RUNNING HEAD: ADAPTABILITY IN VIRTUAL TRAINING ENVIRONMENTS

Eight Basic Principles for Adaptability Training in Synthetic Learning Environments

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The landscape of the modern military arena is characterized by advanced technological systems, rapid accumulation of information, and the need to concisely integrate multiple (sometimes conflicting) sources of intelligence. Successful performance in such operational environments necessitates that individuals be able to quickly and effectively make use of available resources to assess situations in real-time, diagnose and prioritize possible courses of action, and identify/carry out appropriate task strategies. Consequently, a heavy burden is placed on the expertise of individual military operators to formulate and act on well-informed decisions capable of resolving novel, uncertain, or ambiguous task problems (Kozlowski & DeShon, 2004). As a result, imparting military members and leaders with knowledge and skills designed to facilitate flexible, adaptive performance in the face of unpredictable situations is a critical objective of nearly all major defense training initiatives (Barnes, Warner, Hillis, Suantak, Rozenblit, & McDermott, 2006; Mueller-Hanson, White, Dorsey, & Pulakos, 2005; Office of the Under Secretary of Defense, 2010; Tucker & Gunther, 2009). However, the obvious difficulties in training individuals to be adaptable to “unknown” circumstances while also providing instruction on basic and advanced responsibilities relevant to one’s role poses unique challenges for traditional training approaches. How should the instructional environment be structured (e.g., lecture, simulation, observation, etc.) to encourage adaptability? What learning objectives and motivations (e.g., do your best, complete task error-free, achieve X% proficiency, etc.) should be provided to trainees? What instructional techniques (e.g., error-management, active learning, performance feedback, etc.) are likely to promote adaptive expertise without overwhelming learners?

These and similar questions have spurred significant efforts in the research community to examine whether and how adaptability can be improved through training. Over a decade ago, it was noted that our "understanding of how to train, develop, and enhance individual and team adaptability [was still] in its infancy" (Kozlowski, 1998, p. 120). Since that time, unprecedented growth in instructional technologies and synthetic learning environments (SLEs) has led to the development of far more sophisticated and accessible methods for facilitating and evaluating the acquisition of complex skills. Coupled with renewed interest in the development of adaptive learning principles and systems (e.g., Bell & Kozlowski, 2008; Kozlowski et al., 2001), maturation in the comprehension of and proposed solutions to these inquiries has greatly improved the ability to provide successful adaptive training opportunities.

The goal of this chapter is to provide a broad overview of the research literature on enhancing learner adaptability. Throughout, we offer basic principles which summarize our recommendations for applying these empirically-supported techniques and approaches to adaptability training efforts. We begin the chapter by defining adaptability and its foundational psychological processes, and outlining some basic considerations for adaptability training. Next, we briefly discuss the unique properties of SLEs and the manner by which they can be used to foster adaptive thinking. Specifically, we focus on three important components of training design and delivery shown to facilitate adaptability in learners. Lastly, we conclude the chapter by providing recommendations for further reading and topics related to adaptability training.

What is Adaptability?

Conceptual overview

Though adaptability has been examined in a variety of ways (e.g., Neal, Godley, Kirkpatrick, Dewsnap, Joung, & Heskath, 2006; Ployhart & Bliese, 2006; Pulakos, Arad, Donovan, & Plamondon, 2000; Smith, Ford, & Kozlowski, 1997), most treatments broadly characterize the concept as *the ability to modify one's response(s) in order to effectively resolve task demands following one or more situational changes*. However, effective adaptive performance entails more than just reactionary changes to shifts in circumstance; equally important, adaptability also characterizes the *successful generalization of learned knowledge to novel tasks and applications* (i.e., Holyoak, 1991). For example, Wong (2004) relates that during Operation Iraqi Freedom, many junior U.S. Army officials came to realize that the most successful adaptable leaders were not simply those who could identify and enact strategic contingencies based on known situational variables (i.e., recognizing and initiating adequate solutions based on rehearsed knowledge), but also those who could effectively exploit previously unconsidered opportunities when they arose (i.e., creating new solutions based on unpredictable events).

Consequently, in the context of instructional training design, it is useful to think of adaptability as a *thinking/problem-solving process* rather than a characteristic or outcome of discrete ability and knowledge factors (e.g., Kozlowski, Gully, Nason, & Smith, 1999). Perceived of in this manner, the ultimate focus of training design and evaluation should not be to simply ensure that learners can pass a competency test at the end of training; instead, the goal of the training system is to improve the efficiency and effectiveness by which learners:

- Process, assess, and organize information from a situation
- Develop, select, and/or adopt viable solutions to the issue at hand
- Weigh the feasibility and likely consequences of different decisions/courses of action
- Gather and interpret feedback related to the enactment of the chosen alternative

On the basis of this distinction, we offer a first basic principle for designing adaptability training interventions:

> ***Principle 1**: Training systems should reinforce the importance of adaptive thinking rather than the achievement of knowledge/skill competency as the critical final goal for learners.*

As described above, adaptive thinking involves dynamic situational analysis of environmental variables, continual monitoring and evaluation of progress towards the desired objective, and active control and prioritization of one's cognitive and physical resource allocation (DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004; Smith et al., 1997). Effective adaptive behavior therefore reflects one's comprehension of *what is happening currently* and *what should be changed next* to resolve an encountered problem or situation (Kozlowski, 1998; Kozlowski & Bell, 2007; Kozlowski & DeShon, 2004). The underlying dynamics of adaptability are intimately related to two psychological processes: *self-regulation* and *metacognition*. Theories of self-regulation describe the basic mechanisms of intrapersonal control that individuals employ to direct their emotions, behaviors, and thoughts toward desired goals (Boekaerts, Pintrich, & Zeidner, 2005; Vohs & Baumeister, 2011). As shown in Figure 1, self-regulatory systems generally follow a cyclical pattern in which individuals engage in some activity (i.e., exert effort, behavior, strategy, etc.) that produces a change in performance. Feedback regarding that current performance (either from an external source or as interpreted by the individual) is then examined and compared to the desired situational goal. The result of this comparative evaluation stimulates the individual to pursue further action (the same as before or different) in an effort to reduce any identified discrepancies between the current situational state and the desired goal state (see Carver & Scheier, 1981, 1998, 2011). Metacognition, colloquially defined as “thinking about thinking,” refers broadly to one’s knowledge, awareness and management of thoughts relevant to goal attainment (Flavell, 1979). Within the broader framework of self-regulation, metacognition encapsulates skills which facilitate the internal discrepancy-reducing function of individuals’ thought processes, such as planning, monitoring, and revising behaviors as well as understanding appropriate task strategies and comparing goal states (Kraiger, Ford, & Salas, 1993).

Insert Figure 1 about here

Basic Training Design Considerations for Promoting Adaptability

Adaptive thinking is thus characterized by active self-regulation and metacognitive awareness which enables individuals to comprehend situational disturbances and novel events (i.e., appropriately interpret environmental feedback in light of one’s goals) and pursue new approaches for resolving the issue. When seeking to improve learners’ adaptive thinking through training however, it is important to note that adaptability is an advanced instructional goal that will generally only occur well into any actual training program (if at all, depending upon the duration and targets of training, Kozlowski et al., 2001). The development of adaptive thinking and expertise is cumulative and requires attention to and focus on intervening steps in the learning process before it could realistically be expected to manifest (Kozlowski & Bell, 2007). Although this implies that improving adaptability in complex environments is a longer-term outcome, it also suggests that the future emergence of effective adaptive thinking can be facilitated by the sequencing, foci, and presentation of training experiences (Kozlowski, 1998). A broad sketch of this training structure is presented in Figure 2 and briefly described below; for further reading on basic training design considerations, readers may wish to consult Carliner (2003), Goldstein and Ford (2002), Piskurich, Beckschi, and Hall (2000), or Kozlowski and Salas (2010).

Insert Figure 2 about here

During early stages of training, the emphasis should be on helping learners to retain basic declarative facts, concepts, and definitions that represent domain knowledge about *what something means*. This can be accomplished using fairly standard training procedures (i.e., lecture, reading, etc.) incorporating rote memorization, rehearsal, and static presentations. As learners are exposed to more complex applications of declarative knowledge, they can begin to build procedural knowledge that represent *how things work together* (i.e., “If A occurs, then B happens”) (Ackerman, 1986, 1987; Anderson, 1982, 1993). During this intermediate stage of training, it is useful to provide trainees with both observational learning and structured experiential opportunities they can use to induce underlying features, strategies, and skills that lead to goal attainment (Zimmerman, 2005). With continued experience and practice, procedural knowledge chunks can become integrated into interconnected and contextualized relational networks that enable learners to understand *when, where, and why* certain knowledge or actions are applicable (Ausubel, 1963; Glaser, 1989; Johnson-Laird, 1983; Rouse & Morris, 1986). At this more advanced knowledge acquisition stage, training experiences should encourage learner experimentation and make use of dynamic task environments that require strategic and reactive reasoning to relevant task situations (Bell & Kozlowski, 2002; Kozlowski et al., 2001). Based on the preceding, we present our second principle of adaptability training as follows:

<u>Principle 2</u>: Adaptive expertise should be treated as an advanced instructional goal that is nurtured through the acquisition of relevant declarative, procedural, and strategic knowledge experiences over time.

