4 Transfer in Sports, Medical, Aviation, and Military Training

This chapter focuses on the physical performance-oriented fields of sports, medical, aviation, and military education to consider the value in automatic, embodied, and non-verbalized forms of transfer. Fields presented here grapple with questions of embodied and bodily transfer, often in high-stakes professional settings, we believe such a perspective broadens the more conventional approaches to transfer in writing studies that have tended to emphasize transfer's deliberative and discursive features and measures.

We first chronicle how theory and research within sports education accounts for the intersection between bodily performance, in situ and embodied action, and cognition and metacognition. This vein of scholarship has implications for how we in writing studies think about the role of the body and action in writing and helps bridge some theoretical gaps around the teaching of technical skills and situational awareness through its emphasis on embodied cognition. Second, we review transfer research from medicine, aviation, and military training, which likewise emphasizes active, in situ performance and transfer. These fields add the compelling dimension of fidelity through simulation training to conversations about transfer and writing. Such research on the role of real-world fidelity in transfer is especially informative for cases where we seek to connect classroom writing assignments with those found "in the wild." Such work has a strong history and presence in writing studies through focus on internships, service learning, and some professional writing curricula (see Chapter 10 on "Writing across Contexts: From School to Work and Beyond"). Work

presented on fidelity in medical, aviation, and military education challenges writing studies to consider broadening types and dimensions of fidelity (e.g., physical, affective, sensory) when building learning environments or simulations that can facilitate transfer. This chapter concludes by offering theoretical and pedagogical constructs from sports, medicine, aviation, and the military and invites readers to consider how embodied cognition, the role of fidelity in planning and teaching for transfer, and approaches to creating simulated environments can all enliven approaches to writing-related transfer.

Sports Education

An important debate for transfer studies in sports education is whether, when, and how to distinguish between teaching isolated technical skills (e.g., dribbling in basketball or a ball toss in tennis) and context-dependent awareness (e.g., decision making within the pass of a live game or the flurry of a throw). Given long-standing discussions within writing studies on transfer of skills versus awareness, this strand of research from sports education is especially resonant. Such debates, which we address in Chapter 6 on "Research on Transfer in Studies of Second Language Writing," Chapter 7 on "Transfer in First-Year Writing," and Chapter 8 on "Infrastructure for the Transfer of Writing Knowledge: Writing Across the Curriculum and Writing in the Disciplines" drove many early conversations about transfer in writing studies. The thrust here was the question of how the teaching of generalized writing skills could transfer into community-specific writing situations while also recognizing literacy as a situated social practice. Sports education research offers insights into this debate for writing studies through its emphasis on how transfer connects bodily performance and embodied action with cognition and metacognition.

A Paradigm in Sports Education: Teaching Games for Understanding

Sports education experienced a significant paradigm shift in the early 1980s related to social constructivist theories of learning and new perspectives on how the body and mind interact with their environment. As a response to long-standing behaviorist approaches in sports education, the new social constructionist focus emphasized situated, contextualized, and participatory learning as critical for transfer of

training across games and from practice to performance. Most famously, Bunker and Thorpe (1982) ushered in a changed set of research and pedagogical questions that supplemented the prior dominance of technical and motor skills (connected to behaviorist models) for an additional emphasis on tactical awareness within a whole game context. Questions of transfer moved from a discussion of motor learning in isolation to contextual and active learning through deliberate structuring and scaffolding during game play. Over time, this emphasis on decision-making and tactical awareness in game play has come to drive most questions of transfer theory and pedagogy in sports education. Relevant to writing studies is the question of how to balance skills and tactics when the pedagogical goal is for learners to transfer their knowledge into the messiness and ill-structured nature of real-world activity. The dominant response in sports education has been to design classrooms to teach for tactical awareness primarily, with skill-level instruction embedded within game play. Despite this general level of consensus, we do find variation in how tactical approaches deal with skills. For instance, research asks whether transfer is best achieved when sports-specific skills (e.g., basketball) are taught through those sports alone or whether the teaching of some generalized skills at the level of sports-types (e.g., net games) can transfer across sports. Such multi-variant possibilities in embodied transfer have implications for writing transfer**.**

In their landmark theoretical article on sports education and transfer research, Bunker and Thorpe (1982) argued that teaching games as "a series of highly structured lessons leaning heavily on the teaching of techniques [specific motor responses]" (p. 5) was too contrived and artificial; those "failed to take into account the contextual nature of games" (p. 5). Light and Fawns (2003) link this shift, in part, to Dewey's (1936/1986) descriptions of "executive intelligence" and "mindful action" (p. 163). Bunker and Thorpe (1982) proposed that players needed learning environments that brought together the individual, the task, and the context for long-term success in game play; they argued that learning within this configuration was more likely to transfer than was mastery over isolated technical skills. Departing from earlier work on motor skills, Bunker and Thorpe (1982) made the radical claim that tactical considerations and tactical awareness, rather than particular skills, should be starting points in games teaching. Bunker and Thorpe (1982) introduced a changed coaching sequence

from fronting skills to now fronting game appreciation (i.e., the rules and constraints of the game), tactical awareness, and abstract constructs, which they argued would aid in overall understanding, deeper interest, and motivation to play. This revised sequence didn't reject teaching technical skills altogether; rather, it built up to skills through a focus on *how* games were played. Moreover, their educational model emphasized "sport performance [as] a complex product of cognitive knowledge about the current situation and past events combined with a player's ability to produce the sport skill(s) required" (Thomas et al., 1986, p. 259). From this perspective, types of practice that activate the arena of cognition, decision-making, and tactical awareness within situated activity could prime transfer into a game setting.

This approach—teaching games for understanding (TGfU)—"adopt[s] a more ecological, holistic view of learning" (Light, 2008, p. 22) that foregrounds the body and the body's relationship to cognition and context. Understanding thus arises from the learner's engagement in the world through perception, motor action, and bodily senses" (p. 23). Drawing on work in phenomenology, educational theory, and cognitive science, TGfU is "deeply tied into processes of cognition and the fluid physical context within which they are performed" (Light & Fawns, 2003, p. 164). Thus, teaching for transfer requires activation of embodied cognition. The importance of embodied cognition for transfer has also been developed in the field of cognitive psychology more generally (for more see Chapter 2). In that field, the work of Nemirovsky (2011), for instance, affirms the potential physicality of transfer as an action that resides in the body and can be reignited later under similar contextual and material circumstances.

Broadly, tactical approaches to sports education intertwine body and mind with a focus on situated learning, noting that "inherent [in the] problem of discrete skill practice is that learning is often decontextualized" (Turner & Martinek, 1995, p. 45). Like fields described throughout this book, theories of situated learning inform games teaching and learning, and provide a theoretical connection between "culture, contexts and activities" through its emphasis on communities of practice (Griffin et al., 2005, p. 219). Griffin et al. (2005) argue that "TGfU provides a structure for situated learning to occur within a community of practice, based in the meaningful, purposeful and authentic tasks presented and practiced by students" (p. 219). These theoretical shifts, which bridge embodied and cognitive dimensions of

learning with theories of situated learning, are an important base from which tactical approaches address questions of transfer.

Writing studies' long-standing debates over whether and how to teach generalized skills versus situationally and rhetorically specific skills and strategies, especially in first-year writing, may benefit from including theories of embodied cognition into this conversation. Emphasis on holistic learning coupled with decision-making through meta-awareness both supports current sociocultural approaches to teaching writing *and* suggests a need for more attention to the embodied, habituated, and dispositional characteristics of writing and learning to write. In other words, writing skills and strategies are embedded in larger actions, processes, and practices. This work might ask us to consider how disaggregating features of writing from their genres and communities does not necessarily disrupt or support the ways writers have deeply internalized when and how to use certain skills and strategies over others.

Tactical Approaches to Transfer in Sports Education: Pedagogical Implications

Classification Systems and Vertical and Thematic Transfer. