

**Enhancing Learning, Performance, and Adaptability
for Complex Tasks**

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Project Objectives

Problem Background

With the transition to the 21st century, organizations of all types are under increasing pressures to develop well-trained workforces with cutting-edge technical skills. This trend is perhaps nowhere more apparent than in the military where rapid advances in complex technologies have created an unparalleled demand for high level skills and, therefore, training. Regardless of the setting, organizations increasingly seek training systems that can provide continuous updating and flexible, adaptive skills. Moreover, such systems must be able to provide instruction that can be accessible to everyone, provided on demand at anytime, and delivered cost effectively. The promise to meet these emerging challenges for training system design appears to be through the advent of emerging computer-based technologies that include web-based, embedded, and simulation-based forms of distributed training. These new training tools hold the promise of satisfying many practical demands. With an appropriate technical infrastructure, they have the potential to be widely accessible and can be delivered to anyone at anytime. With an appropriate instructional infrastructure, they can adapt to the needs, learning styles, and progress of different trainees and can be tailored to teams. Moreover, by eliminating the need for dedicated training facilities with their associated support and travel requirements, they can be extraordinarily cost-effective. Thus, distributed training in the form of these emerging technologies has the potential to resolve several difficult problems for training design and delivery.

Distributed training or distributed learning systems (DLS; Kozlowski & Bell, in press) are general labels used to describe systems in which trainees are geographically separated from an instructor and/or other trainees, and can assume two primary forms. One form of distributed training uses advanced video-conferencing and communication technologies to enable an instructor to hold class for trainees in geographically remote locations. Because this form of distributed training makes use of conventional classroom instructional approaches (e.g., lecture, demonstration, and discussion), much of the research evaluating its effectiveness has focused on how rich and interactive the video-conferencing and

communications technologies need to be to prevent declines in student learning. A second form of DLS -- and the form relevant to this proposal -- focuses on interactive multi-media applications in which information (e.g., web-based training) or simulation-based practice can be provided over the Internet or internal intranets. This form of DLS has the potential to enable a new architecture for training design for complex military decision-making tasks (e.g., command and control). Multiple, geographically dispersed trainees (as individuals, teams, or teams of teams) will be able to engage in sophisticated simulation-based practice to hone their basic skills and to develop higher-level strategic and adaptive skills. As yet, research addressing this second form of distributed training is in its infancy. It is this second form of DLS that is the long term application focus of this continuing research effort.

One critical challenge to realizing the promise of DLS is the need for effective principles and strategies -- grounded in psychological theory and research -- to guide the design and application of DLS features and capabilities (Kozlowski & Bell, in press). The technology is merely a medium for delivering information or experience; it is not instruction per se. Indeed, these emerging distributed training technologies are distinguished from more established forms of technology-based training (see Regian & Shute, 1992), such as computer assisted instruction (CAI) and computer-based training (CBT), in that more control in the nature of the instructional experience (i.e., what the trainee attends to and what the trainee acquires from the experience) is shifted to the trainee. That is, where CAI and CBT rely on computer or program control of the learning process, emerging distributed training technologies are more consistent with a learner control paradigm, which

allows the trainee to make choices about the amount, type, sequence, and pace of the information and practice experiences. This paradigm shift in the nature of the instructional experience -- inherent in the new technologies -- is critical because it allows trainees to have unique instructional experiences and because it makes the trainee more responsible for their own learning. Although learner control is often presumed to have many positive motivational benefits, findings regarding instructional effectiveness have been quite mixed and equivocal (Reeves, 1993; Steinberg, 1989; Williams, 1993). Indeed, the best evidence suggests that trainees often make ineffective use of the control they are given. For example, research indicates that trainees under learner control conditions exhibit a tendency to terminate instruction prematurely, negatively affecting their

learning (Tennyson, 1980, 1981). Moreover, much of the literature on learner control has utilized relatively simple learning tasks (Williams, 1993). Complex task domains such as those common in the military command and control environments necessitate the learning of deep task structure, task strategies, and adaptive performance skills (Kozlowski, 1998; Smith, Ford, & Kozlowski, 1997). Complex tasks and team-based task contexts are likely to exacerbate the problems associated with learner control in technology-based training.

The foregoing discussion indicates that the effective utilization of DLS necessitates a better understanding of the factors (individual, team, and learning process) underlying complex skill acquisition; in particular, a better understanding of how individuals maintain motivation focused on learning and allocate limited cognitive resources to individual and team objectives as they endeavor to master task complexities. Understanding this process is predicated on a sound, generalizable theoretical foundation that can specify critical psychological constructs, processes, and outcomes that are responsible for learning, motivation, and performance. Research on skill acquisition across a variety of task domains has begun to converge on theories of action initiation and control (i.e., self-regulation) to model processes underlying learning, motivation, and performance in complex task domains (e.g., Kanfer et al., 1994; Karoly, 1993; Salas & Cannon-Bowers, 2001). This theoretical foundation can guide the development of active learning interventions and techniques that influence the focus and quality of learner regulatory activity (Kozlowski Toney et al., 2001) and, therefore, the learning, performance, and performance adaptability (Bell & Kozlowski, 2000; Kozlowski, Gully et al., 2001). Hence, it constitutes the theoretical foundation utilized in the current research effort.

Research Objectives and Approach

This research program was designed to address critical, but neglected, theoretical issues at the interface of motivational theories and cognitive theories of behavior that are central to understanding the mechanisms that underlie learning, performance, and adaptability. The proposed research built on our prior work (Kozlowski & DeShon, 2001) and on the broad base of theory and empirical support for models of action initiation and control (i.e., self-regulation). Our objective was to examine these critical motivational and cognitive mechanisms of self-regulation, thereby developing principles to enhance learning, performance, and adaptability in complex, simulation-based tasks such as those to be used in distributed training systems.