Note that providing the declarative and procedural knowledge needed to facilitate strategic task approaches/methodologies does not guarantee adaptability. Research has shown that individuals who hold requisite expertise can still experience great difficulty performing their task roles when the demands of their normally-encountered problem domain are substantially altered (Devine & Kozlowski, 1995; Sternberg & Frensch, 1992). To improve adaptive thinking, instructors must explicitly create learning opportunities that engage the self-regulatory and metacognitive processes of trainees (Hesketh, 1997). To do so requires a high degree of control over the learning environment and the capability to design flexible instructional interventions—which are precisely the strengths of synthetic training tools, the topic to which we now direct our attention.

Adaptability Training and Synthetic Learning Environments

Fidelity in Synthetic Learning Environments

Although definitions vary, we treat SLEs as *any type of computer-based instructional technology that is used to create a virtual learning experience* (Bell, Kanar, & Kozlowski, 2008; Cannon-Bowers & Bowers, 2008, 2010). Such technologies span a wide range of applications that includes both passive (i.e., CD/DVD, web-based training, video) and highly interactive (computer-based games, virtual worlds, high fidelity simulators) mediums (Salas, Kosarzycki, Burke, Fiore, & Stone, 2002). As noted above, SLEs offer a number of unique advantages that make them particularly well suited to complex skill acquisition and adaptability training efforts (Bell et al., 2008; Kozlowski & Bell, 2007):

- More flexibility and control over the presentation, pacing, and delivery of content, which helps optimize learner's sense-making efforts
- Greater task immersion that prompts intellectual arousal, engagement, and behavioral/thought processes relevant to real-world settings
- Ability to efficiently design realistic interactions and communications between persons or with role-crucial technology systems

Unfortunately, the sheer freedom of customizability inherent in virtual learning programs can make the task of implementing such systems daunting. This leads to our third principle of adaptability training specific to SLEs:

> ***Principle 3*: The single-most important consideration for selecting, designing, and crafting an SLE should be the psychological fidelity of the system.**

As opposed to physical fidelity (or the degree to which the training environment faithfully reproduces tangible aspects of the performance environment), psychological fidelity concerns *the extent to which the learning environment elicits the psychological aspects and processes most critical to the desired performance characteristics* (e.g., Kozlowski & DeShon, 2004). A foundational tenet of all training systems (synthetic or not) is that successful learning environments should target the knowledge, skills, and abilities needed to perform a task/job well. Ensuring psychological fidelity in SLEs achieves this by allowing learners to engage and improve the underlying psychological mechanisms that drive related performance applications in real-world settings irrespective of the task being performed. For example, if the desired goal of a training program is to improve the multitasking performance of UAV (unmanned aerial vehicle) pilots, then the degree to which a SLE realistically reflects true-to-life aspects of UAV operation is relatively less important than the degree to which the training system allows learners to practice managing their attention among multiple, simultaneous, and competing demands—an outcome which could be achieved in many different ways that may not resemble a UAV control station. Note that this is not to say that physical fidelity should be forsaken in SLEs, as it carries many desirable qualities also. Instead, this principle is meant to emphasize that the bulk of the design considerations for instituting virtual training methodologies should be directed towards what, which, and how the learning environment invokes the desired behavioral, cognitive, and attitudinal experiences of trainees rather than the appearance of the environment itself (see Bell et al., 2008, Cannon-Bowers & Bowers, 2008, 2010, and Kozlowski & DeShon, 2004, for further information).

In the case of adaptability training in SLEs then, we advance a fourth basic principle:

> ***Principle 4*: SLEs designed to facilitate adaptability should promote active involvement of self-regulatory and metacognitive activities.**

Techniques for Fostering Adaptability in SLEs

SLEs possess a number of desirable qualities that make them well-suited for training adaptive thinking, including the ability to create dynamic information demands that require continual monitoring/interpretation, easily provide customizable feedback and feed-forward information, monitor learners' knowledge and strategy acquisition in real-time (or nearly so), and create "intelligent," unobtrusive prompts that help shape trainees' emotional and cognitive attributions. The self-regulatory and metacognitive processes summarized previously and reiterated in Figure 1 point to three critical components that can be leveraged during training to foster adaptive thinking in SLEs: *instructional goals*, *task engagement*, and *feedback provision*. In the sections below, we briefly introduce these areas and how they might be incorporated into adaptability-focused SLEs. For more detailed treatments of these and similar processes, readers are encouraged to consult Bell and Kozlowski (2008, 2010) and Kozlowski et al. (2001).

Instructional goals. Instructional goals refer to explicit instructions presented to learners that recommend the behaviors and dispositions they should adopt during training. To this end, researchers have traditionally distinguished between two types of instructional goals: *performance goals* and *mastery goals* (e.g., Austin & Vancouver, 1996; Dweck, 1989). A performance goal is one in which the desired end state is an objective, identifiable standard of proficiency (e.g., correctly identify 90% of targets); alternatively, a mastery goal is one in which the desired end state is an approach, technique, competency, or procedure that facilitates task achievement (e.g., develop the most efficient strategy for identifying targets). This distinction has also been described as the difference between encouraging trainees to *demonstrate competence* (performance goals) versus *develop competence* (mastery goals) (Ames & Archer, 1988). A substantial body of research supports the finding that *instructional mastery goals are far superior at promoting metacognitive activity, adaptive thinking, and performance in complex, difficult environments* (Bell & Kozlowski, 2010; Kozlowski, 1998; Smith et al., 1997). As opposed to performance goals, mastery goals have also been shown to enhance the acquisition of declarative, procedural, and strategic knowledge; improve resilience in the face of training failures; stimulate increased interest and positive attitudes towards training; and promote cooperation among trainees (see Kozlowski et al., 2001).

During training, mastery goals can be encouraged by deemphasizing quantitative performance/completion ratings in lieu of promoting learners' mastery of desired task activities

(Mueller-Hanson et al., 2005). Instilling a mastery goal approach is especially important early in adaptability training as it can help learners build confidence in their self-regulatory abilities and efforts to persist (e.g., Winters & Latham, 1996). Also, given that the intended purpose of high-psychological/low-physical fidelity SLEs may not be readily apparent to trainees, using instructional mastery goals to orient learners' expectations and behaviors can provide a stronger sense of purpose and engagement within the training environment.

> ***Principle 5*: Instructional mastery goals that prompt learners to seek out task strategies, develop competence, and learn domain content at a deeper level should be employed early and often during adaptability training.**

Task Engagement. In conjunction with encouraging domain mastery, the manner by which learners experience training content is also essential to engendering adaptive thinking. Although oversimplifying the many subtle distinctions among training delivery methods, it is useful to crudely categorize different task engagement methodologies into *passive learning* and *active learning* approaches. Passive learning approaches—which include familiar training methods such as lecture, observation, demonstration, and proceduralized practice—are characterized by tightly structured learning environments that purposefully place limits on what learners attempt during training by providing detailed, step-by-step instruction on task procedures, concepts, and strategies (Iran-Nejad, 1990). Alternatively, active learning approaches place greater emphasis on learner control of the training environment and require learners to *infer* key concepts, procedures, and strategies related to effective task performance through exploration and experimentation (Frese et al., 1991). The goal in active learning techniques is to encourage individuals to figure out how things work, how to solve problems, and how to apply their knowledge and skills proactively and for themselves. Thus, unlike passive techniques which regulate learning activities through external means (i.e., the instructor, a textbook), active learning approaches prompt learners to self-regulate by assuming responsibility for important learning decisions (e.g., choosing what to focus on, monitoring and judging progress, etc., Smith et al., 1997) with appropriate guidance. Consequently, *active learning approaches are more effective at developing adaptive expertise in learners than passive learning approaches* (e.g., Bell & Kozlowski, 2008; Keith & Frese, 2005; Heimbeck, Frese, Sonnentag, & Keith, 2003).

