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DOES ADDITIONAL TIME IN ONLINE TRAINING RESULT IN HIGHER LEARNING OUTCOMES FOR ELECTRONICS TECHNICIANS?

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14. ABSTRACT
This evaluation examines the influence of time to train on learning outcomes and the role of goal orientations in understanding differences in time durations to complete an online training program. Participants included 111 U.S. Navy trainees participating in a Web-based occupational training program for electronics technicians. Converting from classroom to Web-based instruction led to a 48% reduction in time to train. Additionally, time spent in training did not significantly predict learning outcomes. In predicting time to train, trainees with a high performance-avoid goal orientation tended to take significantly longer to complete training than trainees with a low performance-avoid goal orientation. Additionally, there was a significant interaction between mastery and performance-avoid goal orientations, such that trainees with low mastery and performance-avoid goal orientations completed training significantly faster than trainees who scored high on one or both of these dimensions.

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Technical Report

Does Additional Time in Online Training Result in Higher Learning Outcomes for Electronics Technicians?

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Washington, DC

FOREWORD

Time to train is a key component for managing workforce development. Time, as a non-renewable and perishable resource, impacts all other training elements and needs to be managed explicitly. Effectively managing time to train, impacts the learner and the training provider. To the extent that learner behaviors can be assessed and validated, those factors may be instructional design considerations used by training providers to optimize the learning experience. This report evaluates four hypotheses representing typical learner attitudes. There are other motivations impacting a desire to learn, but those incentive-based factors are not addressed in this research.

G A Redding
Director, ADL Co-Laboratory Hub

**Does Additional Time in Online Training
Result in Higher Learning Outcomes for Electronics Technicians?**

EXECUTIVE SUMMARY

Research Requirement:

This research examines the influence of time to train on learning and the role of goal orientations in understanding differences in the length of time it takes trainees to complete an online training program. As such, this evaluation provides two contributions to existing research. First, it examines the relationship between time to train and learning in an occupational training program to understand if spending more time in training improves learning. Second, this research builds on existing theory and examines the influence of goal orientation dimensions on time to train.

Procedure:

This research includes data from 111 trainees participating in a Web-based occupational training program to become electronics technicians. The course consisted of 33 self-paced modules comprised of a wide variety of topics including electricity and circuits. Each workday, trainees reported to a computer lab in an organizational facility where they spent six hours in training as part of their full-time paid positions. Facilitators staffed the computer labs and were available to answer trainees' questions. Classes were comprised of 12 to 30 trainees, each pursuing individual training paths. Trainees progressed at their own paces and could spend as much time as desired reviewing each module, but could not progress to the next module until they demonstrated knowledge of the material on a post-training test.

Findings:

Trainees completed the 33 modules in an average of 45 days. Compared with the legacy classroom time of 86 days, converting to Web-based instruction resulted in a 48% reduction in time to train. Although trainees varied greatly in the amount of time spent in training (lengths ranged from 21 to 72 days), time spent in training did not significantly predict learning. In predicting time to train, trainees with a high performance-avoid goal orientation tended to take significantly longer to complete training than trainees with a low performance-avoid goal orientation. Additionally, there was a significant interaction between mastery and performance-avoid goal orientations, such that trainees with low mastery and performance-avoid goal orientations completed training significantly faster than trainees who were high on one or both of these dimensions.

Utilization of Findings:

As this research points out, goal orientation is a key behavioral factor is predicting a learners' time to train to a prescribed level of performance. To the extent that learners can be assessed to expose a low mastery goal orientation coupled with a low performance-avoid goal orientation, there is an opportunity to capture a reduced time to train. Training providers could adjust their instructional design accordingly and recoup cost to train.

DOES ADDITIONAL TIME IN ONLINE TRAINING RESULT IN HIGHER LEARNING OUTCOMES FOR ELECTRONICS TECHNICIANS?

CONTENTS Page

Does Additional Time in Online Training Result in Higher Knowledge Levels for Electronics Technicians?

1. Introduction

Training technologies have triggered dramatic increases in the use of Web-based instruction by reducing costs and increasing capabilities. A hallmark of Web-based instruction is the ability to design self-paced instruction—where trainees can control their learning experiences by spending as much time as they want or need learning the material. Providing trainees with control over the instructional pace allows them to tailor their learning experiences to meet their individual needs (Brown & Ford, 2002) and has been shown to have a positive effect on learning in Web-based instruction (Sitzmann, Kraiger, Stewart, & Wisher, 2006).

In providing trainees with control over the instructional pace, trainees must self-regulate the level of effort they exert during training (Brown, 2001). One objective indicator of trainees' effort in a self-paced training program is time to train—the length of time that trainees spend in the training environment. This is an important variable in organizational training programs when trainees are paid for the time spent in training directly influencing organizational training costs. Therefore, it is critical to understand the effect of time to train on learning as well as individual differences that may influence time spent in training.

Three individual differences that may influence time to train are trainees' goal orientations. Goal orientations represent individuals' dispositions toward developing or demonstrating competence in learning situations (VandeWalle, 1997). Research by Elliot and Harackiewicz (1996) and VandeWalle (1997) suggests that the goal orientation domain includes three dimensions: a desire to improve one's competence (mastery goal orientation); the desire to prove one's competence and gain favorable judgments (performance-prove goal orientation); and the desire to avoid negative judgments and disproving one's competence (performance-avoid goal orientation). Based on Dweck's (1986) social-cognitive theory of motivation, trainees' goal orientations affect the nature and quality of skill acquisition through their influence on the focus of trainees' goals. In turn, this influences the allocation and direction of effort during training (Fisher & Ford, 1998). As such, goal orientations are likely to be important predictors of time to train.

This research examines the influence of time to train on learning and the role of goal orientations in understanding differences in the length of time it takes trainees to complete an online training program. As such, this evaluation provides two contributions to existing research. First, it examines the relationship between time to train and learning in an occupational training program to understand if spending more time in training improves learning. Second, this research builds on existing theory and examines the influence of goal orientation dimensions on time to train. The following sections review previous research on the effect of time to train on learning and discuss theoretical rationale as to why goal orientation dimensions should influence time to train in a self-paced training environment.

1.1 Time to Train and Learning

Self-regulation theories assume trainees regulate the amount of effort they allocate to training in order to maintain performance at a desired level (Kanfer & Ackerman, 1989; Pintrich, 2000). Spending time in training is also a behavioral indicator of effort exerted during training (Fisher & Ford, 1998). Theory suggests and researchers have demonstrated that exerting effort has a positive effect on learning outcomes (Fisher & Ford, 1998; Kozlowski & Bell, 2006; Locke & Latham, 2002). Additionally, previous research has found a positive relationship between time spent in training and learning (Brown, 2001; Fisher & Ford, 1998). The hypothesis is that trainees who spend more time in training will learn more.

Hypothesis 1. Time to train will have a positive effect on learning.

Time to train is a behavioral indicator of effort, but spending more time in training will only translate into learning gains if trainees are focusing their time on learning the training material (Kanfer & Ackerman, 1989). Trainees' goal orientations reflect individual differences that influence the extent to which trainees are concentrating and the degree to which spending time in training results in learning gains. In the following section, we review the goal orientation literature and present hypotheses for how goal orientation dimensions should influence time to train.

1.2 Goal Orientations

Mastery goal orientation refers to the tendency to strive to learn as much as possible, overcome challenges, and increase one's level of competence (Ames, 1992; VandeWalle, 1997). Trainees with a high mastery goal orientation tend to be more motivated to learn the course material (Wolters, 2004) and are more likely to devote time and effort to training (Button, Mathieu, & Zajac, 1996; Fisher & Ford, 1998). This individual commitment to learning should increase the amount of time that trainees with a high mastery goal orientation spend in a self-paced training environment.

Hypothesis 2. Mastery goal orientation will have a positive effect on time to train.

Performance-prove goal orientation refers to a desire to prove one's competence and gain favorable judgments (VandeWalle, 1997). Trainees with a high performance-prove goal orientation perceive ability as a fixed attribute and believe effort and ability are inversely related, such that exerting effort is an indicator of low ability (Dweck & Leggett, 1988). Because time to train is an observable indicator of effort, trainees with a high performance-prove orientation should strive to minimize time spent in training when regulating their behavior to prove that they are capable of learning the material without exerting much effort. This is consistent with Pintrich's (2000) suggestion that trainees who focus on performing better than others are thought to be less likely to devote time and effort to training.

Hypothesis 3. Performance-prove goal orientation will have a negative effect on time to train.

Performance-avoid goal orientation represents the motivation to avoid negative judgments from others and avoid appearing incompetent (VandeWalle, 1997). Trainees with a high performance-avoid goal orientation tend to focus on self-protective processes—producing an anxiety-based preoccupation with self-presentation. Based on self-regulation theories (e.g., Kanfer & Ackerman, 1989), if trainees are diverting cognitive resources away from on-task efforts, trainees with a high performance-avoid goal orientation may not devote enough effort toward concentrating on the material, thereby increasing the time spent in training in order to learn the course content.

Hypothesis 4. Performance-avoid goal orientation will have a positive effect on time to train.

2. Method

2.1 Participants and Procedure

The sample consisted of 111 U.S. Navy trainees participating in a Web-based occupational training program to become electronics technicians. Ninety-one percent of trainees were male and the average age was 22 years. The training program had recently been converted from an Instructor-led delivery approach to residence-based, facilitated, self-paced online learning. The resulting web-based modules were derived from and provided for the same objectives as the previous courses, covering a wide variety of topics. A list of the modules is presented in Table 1.

Table 1
Modules included in electronics technicians training course

Introduction to electricity	Relays & switches	Combinational logic functions
Multimeter measurements	Diodes & diode circuits	Flip-flop circuits
Basic DC circuits	Transistor circuits	Register memory circuits
Complex DC circuits	Power supplies	Arithmetic counting
Introduction to AC	Transistor amplifiers	Conversion & data circuits
AC test equipment	Transistor oscillators	Microprocessors
Inductance & RL circuits	Transistor pulse circuits	Basic motors
Capacitance & RC circuits	Trigger device circuits	Basic synchro/servo
RC time constants & transients	Operational amplifiers	Advanced synchro/servo
Resonance	RF electronics	Basic radar systems
Transformers	Digital logic functions	Communication systems

Each workday, trainees reported to a computer lab in an organizational facility where they spent six hours in training as part of their duty positions. Facilitators staffed the computer labs and were available to answer trainees' questions. Classes were comprised of 12 to 30 trainees, each pursuing individual training paths. Trainees progressed at their own paces and could spend as much time as needed reviewing each module, but could not progress to the next module until they demonstrated knowledge of the material on a post-training test. Trainees were allowed to retake each test until they demonstrated at least a minimum level of proficiency. The underpinning design remained rooted in the legacy instructor-centric course with little learner resources outside of informational content. The courses were available outside of the classroom, in learning resource centers, which were accessible within trainees' living quarters. Extra study time was also provided as a form of remediation for those trainees whose pace extended well beyond expected completion times.

2.2 Measures

2.2.1 Cognitive Ability

Cognitive ability was assessed using the verbal scale of the Armed Services Vocational Aptitude Battery (ASVAB). The ASVAB is a commonly used measure of cognitive ability (Turnage & Kennedy, 1992) and previous research has shown ASVAB is a strong predictor of success in training (Earles & Ree, 1992).

2.2.2 Goal Orientations

Goal orientations were assessed using a 20-item scale adapted from Zweig and Webster (2004). Participants responded to each item on a six-point scale (1 = disagree strongly to 6 = agree strongly). Sample items included, "The opportunity to do challenging work is important to me" (mastery), "I value what others think of my performance" (performance-prove), and "I avoid circumstances where my performance will be compared to others" (performance-avoid). Coefficient alpha for each scale was .74.

2.2.3 Time to Train

Time to train was measured as the number of days spent in training. The average time spent in training was 44.96 training days (SD = 10.29).

2.2.4 Learning

After completing each of the modules, trainees completed knowledge assessments on the computer. The assessments were created by subject matter experts to measure trainees' ability to remember and comprehend the training content. The tests were virtually identical to the tests that had been used in the instructor-led version of the course. In order to progress to the next module, trainees were required to answer at least 72% of the questions correct. If trainees did not reach this criterion, they were remediated back into that training module and then were allowed to retake the test. In this evaluation, the learning measure reflects the average of trainees' best scores on each of the 33 modules.

3. Results

The average time spent in training was 44.96 training days, with lengths ranging from 21 to 72 days (see Figure 1). Legacy classroom time for this course was 86 days. Thus in converting to Web-based instruction, time to train was reduced by 48%.

Figure 1
Variability in time to train

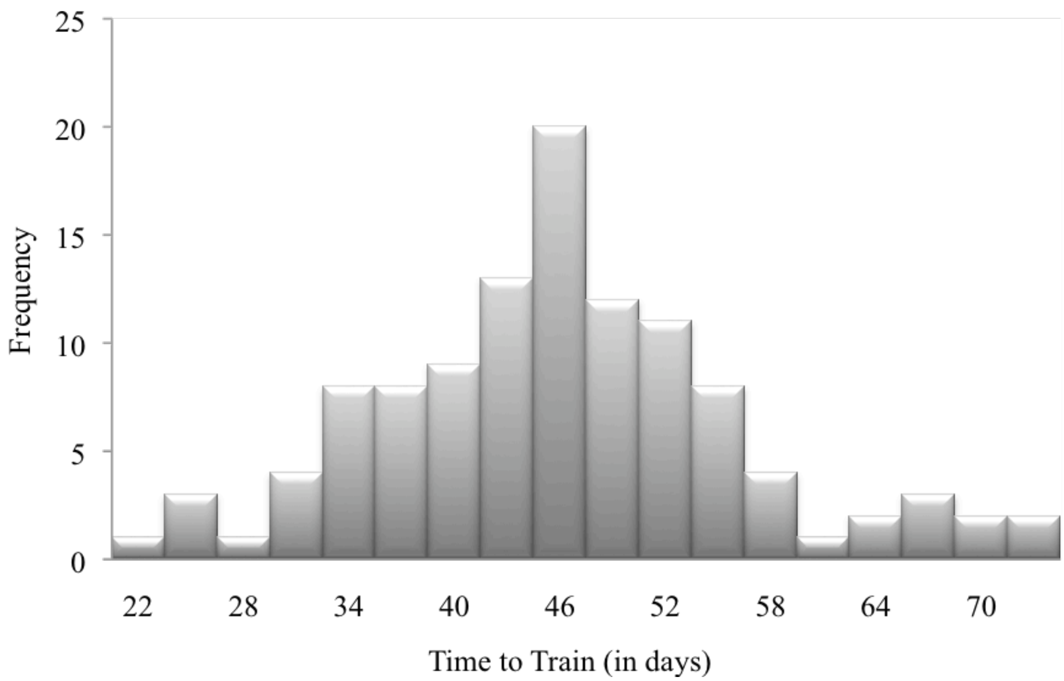


Table 2 presents the means, standard deviations, and intercorrelations among the variables. Consistent with prior research, cognitive ability exhibited a significant positive correlation with learning. However, cognitive ability did not significantly correlate with time to train. Based on these results, cognitive ability was used as a control variable when predicting learning (Hypothesis 1), but not when predicting time to train (Hypotheses 2-4).

Table 2
Descriptive Statistics and Intercorrelations of Variables

Variable	*M*	*SD*	1	2	3	4	5
1. Cognitive ability	56.86	4.35	-				
2. Mastery goal orientation	5.09	0.57	.05	-			
3. Performance-prove goal orientation	4.20	0.78	.00	.32*	-		
4. Performance-avoid goal orientation	3.21	0.79	-.12	.43*	.08	-	
5. Time to train	44.96	10.29	.03	-.13	-.06	.24*	-
6. Learning	86.01	3.47	.26*	.22*	-.06	-.18	-.15

Note. * $p < .05$, $N = 111$.

3.1 Predicting Learning

The first regression analysis examined the effect of time to train on learning in order to test Hypothesis 1. As shown in Table 3, cognitive ability and the three goal orientation dimensions were entered as control variables in step one. Cognitive ability and mastery goal orientation had significant positive effects on learning. Adding time to train to the model (step two) did not account for significant variance in learning, failing to support Hypothesis 1. Post hoc analyses were conducted to test for interactions among goal orientation dimensions and between cognitive ability and time to train when predicting learning. The three two-way goal orientation interaction terms and the cognitive ability by time to train interaction did not have a significant effect on learning.

Table 3
Regression of Learning on Goal Orientations and Time to Train

Predictors	R^2	ΔR^2	β	*t*
Step One:	.13*			
Cognitive ability			.25*	2.74
Mastery goal orientation			.23*	2.11
Performance-prove goal orientation			-.13	-1.32
Performance-avoid goal orientation			-.04	-0.34
Step Two:	.15*	.02		
Cognitive ability			.26*	2.83
Mastery goal orientation			.23*	2.11
Performance-prove goal orientation			-.14	-1.43
Performance-avoid goal orientation			.00	-0.01
Time to train			-.14	-1.46

Note. $*p < .05$, $N = 111$.

3.2 Predicting Time to Train

Hypotheses 2, 3, and 4 predict trainees' goal orientations will influence the amount of time spent in training. As shown in Table 4 (step one) Hypotheses 2 and 3 were not supported. Mastery and performance-prove goal orientations did not significantly predict time to train. However, Hypothesis 4 was supported. Performance-avoid goal orientation had a significant positive effect on time to train. Specifically, trainees who were one standard deviation above the mean on performance-avoid goal orientation tended to take 47 days to complete the training program. Trainees who were one standard deviation below the mean tended to take 42 days, a five-day reduction in time to train.