The dominant motivational paradigm in current research on the initiation and control of action is self-regulation theory. Self-regulation theory has developed a broad base of empirical support as an effective model of the cognitive, behavioral, and affective mechanisms that contribute to task performance. Although there are several different models of self-regulation, the models converge around key features of a process that sketches the paradigm. In essence, individuals regulate their attention and effort around goals that are either self-set or influenced by the environment (e.g., what an instructor says, what a system prompts). Feedback indicates the degree of discrepancy between current performance and the goal. Moderately negative discrepancies are affectively unpleasant and generally prompt additional effort or a revision of strategy to close the gap between performance and the goal. Substantially negative discrepancies are very unpleasant and may prompt withdrawal of attention and effort -- the individual gives up. Positive discrepancies are pleasant and may prompt coasting or the reallocation of attention to another goal. As a general model of task performance, self-regulation theory has amassed considerable support (Karoly, 1993).

Remarkably, however, fundamental theoretical mechanisms of self-regulation that are relevant to understanding how individuals learn and adapt their skills in complex task environments have received relatively little research attention. These mechanisms and the issues to which they are relevant include:

- *Goal Representation* -- What intervention and individual difference factors affect the manner in which individuals represent goals (i.e., goal orientation: learn, prove, avoid) and what are the effects of these goal representations on learning strategies, performance, and adaptability? Can *active learning* inductions, that influence goal representations, influence self-regulatory processes and learning, motivation, and performance? If so, such interventions will provide powerful levers for DLS design.
- *Self-Regulation in Multiple Goal Environments* -- Complex tasks require individuals to regulate cognition, behavior, and affect across multiple goals. This is particularly the case in complex, team-based task environments where individuals have to dynamically shifts the focus of self-regulation among multiple goals (individual and team)? Is the process of team regulation analogous to the process of self-regulation? If so, it will allow generalization of knowledge regarding *self-regulation* to better understand *team* learning, motivation, and performance.
- *Malleability of Self-Regulatory Skills* -- How can individuals be trained to adapt effective goal representations and optimize resource allocation across multiple goals? How can feedback be tailored to individual characteristics, learning styles, and rate of progress to effectively guide their self-regulation?

Our scientific objective is to investigate these neglected theoretical mechanisms, thereby extending the applicability of self-regulation theory to better understand learning and adaptability. This scientific objective has pragmatic value. Training is increasingly being shifted out of the classroom and into alternative

media that necessitate more trainee responsibility for his or her own learning. Thus, current efforts to design distributed training systems necessitate the application of instructional principles to guide the learner; principles that enable the learning experience to be tailored to the individual's abilities, current level of skill development, and rate of progress. The basic research questions we will address are critical to understanding how to apply self-regulation theory to accomplish this objective, and to enable us to answer such basic questions as: What individual psychological constructs and situational factors affect the quality of self-regulation? How can the quality of self-regulatory strategies be enhanced? How can instructional goals and system generated feedback be tailored to the individual to enhance learning, performance, and adaptability?

Research Program Summary

Research Objective: Goal Representation

Core Elements of Active Learning: Mindfulness, Motivation, and Emotion Control Effects on Self-Regulated Learning and Adaptability

Bradford S. Bell and Steve W. J. Kozlowski

Research across different disciplines and using a variety of techniques has indicated that interventions that prompt the trainees to approach learning as an effortful, conscious, and mindful process – *active learning* – are generally associated with improved skill acquisition and adaptability for complex tasks (Smith et al., 1997). Unfortunately, however, the theoretical approaches and the nature of techniques employed have lacked integration. Thus, deriving a consistent set of principles from this domain of research that can be used to design tools to enhance self-regulation, learning, and performance has been elusive (Kozlowski, Toney et al., 2001). This research, in part supported by this project, synthesized a set of three core elements underlying a broad range of active learning techniques -- mindfulness, motivation, and emotion control. *Mindfulness* concerns the extent to which learners meta-cognitively monitor, strategize, and actively regulate their learning. It was hypothesized that mindfulness prompted by providing the learner with guided exploration (vs. greater program control) would be beneficial for the quality and focus of self-regulatory activity. *Motivation* concerns the type of goals that learners adopt during training and the extent of effort devoted toward goal accomplishment. A variety of research streams suggest that a goal orientation focused on task mastery is more beneficial than a goal orientation focused on performance achievement for learning complex tasks, even though the use of performance objectives in training is quite common. It was hypothesized that the adoption of a mastery goal orientation, induced by instructions to make (vs. avoid error) during training would be beneficial. *Emotion control* is relevant because it is very common for trainees to experience a sense of failure, which depletes self-regulatory resources and task focus, especially early during complex skill acquisition. It was hypothesized that emotional control strategies in the form of positive self-statements (vs. no strategy) would be beneficial.

Experimental data were collected from 350 participants. Key findings from this research indicated pervasive effects for the instructional and motivational components on self-regulatory processes, learning, and

performance. In particular, trainees exhibited higher levels of both active learning and adaptability when they received exploratory instruction and were exposed to a mastery-orientation induction (error approach). In addition, cognitive ability and goal orientation traits interacted with the manipulations, suggesting that it may be desirable to tailor particular training components to fit individual capabilities and learning styles. Of note, the effects of the instructional and motivational components on performance adaptability (i.e., skill generalization) were greater than effects on performance during training. This suggests that the Active Learning elements of exploration and error approach have the potential to enhance learning and adaptive performance for complex task domains. Importantly, these components have similarities with components of Mastery Training (see below), suggesting a core set of components that can be used to shape self-regulatory processes, learning, and adaptive performance in technology-based training.

Bell, B. S. (2002). *An examination of the instructional, motivational, and emotional elements of active learning*. Unpublished doctoral dissertation, Michigan State University, East Lansing, MI.

Bell, B. S. & Kozlowski, S. W. J. (2003, April). An examination of the instructional, motivational, and emotional elements of active learning. In B. S. Bell & S. W. J. Kozlowski (Chairs), *Active learning: Critical elements, instructional supports, and learning processes*. Symposium presented at the 18th Annual Conference of the Society for Industrial and Organizational Psychology, Orlando, FL.

Bell, B. S. & Kozlowski, S. W. J. (2004). *Core Elements of Active Learning: Mindfulness, Motivation, and Emotion Control. Effects on Self-Regulated Learning and Adaptability*. Manuscript submitted for publication.

