a range of online courses found that time, study environment, and effort regulation subscales from the cognitive learning strategies section of the Motivated Strategies for Learning Questionnaire (MSLQ) were predictive of course grade [29; for the original development of the MSLQ, see 26, 28]. However, we have not found any research examining either learners' Grit or Mastery Orientation in fully online classrooms.

Do online learners' metacognitive learning beliefs predict their success in online learning? Online learners are often drawn from a significantly different population than traditional classroom learners and subsequently may hold different beliefs about learning from traditional classroom learners [1]. For example, students who reported a preference for online learning over a traditional classroom endorsed fewer mastery orientation beliefs and more passive learning strategies than students who preferred a traditional classroom [10]. In contrast, it is likely that online courses require sustained initiative from learners who are expected to be highly self-paced and motivated. This research raises the troubling possibility that online education appeals to the very populations of students least likely to succeed there.

It is important to ensure that metrics for students' beliefs about learning remain valid across the variety of platforms and technologies employed in online education. For instance, one study that examined 145 participants in an online programming course using the MSLQ found significant differences in test anxiety between male and female participants on an independent test anxiety measure, yet did not find evidence for differences on the test anxiety scale of the MSLQ [34]. It is crucial to establish the validity of measures developed in traditional academic settings when these measures are employed in online educational environments.

Present Research

Two studies examined a short Learning Beliefs scale with adult participants in both an online course and an online experiment. First, this research seeks to replicate previous research findings that suggest that learning beliefs will predict the performance of online learners. This research

also ascertains if a *brief* scale could be predictive of useful learner characteristics such as performance and course satisfaction. One large barrier to using traditional learning beliefs metrics in online education is the difficulty of administering these large assessments to many users in an online course. The MSLQ, one of the most frequently used measures of Self-Regulated Learning, comprises eighty-one items. Administering such a battery to large numbers of learners is exceptionally difficult, and an abbreviated learning scale may elicit considerably higher response rates than the low response rates typically observed from online learners [1]. This research presents a pilot investigation of such a tool.

STUDY 1: PILOTING AN ABBREVIATED LEARNING BELIEFS SCALE

Study 1 examined an abbreviated Learning Beliefs Scale with participants completing a brief cognitive task online. This study also investigated exploratory questions about whether learning beliefs would impact learners' attitudes towards the online task. One such question was whether holding more adaptive learning beliefs predicts greater task positivity. Previous research has found that learners who score high in adaptive learning beliefs are more likely to demonstrate intrinsic motivation in challenging tasks and perceive difficult tasks as enjoyable [2, 15, 17]. Another exploratory question was whether Learning Beliefs predict participants' perception of the helpfulness of task feedback.

Participants

One hundred twenty-five undergraduate participants from a Southern California university participated in Study 1; there were thirty-eight males and eighty-seven females (age range 18-34; $M = 20.56$). Participants voluntarily enrolled in an online experiment and received course credit for participation.

Materials and Procedure

Abbreviated Learning Beliefs Scale

Prior to Study 1, we pilot-tested multiple items from three major learning beliefs assessment tools: the Metacognitive Self-Regulation subscale of the MSLQ [26], Mastery Orientation [17], and the Grit-S [16] questionnaires.

Pilot testing with 50 university undergraduates and 90 online course participants indicated that the strongest individual items from each scale were two mastery orientation items, four grit items, and nine items from the self-regulated learning subscale from the MSLQ, which we then used to form the abbreviated Learning Beliefs Scale with 15 items (Table 1).

Participants completed the experiment through the Qualtrics online experiment site. After completing demographics survey and consent form, participants were instructed to complete a Compound Remote Associates task, a task normally used as a general measure of creativity and problem solving [3, 7]. In this pilot study it provided

participants with a brief but engaging cognitive task. The task presented subjects with three separate words (e.g., “swiss/cottage/cake”) and asks them to generate a word that could be meaningfully combined with each of the three individual words (e.g., “cheese”). Across two trials, participants completed twenty total questions in this series.

Participants were shown performance feedback after the first trial. However, in reality this feedback was fixed and randomly varied to either present participants with either a high score (e.g., “you have scored 95/100”) or a low score (e.g., “you have scored 35/100”). Randomly assigned feedback explored whether learning beliefs impact participants’ perception that feedback was helpful, even when inaccurate. Participants then completed the second trial of the Compound Remote Associates Task. After both tasks were complete, participants were asked a series of follow-up questions with a 5-point Likert scale. Four questions dealt with positivity towards the task: *I enjoyed this task*, *I thought this task was well designed*; *I thought this task was confusing* (reverse coded), *I thought this task measured something meaningful about my abilities* (Task Positivity). Finally, participants responded to the question, *getting feedback on my task performance was helpful* (Feedback Helpfulness).

Study 1 Results

Participants’ responses to the four follow-up questions were averaged to create a single Task Positivity measure. A maximum-likelihood factor analysis tested the hypothesis that the individual subscales were driven by a common factor, and supported the use of a single score for this measure ($\chi^2=81.88$, $p < .0001$). The 15 items on the Learning Beliefs Scale were averaged to yield a single Learning Beliefs score for each participant.

There was no significant effect from the negative and positive task feedback conditions. This variable was therefore excluded from subsequent analyses.

A MANOVA was conducted with gender, age, and Learning Beliefs as independent variables and Task Positivity and Feedback Helpfulness as outcome measures. Task Positivity was predicted by Learning Beliefs, indicating that participants who held more adaptive learning beliefs also had a more positive perception of the online task: $F(1,124) = 8.99$, $p = .003$. A higher Learning Beliefs score also predicted learners’ perception that the task feedback was helpful, $F(1,124) = 11.39$, $p = .001$. Learning Beliefs did not significantly predict performance on the Compound Remote Associates Task.

STUDY 2: LEARNING BELIEFS IMPACT PERFORMANCE

Study 2 examined the abbreviated Learning Beliefs Scale in a subsample of students participating in an online course in order to ascertain whether learners’ adaptive learning beliefs predict performance in an online educational environment. We further investigated whether participants’

learning beliefs predict other attitudes about the course such as overall course experience and positive perceptions of peer assessment.

Participants

Participants were recruited via email from a massive open online course entitled Human-Computer Interaction that was offered from a Southern California university partnering with the Coursera online education platform (<https://www.coursera.org>). Participants received no course credit or other incentives for participating in the study. This course was an entirely online, 9-week college introductory level course focusing on Human-Computer Interaction and Design, and covered topics such as storyboarding, wireframing, and user testing. Participants in this course also participated in a peer assessment system where learners’ project assignments were reviewed and graded online by anonymous fellow students.

This course was instructed by one of the authors of this paper, however, no data was examined until the course was

Subscale Items	
Mastery Orientation	I want to learn as much as possible in this class
	I prefer course material that arouses my curiosity, even if it is difficult to learn
Grit	I finish what I begin
	I work very hard. I keep working when others stop to take a break
	I stay interested in my goals, even if they take a long time (months or years) to complete
Metacognitive Self-Regulation	I am diligent. I never give up
	I ask myself questions to make sure I know the material I have been studying.
	When work is hard I either give up or study only the easy parts. (reverse coded)
	I work on practice exercises and answer end of chapter questions even when I don't have to.
	Even when study materials are dull and uninteresting, I keep working until I finish.
	Before I begin studying I think about the things I will need to do to learn.
	I often find that I have been reading for class but don't know what it is all about. (reverse coded)
	I find that when the teacher is talking I think of other things and don't really listen to what is being said. (reverse coded)
	When I'm reading I stop once in a while and go over what I have read.
	I work hard to get a good grade even when I don't like a class.

Table 1: Learning Beliefs Scale

completed and all grades were assigned. Data was anonymized and all analyses were conducted in aggregate by the non-instructor author. This course was available for free, and required only an email address to participate. All participants gave consent for their course data to be used in research. Out of the 29,633 online learners who engaged with at least some course materials, only 204 enrollees completed the End Survey and were therefore available for this study. These low response rates are commensurate with typical online course response rates [1]. Participants who had failed to complete any graded assignments were then excluded from the sample, leaving 171 final participants.

Materials and Procedure

Participants voluntarily participated an End Survey that included the Learning Beliefs Scale used in Study 1 (Table 1). In addition, participants were asked questions about their course satisfaction (Course Enjoyment), perception of their performance (Performance Expectation), and perceptions of the peer assessment system (Peer Assessment Experience; see Table 2 for individual items). Finally, course performance across four quizzes and six project assignments was obtained for each participant. The quizzes were automatically graded with a multiple-choice rubric while the project assignments were graded through the peer assessment system.

Study 2 Results

Participants' Course Enjoyment and Performance Expectation were positively correlated, $r(171) = .43$, $p < .0001$, indicating that learners who expected a higher grade in the course also tended to report greater enjoyment of the course. However, Course Enjoyment was not significantly related to Total Grade (Total Grade was calculated for each participant by adding the sum total of all points obtained for individual assignments and quizzes in the course; descriptive statistics for all measures can be found in Table 3).

Cronbach's alpha indicated good reliability for the Learning Beliefs Scale items ($\alpha = .73$). To examine predictors of Total Grade, a MANOVA was conducted with Learning Beliefs, Course Enjoyment, Peer Assessment Experience and Performance Expectation as independent variables and Total Grade as the dependent variable. This model significantly predicted Total Grade, $F(10,95) = 3.60$, $p < .001$. Effect tests indicated a significant main effect of Performance Expectation, $F(1,95) = 2.18$, $p < .0001$, as well as Learning Beliefs, $F(1,95) = 7.06$, $p < .001$, for Total Grade. These results indicate that participants who endorse more adaptive learning beliefs tended to perform better in this course on the graded metrics. Unsurprisingly, participants who felt that they did well in the course also tended to perform better in the graded metrics. No significant interactions were found between these variables.

To examine predictors of Course Enjoyment, a MANOVA was conducted with Learning Beliefs, Peer Assessment Experience, Performance Expectation and Total Grade as

independent variables and Course Enjoyment as the outcome measure. Because not all participants completed every subscale on the End Survey, total participant N varied for these analyses. This model significantly predicted Course Enjoyment, $F(10,95) = 3.60$, $p < .001$, and effect tests indicated that there was a main effect of Learning Beliefs on Course Enjoyment, $F(1,95) = 7.05$, $p < .001$, as well as Performance Expectation, $F(1,95) = 17.88$, $p < .0001$. There were no significant interactions found.

Overall, learners' attitudes towards the peer assessment experience were slightly positive ($M=4.47$). Neither significant relationships nor statistical trends were found between learners' Peer Assessment Experience and Learning Beliefs, Course Enjoyment and Performance Expectation (all $ps > .10$). However, a significant main effect was found for Total Grade, $F(1, 97) = 8.70$, $p = .004$, indicating that participants with a higher graded performance in the course were more positive towards the peer assessment system. This relationship was also supported by a moderate correlation between Total Grade and participants' positive attitudes towards the peer assessment experience, $r(99) = .28$, $p = .003$.

DISCUSSION

In these studies, learners' metacognitive beliefs about learning predicted academic achievement online. Study 1 details the development of a brief Learning Beliefs scale that was pilot tested with participants in an online cognitive task. This scale predicted participants' enjoyment of the task, as well as the perception that feedback was helpful, regardless of whether that feedback was positive or negative. In Study 2, the Learning Beliefs scale was administered to participants in a massive open online course. Participants who measured high in adaptive attributes

Variable	Items
Course Enjoyment	Rate your overall course-taking experience (6-point scale)
Performance Expectation	How well did you feel you did in this course (5-point scale)
Peer Assessment Experience	<p><i>Items on 6-point scale</i></p> <p>If you used the peer assessment system (for assignments), how accurate was the feedback you received from others?</p> <p>How detailed was the feedback you received from others?</p> <p>How much did you feel like you learned from assessing your own work?</p> <p>How much did you feel like you learned from assessing others' work?</p> <p>The peer assessment process was tedious (reverse coded)</p> <p>I put sufficient effort into grading peers</p> <p>Peers put sufficient effort into grading me</p>

Table 2: End Survey for Study 2

achieved higher grades than participants low in these attributes, and also reported greater overall course enjoyment.

One of the most compelling reasons to target students' metacognitive beliefs is that these beliefs inform a systemic perspective on learning that reinforces achievement [33]. Beneficial learning beliefs mediate how different students *interpret* the same situations in more or less desirable ways. For example, Mastery-oriented and Grit-driven learners believe that challenges during learning are both expected and beneficial, and tend to interpret a low grade as an indicator that they need to expend more effort and try again. In contrast, learners who are motivated by external grades and short-term goals are more likely to interpret a low grade as an indication that they should give up, for fear of demonstrating incompetence [17].