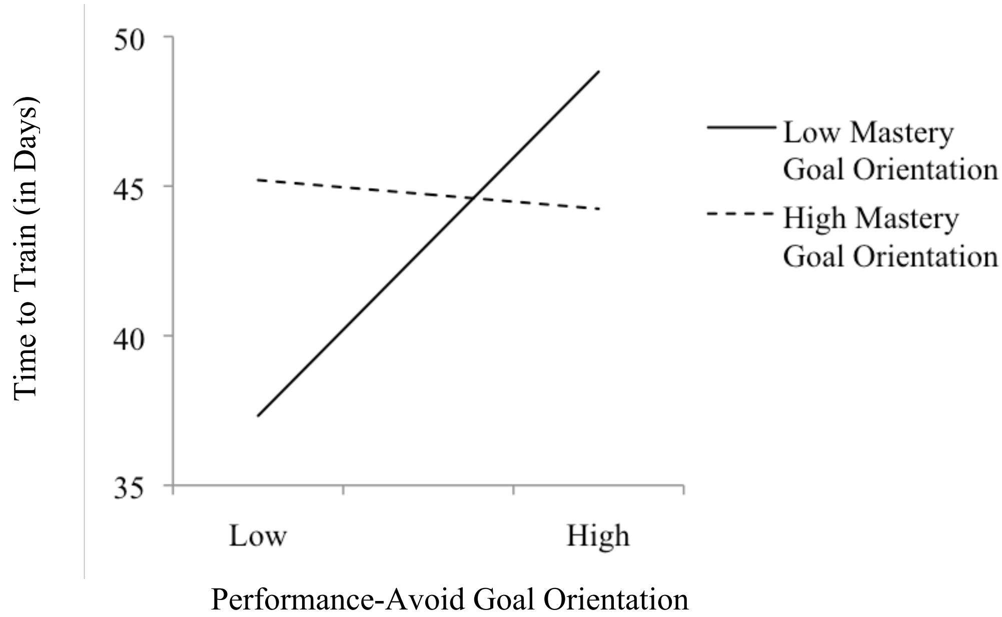
Table 4
Regression of Time to Train on Goal Orientations and Goal Orientation Interactions

Predictors	R^2	ΔR^2	β	*t*
Step One:	.06			
Mastery goal orientation			-.01	-0.06
Performance-prove goal orientation			-.08	-0.73
Performance-avoid goal orientation			.24*	2.24
Step Two:	.16*	.10*		
Mastery goal orientation			.08	0.07
Performance-prove goal orientation			-.12	-1.09
Performance-avoid goal orientation			.26*	2.48
Performance-prove × Performance-avoid			-.06	-0.49
Mastery × Performance-avoid			-.32*	-3.15
Mastery × Performance-prove			-.06	-0.61

Note. $*p < .05$, $N = 111$.

In a review of the goal orientation literature, DeShon and Gillespie (2005) noted the importance of adopting a profile perspective of goal orientation—considering the dimensions of goal orientation in concert. To examine the combined effects of the goal orientation dimensions, post hoc analyses were conducted to examine interactions among the three goal orientation dimensions when predicting time to train. To test for interactions, the three multiplicative terms were added as predictors of time to train in step two. As shown in Table 4, the inclusion of the three interaction terms accounted for an additional 10% of the variance in time to train, after controlling for the main effects and there was a significant interaction between mastery and performance-avoid goal orientations. As shown in Figure 2, trainees with both low mastery and low performance-avoid goal orientations completed training quickly, while trainees with high mastery and low performance-avoid goal orientations took considerably longer.

Figure 2
The interaction between mastery and performance-avoid goal orientations when predicting time to train.



4. Discussion

While trainees varied greatly in time spent in the training program (lengths ranged from 21 to 72 days), time to train was not a significant predictor of learning. Future research is needed to explore explanations as to why additional time in training did not translate into improvements in knowledge levels. One explanation may be how trainees are using their time in training. Trainees who complete the modules quicker may be more actively engaged in the material than trainees who take longer. Another potential explanation may be trainees' prior experience in the topic of training. While time in training may increase knowledge levels for novices, trainees who enter the training environment with some foundational knowledge may be able to move through the training faster while achieving high test scores.