Disentangling Achievement Orientation and Goal Setting: Effects on Self-Regulatory Processes

Steve W. J. Kozlowski and Bradford S. Bell

Researchers (Kozlowski, Gully et al., 2001; Kozlowski, Toney et al., 2001; Seijts et al., 2004; Winters & Latham, 1996) have indicated that the provision of mastery, relative to performance, goals during training enhances self-regulatory processes, learning, and adaptive performance. They note, in contrast, that conventional training design generally focuses on performance maximization with deleterious effects on self-regulatory processes, learning, and performance. This work has yielded a form of active learning called Mastery Training (MT) with high potential for integration into various forms of distributed, technology-based training. However, because MT manipulations are formed from a combination of specific components, and the underlying components of MT represent different theoretical approaches, it has been impossible to specify

which components are responsible for the different process effects attributed to MT. Thus, this research, supported in part by this project, was designed to disentangle the theoretical foundations and the three basic components of MT (Achievement Orientation or Goal Frame: Skill Mastery vs. Performance; Goal Content: Learning Objectives vs. Score Objectives; Goal Proximity: Sequenced vs. Terminal) in an effort to determine which MT factors, singly and in combination, enhanced self-regulatory activity. Also of key interest were the effects of motivationally inconsistent combinations of achievement orientation and goal content. That is, it common in training, where the goal is to learn, for instructors or leaders emphasize high errorless performance. Thus, an important purpose of this research was to decompose the effects such inconsistencies on self-regulatory processes and outcomes.

Data were collected from 524 participants in a 2 (Goal Frame: Skill Mastery vs. Performance) by 2 (Goal Content: Learning vs. Performance Goals) by 2 (Goal Proximity: Sequenced vs. Terminal Goals) design. Results revealed that all three factors had a significant influence on individuals' self-regulatory activities, with goal content exhibiting the greatest influence. Goal frame and content focused on learning rather than performance was beneficial for trainees' self-regulatory activity, and goal frame and content focused on performance was least beneficial. Inconsistent combinations of goal frame and content exhibited theoretically expected asymmetrical effects. In general, a learning frame with performance goals were better than a performance frame and learning goals. Finally, goal proximity was more beneficial under performance goals, whereas terminal goals were a better fit for learning goals. The basic message of this work – exploratory, mastery-oriented frames and goals that reflect mastery task elements – are potent tools for simulation-based instructional design.

Bell, B. S., Kozlowski, S. W. J., Dobbins, H. W. (2002, April). Effects of learning frame, goal content, and goal sequence on learning processes and training outcomes. In S. W. J. Kozlowski (Chair), *Advances in training effectiveness: Traits, states, learning processes, and outcomes*. Symposium presented at the 17th Annual Conference of the Society for Industrial and Organizational Psychology, Toronto, Ontario.

Kozlowski, S. W. J., & Bell, B. S. (2004). *Disentangling achievement orientation and goal setting: Effects on self-regulatory processes*. Manuscript submitted for publication.

Goal Orientation and Feedback Effects on Individual and Team Training Outcomes

Steve W. J. Kozlowski, Richard P. DeShon, Aaron M. Schmidt, and Brad A. Chambers

Although there is growing research support for the effectiveness of MT at the individual level of analysis, to date there has been few efforts to generalize mastery goals – and their underlying processes – to the team level. This is an important issue because individual-level phenomena often evidence substantial changes in form in team contexts (i.e., the construct changes; Kozlowski & Klein, 2000). Thus, construct composition (i.e., theoretical and empirical generalization) of the individual-level processes to the team level is required to establish the applicability of promising individual-level training techniques in teams. This research represents an effort to compose a mastery goal focus (MGF), relative to a performance goal focus (PGF), and their underlying psychological processes to the team level. In addition, because research has suggested that feedback also has the potential to affect goal focus (Kluger & DeNisi, 1996), two forms of feedback were crossed with goal focus: Self-Feedback (information on one's own performance) vs. Team Context Feedback (self-performance along with the performance of other teammates). The expectation was that team context feedback would prompt more effective regulatory processes around team level constructs, relative to self-feedback, which would focus more resources on individual level constructs.

Experimental data were collected from 540 participants formed into 180 3-person teams. Findings from this research (Kozlowski, DeShon, Schmidt, & Chambers, 2003) indicate that both interventions affected knowledge acquisition and goal focus such that team mastery goal focus and team context feedback (individuals can calibrate their performance with respect to their teammates) had positive effects. Of interest, team performance goal focus interacted with team context feedback for knowledge acquisition. In essence, team performance goal focus had more positive effects when teams received team context feedback relative to self-feedback; team mastery goal focus was insensitive to feedback type. The interventions exhibited subsequent effects on regulatory processes and performance outcomes. Findings overall suggest promise for team context feedback as a useful instructional intervention for promoting regulatory activity, learning, and performance; subsequent work is following up. Results for team mastery and performance goals suggest some challenges in translating the well-established effects at the individual level when goal frames are composed at the team level. In particular, this research indicated that while mastery goal focus has robust effects at the

individual level, at the team level performance goal focus interacted with team context feedback to stimulate effective learning and team performance. These findings suggest that performance training goals, coupled with team context feedback, may be a potent lever for team skill acquisition. In addition, the findings indicate that care is needed when attempting to generalize robust findings at the individual level to the team level. There is a need for careful distinctions between individual and team based simulation and instructional design.

Kozlowski, S. W. J., DeShon, R. P., Schmidt, A. M., & Chambers, B. A. (2003, April). Trait, goal, and feedback effects on individual and team regulatory processes. In B. S. Bell & S. W. J. Kozlowski (Chairs), *Active learning: Critical elements, instructional supports, and learning processes*. Symposium presented at the 18th Annual Conference of the Society for Industrial and Organizational Psychology, Orlando, FL.

Research Objective: Self-Regulation in Multiple Goal Environments

A Multiple Goal, Multilevel Model of Feedback Effects on the Regulation of Individual and Team Performance

Richard P. DeShon, Steve W. J. Kozlowski, Aaron M. Schmidt,
Karen R. Milner, and Darin Wiechmann

Working in a team requires the regulation of individual behavior with respect to multiple goals, making regulatory processes in the team context multilevel in nature. We first developed a conceptualization of the influence of multiple goals--individual and team--on feedback loops underlying the regulation of individual attention and behavior allocation. That is, a model of the process by which individuals prioritize attention between competing self and team goals and how the dynamic allocation of regulatory resources yields individual and team performance. Figure 1 below presents a model of how interdependent feedback loops result in the regulation of behavior with respect to both individual and team goals. In this model, two feedback loops have distinct individual and team goals that compete for control of the individuals' behavior.