Students' learning beliefs can be greatly swayed by the learning beliefs implied by a learning environment [2, 5, 27]. Online education systems offer a valuable opportunity to tailor educational environments to support beneficial metacognitive learning strategies for learners who lack these skills. Yet many of these systems are still largely "one-size-fits-all," offering the same services, assessments and materials to all students regardless of individual differences [6, 32]. One area for future research is how learning platform design could improve students' metacognitive self-regulation behaviors and learning beliefs. In traditional classrooms, educational interventions that modify students' learning beliefs produce long-term benefits in academic achievement, resilience, and motivation [4, 33, 38]. Identifying students who display maladaptive learning beliefs could help online education provide similar beneficial interventions to struggling learners.

Learning Beliefs, Enjoyment and Peer Assessment

It is also interesting that Learning Beliefs predicted both course performance and satisfaction in Study 2, as well as task enjoyment in Study 1. This suggests that adaptive learning strategies may impact both the quality of academic

work, *and* students' emotional engagement. This is commensurate with previous research in traditional classrooms; for instance, Mastery Oriented learners are more likely to view mistakes as an expected part of learning, which encourages personal satisfaction in challenging work, and reduces performance anxiety [18]. However, participants' enjoyment did not predict their course performance in Study 2. While it seems intuitively likely that enjoyment could prompt more engagement and therefore better performance, this relationship remains unclear. Of course, there are many methods to measure students' enjoyment, and Study 2 obtained only a minimal self-report measure of course enjoyment. It is possible that richer measurements of students' enjoyment, such as longitudinal measurements gathered intermittently throughout a course, would reveal a mediating effect of enjoyment on performance. Future studies should examine this possibility.

One exploratory question investigated in Study 2 was whether more adaptive learning beliefs would impact participants' perceptions of peer assessment. It is possible, for instance, that highly self-regulated learners better manage the metacognitive demands of learning to give relevant feedback to peers. However Study 2 did not find any evidence that participants' Learning Beliefs impacted their positive or negative perception of peer assessment. Furthermore, no evidence was found that students' expectations of a high grade or course enjoyment predicted their attitudes towards peer assessment. While attitudes towards peer assessment were only an exploratory question in these studies, it is important to understand these attitudes. Some research suggests that online learners perceive peer assessments to be unfair, and that these beliefs may be strengthened after participating in the peer assessment process [9, 13, 19]. Further research suggests that online students are unlikely to engage in help-seeking and peer learning behaviors, for instance, indicating that they would be unlikely to collaborate with peers on work or ask peers for clarification on difficult concepts [29]. As peer assessment systems continue to be used in online systems, it will be important to characterize online learners' attitudes towards peer

Scale	Range	Minimum	Maximum	<i>M</i>	<i>SD</i>
Mastery	7.00	3.00	7.00	6.05	0.73
Grit	7.00	2.00	7.00	5.06	1.10
SRL	7.00	3.11	6.88	4.71	0.70
Learning Beliefs (combined score)	7.00	2.96	6.96	5.28	0.67
Course Enjoyment	6.00	1.00	6.00	4.99	0.89
Performance Expecta- tion	5.00	1.00	5.00	3.28	0.87
Attitudes towards Peer Assessment	7.00	1.00	6.50	4.47	0.90

Table 3: Descriptive Statistics for Study 2

assessment and discover what factors influence these attitudes.

Future Studies and Conclusion

It is important to note some key limitations of this research, which should be addressed in future studies. One obvious limitation of these studies is the reliance on self-selection for participation in the online course, and future research should examine learning beliefs across a larger body of randomly selected online learners. Many of the measures employed in these studies relied on self-report, and it will be important to consider richer behavioral measures for attributes such as course enjoyment. It is also important to examine these beliefs across a wider variety of online courses in different subject domains, as participants may differ greatly across these courses. Finally, there is a significant dearth of research on how cross-cultural contexts affect learner beliefs in online education, and given the international population enrolling in online courses, it will be crucial to understand these contexts.

In the past two decades, education research has increasingly called for curricula that not only helps students learn content knowledge, but also develops positive metacognitive beliefs [1, 2, 33]. One prominent example of this approach is Dweck and colleagues' mindset research, which has uncovered the powerful positive impact of believing that intelligence is malleable with effort [4, 33]. Students who hold this *growth mindset* are more likely to believe that learning is a dynamic process and expend effort, resulting in greater educational opportunity. Metacognitive learning strategies examined in the present research, on the other hand, center on how well students understand the learning process itself. Learners who engage in efficient and rewarding processes for learning will be more likely to succeed under the unique constraints of distance learning [1, 10]. Online education that helps all learners to develop these learning beliefs represents an enormous opportunity for beneficial impact.

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