A variety of specific active learning techniques have been explored in the research literature (e.g., discovery learning, guided exploration, error management, mastery training, emotion control, etc.), the details of which are beyond the scope of this chapter (see Bell & Kozlowski, 2010, for further reading). However, two important points should be made concerning active learning approaches. First, especially in the context of SLEs, active learning approaches entail more than "trial by fire" or learning by doing; instructors still play a central role in the learning process by providing 1) appropriately sequenced learning objectives, 2) instructional frames for interpreting successes/failures, and 3) motivational frames for tempering emotional reactions/frustrations (e.g., Bell & Kozlowski, 2002; Chillarege, Nordstrom, & Williams, 2003; Kanfer & Ackerman, 1990; Mayer, 2004). Second, despite their shortcomings in adaptability training, passive learning approaches can still be effective and efficient techniques for developing routine expertise in static environments (Frese, 1995); if certain task duties are highly simplistic and/or must be completed in a specific manner, passive learning approaches may be appropriate.

> ***Principle 6*: Active learning approaches that encourage learners to discover and infer task-critical concepts, principles, and strategies on their own some basic guidance should be employed during adaptability training.**

Feedback provision. The last, and arguably most important, consideration for improving adaptive thinking in learners concerns the provision of feedback. Feedback is imperative to training systems—especially those with self-regulatory components—as it provides learners with the capability to gauge strengths/weaknesses and influences future cognitive, behavioral, and emotional pursuits within the learning environment (Carver & Scheier, 2011). Owing to their computing power and often flexible control over information reporting, SLEs are powerful tools for designing and making available virtually any combination of feedback that could be imagined. From a more analytic approach however, it is useful to focus on two essential features of feedback: its *informational properties* (i.e., descriptive characteristics of learner accomplishment, such as number of items correctly answered) and its *interpretative properties* (i.e., characteristics which help learners make sense of their training efforts, activities, and achievements) (Kozlowski et al., 2001). While it is common to find elements from both of these categories interspersed within most feedback systems, *interpretative feedback properties hold the greatest significance for adaptability training*.

There are a number of nuances and distinctions regarding what, how, and when to incorporate interpretive feedback qualities into adaptability training; readers are encouraged to consult Kozlowski et al. (2001) for a detailed description of the various options available for designing such elements or Bell and Kozlowski (2002) for an example of their usage in SLEs. As a basic summary of this process though, interpretative feedback elements should provide information that assists learners in drawing accurate interpretations about *what happened* (evaluate), *why something happened* (attribute), and *what should happen next* (guide). Note that although the previous principles regarding instructional mastery goals and active learning approaches were predicated on encouraging individuals to explore their learning environment and reach their own conclusions regarding aspects of these questions, the provision of well-constructed interpretative feedback in such environments has been shown to be crucial to maintaining effort during training, ensuring learners appropriately sequence attention towards desired objectives, and improving self-confidence (e.g., Bandura & Cervone, 1983; Martocchio & Dulebohn, 1994 Tennyson, 1980; 1981).

***Principle 7*: Interpretative feedback which assists learners in evaluating, attributing, and guiding their behaviors, thoughts, and emotions during training should be incorporated into adaptability training.**

Concluding Remarks

The basic principles of adaptability training in SLEs that we have described to this point are summarized in Table 1. These recommendations should be treated as broad interpretations of the research literature on fundamental issues of adaptability training. Using SLEs, military training instructors have more potential than ever before to improve the adaptive thinking capabilities of trainees. However, the development of effective adaptive expertise is not likely to be achieved simply through the completion of a single or even multiple training courses. While such training efforts mark a crucial (and often missed!) first step, adaptability is a skill predominately honed “in the wild;” it must be prompted and reinforced in the performance environment by leaders who, in effect, play the role of instructors for the subsequent development of adaptive expertise. Consequently, we offer one final principle related to the development of adaptive expertise which extends beyond the formal training environment and into active duty:

<u>Principle 8</u>: Adaptive behaviors and thinking learned during training must be facilitated and reinforced in the wild.

One particularly important consideration for fostering adaptability post-training is the provision of opportunities to perform activities and tasks once individuals have assumed their normal job roles. While providing individuals with chances to practice role-specific activities is critical to facilitating the transfer of factual and procedural knowledge to the job (Ford, Quiñones, Sego, & Sorra, 1992), the provision of opportunities to learn, explore, and engage in relevant extra-role tasks (i.e., tasks which an individual in a particular job might not normally perform, but which share some common functions) is important for improving individuals' awareness of the consequences, alternatives, and outcomes related to their decisions/actions and the development of adaptive expertise (Blickensderfer, Cannon-Bowers, & Salas, 1998; Cannon-Bowers, Salas, Blickensderfer, & Bowers, 1998; Marks, Sabella, Burke, & Zacarro, 2002). Furthermore, leaders can play an important role in ensuring that adaptive thinking is encouraged and rewarded or, at the very least, not punished. For further reading on promoting adaptability beyond training, readers may be interested in consulting research on theories of team adaptation (e.g., Burke, Stagl, Salas, Pierce, & Kendall, 2006; LePine, 2003; 2005; Kozlowski et al., 1999) and dynamic leadership (e.g., Kozlowksi, Watola, Jensen, Kim, & Botero, 2009).