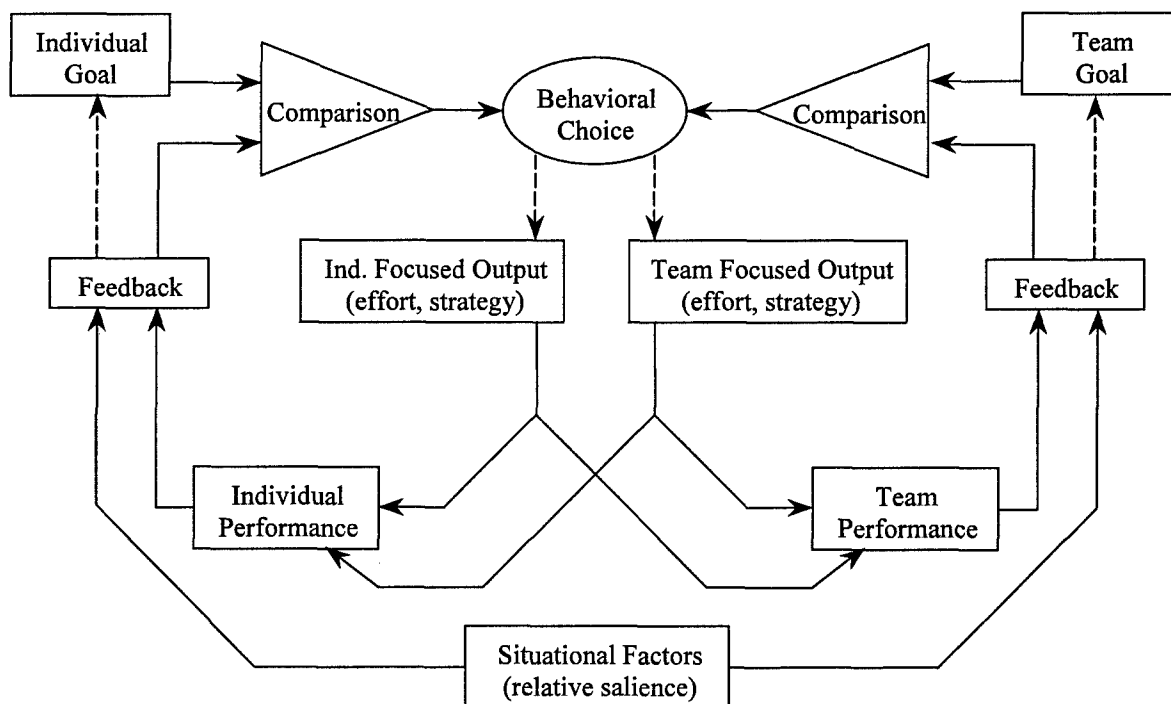


Figure 1. A multiple goal model of self-regulation.

The feedback loop for the individual goal monitors individual-level discrepancies between current performance and goal states and activates behavioral outputs needed to reduce the discrepancy. The team feedback loop operates similarly on the individuals' team goals to activate behavioral outputs needed to reduce team-level discrepancies. The behavioral output from each of the feedback loops affects the performance levels being regulated by the other feedback loop, such that reducing discrepancies for one feedback loop will often result in increased discrepancies on the other feedback loop. Finally, the initial characteristics of the situation and subsequent changes in the situation may result in increased discrepancies or increased salience of discrepancies on one or both of the feedback loops. As a result, initial aspects of the situation and changes in the situation may bias the control of behavior toward reducing discrepancies at either the team or individual level. Next, we extrapolated the self-regulatory implications of the multiple goal conceptualization to develop a multilevel model that captured regulatory processes at both levels shown in Figure 2 below.

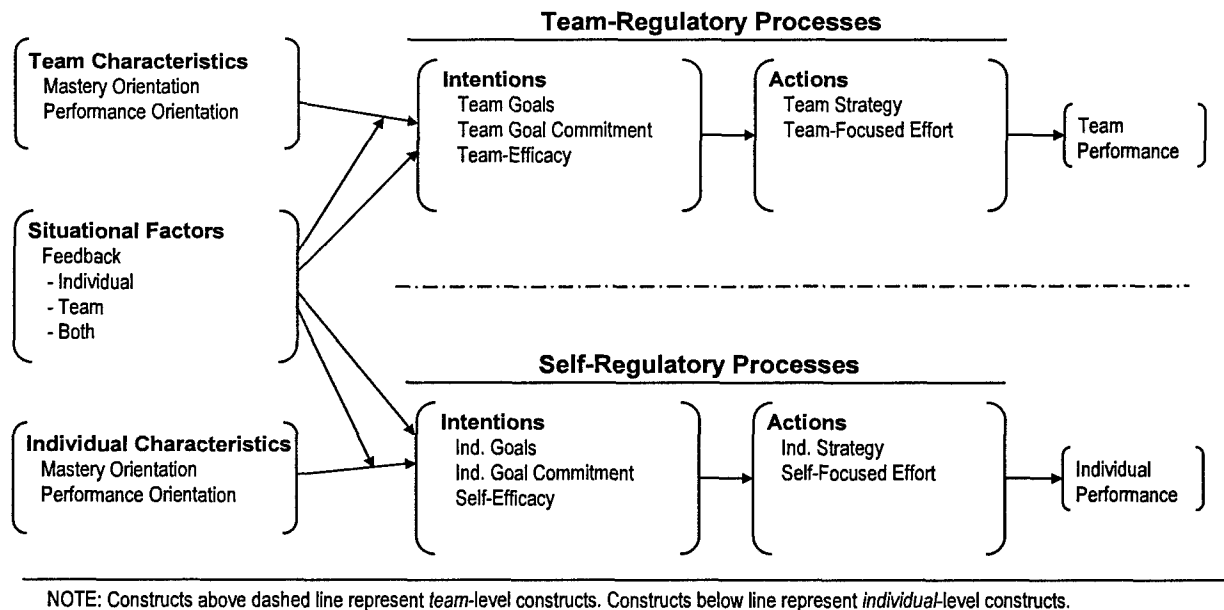


Figure 2. A multilevel model of self- and team-regulation.

Based on this model, predictions concerning the impact of individual and team performance feedback were examined empirically to evaluate the model and to understand the influence of feedback on regulatory processes and resource allocation. Two hundred thirty-seven participants were randomly formed into 79 teams

of three that performed a simulated radar task that required teamwork. We manipulated feedback to influence the focus of regulatory activity, which allowed us to model regulation as a process that operates simultaneously at the individual and team levels. The results of this research supported the multiple goal, multilevel model and the predicted role of feedback in affecting the allocation of resources when individuals strive to accomplish both individual and team goals. In essence, we were able to demonstrate that the key regulatory processes responsible for individual skill acquisition and performance also hold at the team level. Scientifically we validated a "homologous multilevel model" which, to the best of our knowledge, has not been accomplished empirically in prior work (Kozlowski & Klein, 2000).

Validation of this multiple goal, multilevel model means that key aspects of team skill acquisition and performance – those that emerge from lower level but parallel self-regulatory processes – can be effectively modeled in a multiple goal research setting where goals reference individual and team resource allocation. This allows for a more efficient research design strategy that nonetheless is directly relevant to team skill acquisition and performance. This is an important development in this stream of research that will have implications for research transitions and future work.

Kozlowski, S. W. J., DeShon, R. P., & Schmidt, A. M. (2003, August). A multilevel model of self- and team regulation during complex skill acquisition. In H. Liao & A. Joshi (Chairs), *Through a multilevel perspective: Understanding individual and team performance*. Symposium presented at the 63rd Annual Convention of the Academy of Management Association, Seattle, WA.

Kozlowski, S. W. J., DeShon, R. P., Schmidt, A. M., Milner, K. R., & Wiechmann, D. (2003, May). A multilevel, multiple goal model of self- and team regulation during complex skill acquisition. In V. Gonzalez-Roma (Chair), *Diversity and agreement in teams*. Symposium presented at the 11th European Congress on Work and Organizational Psychology, Lisbon, Portugal.

DeShon, R. P., Kozlowski, S. W. J., Schmidt, A. M., Milner, K. R., & Wiechmann, D. (2004). A multiple goal, multilevel model of feedback effects on the regulation of individual and team performance. *Journal of Applied Psychology*, 89, 1035-1056.

What to do?
The Effects of Discrepancies, Superordinate Goals, and Time on
Dynamic Goal Prioritization

Aaron M. Schmidt and Richard P. Deshon

As noted previously, complex tasks are typically multi-faceted, requiring individuals to prioritize between multiple goals and requirements competing for attention. This problem is exacerbated in team

contexts, in which individuals must execute not only their own individual tasks and responsibilities, but must also carry out those tasks and responsibilities that promote effective performance of the team as a whole. Given the limits of human attention, those performing such complex, multi-faceted tasks must shift their attention back and forth among the varying elements of the task at hand, focusing primarily upon only limited aspects of the task space at any given point in time. Despite its criticality, the existing research provides little understanding of how individuals prioritize among goals that are competing for their time, and how this prioritization changes over time as the situation evolves. Rather, current research on complex task performance is limited to tasks that have a single dominant goal. While this simple goal structure is useful for studying general learning and problem solving issues, it has little relevance to the task environments that individuals encounter when performing complex tasks in which they must regulate behavior, cognition, and affect around multiple, often conflicting goals. This research addressed this gap by developing and testing a model describing the processes involved in the dynamic prioritization of competing goals over time.

Experimental data were collected from 252 participants. Key findings from this study indicated that relative progress towards attaining the goals in conflict played a vital role in the dynamic prioritization of competing goals. In general, the results indicate that individuals tend to direct their attention towards whichever goal is furthest from completion at any given point in time. However, the results also demonstrated the importance of superordinate goals – outcomes or end-states that can be met through the completion of the specific task goals in conflict. When only one of the goals in conflict led to the attainment of a superordinate goal, that goal was given greatest priority. When one goal led to the attainment of a positive outcome while the other led to avoidance of a negative outcome (which was equivalent in value), greatest priority was given to the goal that led to the avoidance of a negative outcome. Further, this prioritization tended to change only when individuals were making strong progress towards meeting the goal linked to avoiding a negative outcome. This suggests that goals whose attainment leads to the avoidance of negative outcomes are given greater priority and attention, even to the detriment of other goals leading to positive outcomes. The importance of these findings from an instructional design perspective, is that—much like the related work on mastery vs performance goals—how goals are presented or framed has meaningful impacts on the dynamic

allocation of regulatory resources. Thus, simulation and web-based training design must incorporate goal frames that appropriately leverage the focus of regulatory resources to accomplish targeted learning goals.

Schmidt, A. M. (2003). *Self-regulation in multiple-goal/multi-tasking contexts: The role of discrepancies, higher-level goal framing, and individual differences on dynamic goal prioritization*. Unpublished doctoral dissertation, Michigan State University, East Lansing.

Schmidt, A. M. & DeShon, R. P. (2004, April). The role of discrepancies and superordinate goal framing on dynamic goal prioritization. In A.M. Schmidt & S.W.J. Kozlowski (Chairs), *What to Do? Multiple Goals, Resource Allocation, and Self-Regulation*. Symposium presented at the 19th Annual Conference of the Society for Industrial and Organizational Psychology, Chicago, IL.

Schmidt, A. M. & DeShon, R. P. (2004). *What to do? The effects of goal-performance discrepancies, superordinate goals, and time on dynamic goal prioritization*. Manuscript under review.