These results suggest that goal orientations and the interactions between goal orientation dimensions are significant predictors of time to train. Specifically, trainees with a high performance-avoid goal orientation spent significantly more time in training than trainees with a low performance-avoid goal orientation. On average, trainees who were one standard deviation above the mean for performance-avoid goal orientation took five days longer to complete the training program than trainees who were one standard deviation below the mean. The training examined in this research lasted six hours a day. This translates into a 30-hour reduction in time to train for trainees with a low performance-avoid orientation relative to trainees who are high on this trait. Thus, if organizations are paying trainees to attend a course, trainees' goal orientations can have a large influence on direct training expenses.

In examining the goal orientations in concert there was a significant performance-avoid by mastery goal orientation interaction when predicting time to train. Trainees with low performance-avoid and mastery goal orientations completed training significantly quicker than trainees who were high on one or both of these traits. This finding highlights the value of considering goal orientation profiles when examining training processes (DeShon & Gillespie, 2005), and is consistent with previous research explaining how goal orientations influence learning processes. Trainees who have a high mastery goal orientation believe that effort leads to improved learning (Ford, Smith, Weissbein, Gully, & Salas, 1998) and should exert more effort toward learning the training material. However, trainees with a high performance-avoid goal orientation tend to divert attentional resources toward self-protective processes (Elliot & Harackiewicz, 1996), thereby slowing progress through the course. Together, this suggests trainees with a low mastery goal orientation paired with a low performance-avoid goal orientation should complete the training quickly as they are not intrinsically motivated to master the material and are not actively seeking to avoid negative judgments.

4.1 Limitations

When interpreting these results, it is important to note that there are several limitations to this research. First, time to train was considered as a measure of effort. However, time to train does not take into account whether the learner is processing the information while participating in training. Although this is a theoretical limitation, in the case of organizational training when trainees are paid for time spent in training, time to train is a critical variable as it directly influences organizational costs.

Second, learning was measured as trainees' best scores on the tests and trainees had to correctly answer at least 72% of the questions before advancing to the next module. This potentially restricts the range of scores as no score below a 72% was recorded. Additionally, the results of this research do not address the extent to which time to train predicts retention of the information learned in training, which is an important avenue for future research.

The results of this evaluation are inconsistent with research by Brown (2001) and Fisher and Ford (1998), which found time to train was a significant predictor of learning. However, in their studies the training was markedly shorter than the program examined in this research. In Fisher and Ford's lab study, most students completed the training in less than 20 minutes, while in Brown's field study trainees completed the course in an average of 8.3 hours. Additionally, the nature of the course content differed. Whereas in this research, trainees were learning foundational knowledge that was directly relevant to their future employment positions, Fisher and Ford's study taught undergraduates to use regression to predict stock prices while Brown's study taught trainees a standardized problem-solving process. While these are arguably important skills, the immediate relevance to the trainees may have been less obvious than in this study. Future research should examine whether the length of training courses and contextual factors, such as the content of the course, moderate the relationship between time to train and learning.

In predicting time to train, we did not find a main effect for mastery goal orientation or performance-prove goal orientation. This may be due to the fact that the time to train measure did not account for the quality of the time spent in training, such as the degree to which trainees were focusing their cognitive resources on learning the material. For example, individuals with a high mastery goal orientation may spending the same amount of time in training as someone with a low mastery goal orientation, but how they use that time (e.g., mental focus, learning strategies) may be more effective. Future research is needed to explore the relationships between goal orientation dimensions, objective measures of effort, and the quality of effort during training.

4.2 Conclusion

As organizations move toward Web-based instruction, research is needed to elucidate the decisions that trainees make in self-paced training environments and the impact that these decisions have on learning outcomes. The results of this research suggest goal orientations influence the amount of time that trainees spend in training. Specifically, trainees with a high performance-avoid goal orientation spent significantly more time in training than trainees with a low performance-avoid goal orientation. Also, interactions between the goal orientation dimensions accounted for an additional 10% of the variance in time to train. Mastery and performance-avoid goal orientations interacted such that trainees who were low on both dimensions completed the training faster than trainees who were high on one or both dimensions. However, time spent in the training program was not a significant predictor of learning. Future research is needed to understand how trainees are spending their time in training and how individual differences influence allocation of effort in self-paced training programs.

As this research points out, goal orientation is a key behavioral factor is predicting a learners' time to train to a prescribed level of performance. To the extent that learners can be assessed to expose a low mastery goal orientation coupled with a low performance-avoid goal orientation, there is an opportunity to capture a reduced time to train. Training providers could adjust their instructional design accordingly, and recoup cost to train.

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