Insert Table 1 about here

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Table 1
Eight Basic Principles of Adaptability Training in Synthetic Learning Environments

1. Training systems should reinforce the importance of adaptive thinking rather than the achievement of knowledge/skill competency as the critical final goal for learners.
2. Adaptive expertise should be treated as an advanced instructional goal that is nurtured through the acquisition of relevant declarative, procedural, and strategic knowledge experiences over time.
3. The single-most important consideration for selecting, designing, and crafting an SLE should be the psychological fidelity of the system
4. SLEs designed to facilitate adaptability should promote active involvement of self-regulatory and metacognitive activities.
5. Instructional mastery goals that prompt learners to seek out task strategies, develop competence, and learn domain content at a deeper level should be employed early and often during adaptability training.
6. Active learning approaches that encourage learners to discover and infer task-critical concepts, principles, and strategies on their own and with minimal procedural guidance should be employed during adaptability training.
7. Interpretative feedback which assists learners in evaluating, attributing, and guiding their behaviors, thoughts, and emotions during training should be incorporated into adaptability training.
8. Adaptive behaviors and thinking learned during training must be facilitated and reinforced in the wild.

Figure 1. Model of self-regulatory processes

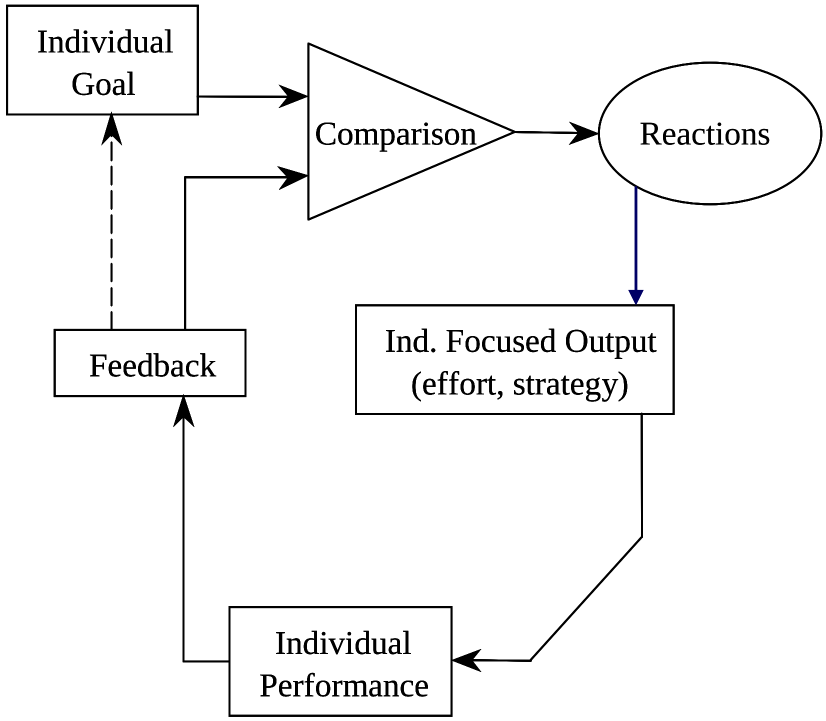

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Figure 2. Instructional design and delivery foci based on complexity of targeted knowledge/skill

Basic ***Knowledge and Skill Complexity*** *Advanced* →

Instructional Goal:	**Declarative Knowledge/Skill**	**Procedural Knowledge/Skill**	**Strategic Knowledge/Skill**	**Adaptive Knowledge/Skill**
Targeted Knowledge/Skill:	Facts, concepts, rules; Definition, meaning *(What?)*	Task principles; Rule application *(How?)*	Task contingencies; Selective application *(When, Where, Why?)*	Generalization of task rules, principles, & contingencies *(What now, What next?)*
Instructional Delivery Technique:	Memorization Static Practice Consistent Mapping Automaticity	←	→	Experimentation Dynamic Practice Variable Mapping Controlled Processing

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