Effects of Implementation Intentions on Individual and Team Oriented Behavior

Richard P. DeShon, Steve W. J. Kozlowski, Aaron M. Schmidt
Anthony S. Boyce and Brad Chambers

As we have noted, complex team tasks necessitate regulation of behavior around multiple goals—those oriented toward accomplishing individual goals and those oriented toward team goals—that cannot be simultaneously accomplished. Given primary individual task responsibilities and goals, the team member must also monitor the need for allocation of resources to team goals. This process of multiple goal regulation requires dynamic shifts in the allocation of limited cognitive and behavioral resources between the goals competing for attention, which incurs switching costs and process losses. Thus, an intervention that improved cognitive efficiency and reaction time would have the potential to enhance the effectiveness of individual and team regulation. One such promising intervention—implementation intentions—is intended to automatically fire a goal-relevant if-then production. We reasoned that, given a primary focus on individual goal regulation, when an implementation intention cues specific team goal-directed behavior it should improve the response latency in shifting resource allocation to the team goal and thereby should yield superior team performance with no decrease in individual performance. In addition to examining the viability of this hypothetical process, this research was also designed to distinguish between the effects of implementation intentions and strategic knowledge as alternative explanations (the presumption being that the cuing of a goal-relevant if-then production would be superior to strategic knowledge that does not cue behavior) and to determine whether the inferential derivation of implementation intentions or strategies would be superior to simply

being presented with optimal implementation intentions or strategies (the presumption being that inference would be superior because it entails greater cognitive effort and depth of processing).

Experimental data were collected from 263 participants. Results provided clear support for the general conclusion that implementation intentions provide substantial support for individuals who are balancing the performance of multiple tasks in dynamic environments. Furthermore, as expected, the benefit of implementation intentions was primarily limited to those individuals who actually formed them on their own rather than having well formed implementation intentions provided to them. Apparently, the connections that are made when forming the implementation intentions serve an important role in reacting to situational changes. The specific linkage of situational cues with specific actions also resulted in a clear performance advantage for individuals who formed implementation intentions over those who either formed or were provided with more general strategies for team target processing. Finally, implementation intentions affected performance by increasing the number of team targets that were noticed and processed and by increasing the speed with which those targets were processed. The initial performance advantage associated with having formed implementation intentions resulted in higher goals being set on subsequent performance trials. We had also hoped to find that implementation intentions would improve team performance without decrementing individual performance. This occurred in part. The individuals in the implementation intentions conditions did not perform worse on individual targets than individuals in the strategy conditions. However, the individuals in the control condition focused much of their energy on processing individual targets rather than team targets and so it appears that implementation intentions resulted in worse individual target performance relative to the control condition. This result is primarily due to the relative bias toward processing individual targets in the control condition and team targets in the other experimental conditions. Thus, it would be useful to investigate additional research conditions where participants form implementation intentions for both individual and team targets. Although we would caution that additional research is needed, these early findings suggest that implementation intentions are a promising training intervention for improving resource allocation efficiency for tasks that involve regulation around individual and team goals.

DeShon, R. P., Kozlowski, S. W. J., Schmidt, A. M., Boyce, A. S., & Chambers, B. (2004, April). Effects of implementation intentions on individual and team oriented behavior. In A.M. Schmidt & S.W.J. Kozlowski (Chairs), *What to do? Multiple goals, resource allocation, and self-regulation*.

Symposium presented at the 19th Annual Conference of the Society for Industrial and Organizational Psychology, Chicago, IL.

Research Objective: Malleability of Self-Regulatory Skills

Effect of Velocity Feedback on Individual and Team Performance

Richard P. DeShon, Steve W. J. Kozlowski, Aaron M. Schmidt,
Anthony S. Boyce and Guihyun Park

Research reported previously under the first objective, *Goal Representation*, is also substantially relevant to the current objective, *Malleability of Self-Regulatory Skills*. The primary difference is that rather than influencing the nature, focus, and quality of self-regulation via characteristics of goal states, the current work shifts the leverage point to the nature of feedback provided to the learner. Not in the form of different information, but rather in the form of the referent or anchor provided that makes the feedback information meaningful for self-regulatory activities.

Research has shown that individuals tend to focus on rate of progress goals when discrepancies are large. This is very functional and is akin to setting reasonable goals on a difficult task. Reducing very large goal discrepancies in a short period of time is unlikely. However, the individual will often be satisfied with performance as long as the discrepancy between the goal and current performance is being reduced at an adequate rate. This concept is referred to velocity feedback -- how fast is the discrepancy being reduced? In our research on team adaptive performance, we've observed an interesting addition to this basic finding. Individuals do tend to focus on the rate of discrepancy reduction. However, learning and performance follow a negatively accelerating curve and tend to level off as the individual gets close to the final task goals. If the individual focuses on the rate of progress, and the rate of progress slows down as the goal is approached, then it is possible that the individual will become dissatisfied with progress and will withdraw cognitive effort. This raises a number of interesting questions that are particularly relevant in multiple goal contexts.

If individuals naturally tend to focus on rate of progress information when the discrepancy between actual performance and goal performance is large, it might be useful to provide feedback in terms of rate of progress information. A basic question is whether individuals chose to work toward goals where they are satisfied by performance or whether they work toward goals that are dissatisfying. If an individual tends to work toward goals that are being approached at a reasonable rate and avoid goals that aren't being approached at as fast a rate, then the presentation of feedback will have serious implications for the focus of attention in

learning and performance settings. Another question has to do with the framing of feedback. As mentioned above, we have observed individuals who became frustrated when their rate of progress slowed down, even though their performance was actually quite good. This implies that care must be taken when presenting feedback in terms of rate of progress information to maintain task persistence and satisfaction.

An important issue to be addressed is the anchor point used for rate of progress feedback and its effect on learning. When presenting rate of progress feedback, it is possible to anchor the feedback with respect to the initial performance level or the goal level. If learning and performance follow a negatively accelerating curve that asymptotes as the goal is approached (see Figure 1 below), it might be better to provide feedback using the goal level as the anchor point because small changes at the end can be presented as reducing the performance-goal discrepancy in perceptually significant steps. So, rate of progress feedback anchored to initial performance would be,

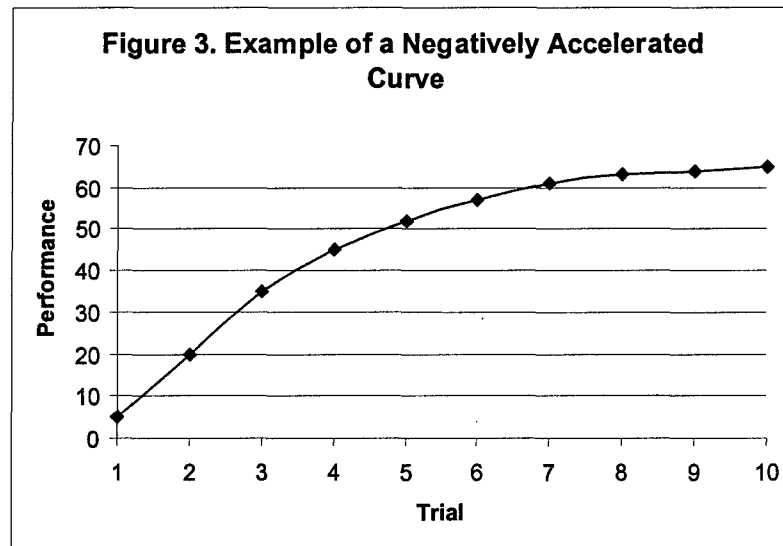
$$\frac{\text{New Performance} - \text{Old Performance}}{\text{Old Performance}} \times 100$$

and rate of progress feedback anchored to goal level would be,

$$\frac{\text{Old Discrepancy} - \text{New Discrepancy}}{\text{Old Discrepancy}} \times 100$$

To be concrete, consider the example in Figure 3. Assume that initial performance on trial 1 yielded a score of 5 points and that the final goal level was 70 points. On trial 2, the person obtains a score of 20. Using initial the initial performance level of 5, this is a 300 percent increase in performance -- a perceptually large improvement in performance. Using the final goal as the anchor point, this is a 23 percent decrease in the discrepancy. It is likely that the rate of progress feedback based on the initial performance anchor will be perceived of as a better improvement in performance than the feedback based on the goal level anchor point. Now, consider performance on the final trials as the goal is approached. On the 9th trial, the person achieved a score of 64 and improved this score by 1 point on the 10th score. Using the previous performance anchor, this is a 1.5 percent improvement in performance. However, using the goal level as the anchor, there is a 17 percent reduction in the discrepancy between performance and the goal level. In this case, the goal anchored,

rate of progress feedback is likely to be more motivating. So, the question is, whether it is more important to be motivated by feedback early in the task when performance gains are large or to be motivated at toward the end of the task when performance gains are relatively small.



Thus, this initial research is intended to address the basic question posed above: Which form of velocity feedback will be most beneficial for skill acquisition. The expected results from this research are fairly straightforward and based on the assumption that the rate of progress feedback is more motivating than the absolute discrepancy based feedback. Furthermore, we expect the previous performance anchored, rate of progress feedback to be most motivating at the beginning of the learning process and goal anchored, rate of progress feedback to be most motivating toward the end of the learning process. Following this logic, if initial motivation is the critical determinant of learning and adaptive performance, then previous performance anchored, rate of progress feedback should lead to the best outcomes. Conversely, if sustained motivation toward the end of the learning process is the critical determinant of learning and adaptive performance, then goal anchored, rate of progress feedback should lead to the best outcomes. Both of these feedback presentations should lead to superior learning and performance when compared to the traditional method of absolute discrepancy feedback.

Data were collected from 140 participants under three conditions: Traditional outcome feedback (control), velocity feedback referencing the rate of improvement relative to prior performance (Push), and

velocity feedback referencing the rate of progress relativ to the terminal goal (Pull). In addition to the feedback condition, all participats also received diagnostic information to help them target specific needs for skill development. Results were counter to expectations in that there were no significant main effects of feedback and no interactions with time. However, pull feedback interacted with perceived discrepancies to influence performance such that those participants receiving pull feedback who perceived that they were performing better than their self-set goals had significantly higher levels of overall performance. The mechanisms for this effect are not entirely clear, although it appears that under pull feedback participants maintained effort when perceived discrepancies were positive whereas control and push feedback participants invested less effort. In addition, participants in the pull feedback condition spent significantly more time reflecting on their feedback when discrepancies were positive, whereas control and push participants spent less time reflecting on feedback. This suggests they may have perceived progress to be adequate (performance above goal levels) and were therefore coasting. Further research will be required to replicate the effect and to better identify the underlying self-regulatory mechanisms. However, the research indicates that the effects of velocity feedback are more complex than previously thought, the nature of velocity feedback is an important influence on self-regulation, and that a better understanding of the effects and mechanisms has implications for simulation and computer-based training design.

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Discussion, Transition, and Conclusions

Research Findings and Implications

Goal Representation and Malleability. Our work addressing these related objectives adds to a growing body of robust evidence that goal representation in the form of learning or mastery orientation, relative to an orientation toward performance accomplishment, has substantial positive benefits on the nature, focus, and quality of self-regulatory processes, learning, and performance adaptability. This emerging body of support generally contraindicates the advice generated from the substantial body of work on goal setting (Locke & Latham, 2002) which indicates that difficult and specific performance goals and goal states yield superior performance. In contrast, the accumulating evidence suggests that such effects are limited to simple, well-learned, effort-based tasks. When the task is complex and there is an emphasis on skill acquisition and adaptability, learning goals and state inductions yield superior self-regulation, learning, and adaptability (Bell & Kozlowski, 2004; Kozlowski & Bell, 2004).

Our work on velocity feedback is more formative, in that the research base is less developed and our initial findings were not consistent with expectations. Further research will be required to replicate the effect and to better identify the underlying self-regulatory mechanisms. However, the research indicates that the effects of velocity feedback are more complex than previously thought, the nature of velocity feedback is an important influence on self-regulation, and that a better understanding of the effects and mechanisms has implications for simulation and computer-based training design.

From a training perspective, this stream of research provides a foundation for identifying interventions or levers to influence individuals' goal representations such that situational cues that induce guided exploration (vs. proceduralized instruction), error tolerance (vs. error avoidance), an emphasis acquiring skills (vs. demonstrating performance), and specific learning goals (vs. specific performance goals) better align self-regulatory processes with cognition, behavior, and affective reactions that support learning (Bell & Kozlowski, 2004; Kozlowski & Bell, 2004; Kozlowski, Toney et al., 2001).

An interesting aspect of this research, one with implications for future research efforts, centers on the generalization of these findings from the individual to the team level and the combination of goal representation inductions with feedback. Although models of self-regulation implicate both goals *and*

feedback as key levers of the self-regulatory process, most research has focused almost exclusively on goals *or*, to a lesser degree, on feedback but relatively little research has focused on both goals *and* feedback. Our research showed that the outcomes one would anticipate at the team level, based on an extrapolation from individual level theory and findings, were more complex than expected. Indeed, our research showed that a performance goal representation (vs. mastery goals), coupled with public or team context feedback (vs. private feedback), yielded the substantially superior outcomes at the team level (Kozlowski et al., 2003). This preliminary work indicates a need for additional research that examines the generalization of individual level findings to the team level and, more importantly, additional research on the alignment and coupling of goals *and* feedback.

Multiple Goal Regulation. A significant development in this line of research centered on the evolution of the way we conceptualize performance in the team context. From its inception, our work has been driven by the recognition that team learning and performance are multilevel phenomena that need to be modeled *at both levels* -- something that is rarely done in team performance research. Moreover, our theoretical foundation has evolved to incorporate a multiple goal model of self-regulation that better articulates how team performance emerges from individual resource allocations as team members dynamically shift attention across competing individual and team goals. With that theoretical foundation, we then developed and empirically validated a multiple goal, multilevel model of individual and team regulation -- a model of the process by which individuals prioritize attention between competing self and team goals and how the dynamic allocation of regulatory resources yields both individual and team performance (DeShon, Kozlowski et al., 2004). Establishing the homology (i.e., validating) of our multiple goal, multilevel model is an important advance because it means that key aspects of team skill acquisition and performance -- those that emerge from parallel individual level self-regulatory processes -- can be effectively modeled in a multiple goal research setting where goals reference individual and team resource allocation. With this advance in place, our research shifted to better understand the dynamic process of multiple goal regulation and the factors that influence it.

One study in this effort indicated that, given multiple goals competing for regulatory resources, individuals generally allocated attention toward the goal with the greatest discrepancy magnitude (i.e., the one

that is furthest from completion at any given point in time). The results also demonstrated the importance of superordinate goals – outcomes or end-states that can be met through the completion of the specific task goals. When only one of the multiple goals led to the attainment of a superordinate goal, that goal was given greatest priority. When one goal led to the attainment of a positive outcome whereas the other led to avoidance of a negative outcome (equivalent in value), greater priority was given to the goal that led to the avoidance of a negative outcome. In addition, this resource allocation priority tended to change only when individuals were making strong progress towards meeting the avoidance goal, suggesting that avoiding negative outcomes is given priority even when detrimental to the attainment of positive outcomes. The importance of these findings is that—much like the related work on mastery vs performance goals—how goals are presented or framed has meaningful impacts on the dynamic allocation of regulatory resources (Schmidt & DeShon, 2004). Another set of findings in this work on multiple goal regulation indicated that implementation intentions, relative to specific task strategies, showed promise as one means to enhance goal switching in multiple goal regulation. Those participants who developed and inferred their own implementation intentions had faster reaction times when switching regulatory resources to team goals, thereby yielding higher team oriented performance with no decrement in individual performance (DeShon, Kozlowski et al., 2004). Although we would caution that these findings are preliminary, they suggest that implementation intentions are a promising training intervention for improving resource allocation efficiency for tasks that involve regulation around individual and team goals.

Transitions

As documented in this report, our work on regulation in multiple goal environments yielded important insights on how the self-regulation and resource allocation process -- as individuals endeavor to accomplish both individual and team goals -- accounts for both individual-level and team-level learning and performance. We developed and empirically validated a model of multiple goal, multilevel individual and team regulation that accounts for the process by which individuals prioritize attention between competing self and team goals and how the dynamic allocation of regulatory resources yields individual and team performance. Based on the insights from this work, and in consultation with our Program Manager, we began to transition the research

program to focus on optimal modeling of multiple goal resource allocation processes, because it has the potential to provide a key leverage point for enhancing *both* individual and team learning and performance.

The initial objective in the transition is to develop a mathematically optimal model of multiple goal resource allocation and to appropriately revise our simulation paradigm for focus more directly on the dynamic process of resource allocation. Subsequent research will then be designed to reference experimental interventions to improvements in performance relative to the mathematically optimal model and to human performance benchmarks. Consistent with the theory and research foundation established in our prior work, primary interventions will focus on goals or goal representations, feedback, and the focus of self-regulatory activity and resource allocation. Our evolving research goal is to specify optimal patterns of resource allocation relevant to accomplishing both individual and team objectives. This, then, will enable us to focus on developing techniques that enhance resource allocation relative to an optimal model as a basis for improving learning, performance, and adaptability. Thus, the primary objectives of future research are to:

- Develop an optimal model of team member dynamic resource allocation
- Develop an optimal model of team dynamic resource allocation
- Evaluate interventions relative to optimal individual and team resource allocation

Conclusion

The research findings from this program of work show promise in two primary areas. First, our research has enhanced understanding of self-regulatory processes, their effects on learning and complex task performance, and the ways in which self-regulation can be leveraged using goal and feedback interventions. These findings add to a growing body of instructional principles to guide training design, and provide a foundation for leveraging self-regulatory processes and outcomes by embedding interventions in simulation based and distributed training systems (Kozlowski & Bell, in press; Kozlowski, Toney et al., 2001). Second, our multiple-goal, multilevel model provides a powerful approach to conceptualize, assess, and influence regulation as a simultaneous individual- and team-level resource allocation process that accounts for both individual and team learning and performance. Our transition work will refine the experimental paradigm to better model resource allocation as a *dynamic* process that is sensitive to individual, environmental, and team inputs. Moving forward, our scientific objectives are to better understand this dynamic process, develop tools to monitor multiple goal resource switching in real time, and create manipulations that push resource

allocation dynamics closer to that of optimal performance. As this work makes progress, it will provide a basis for the development of powerful tools for technology-based training and performance management.

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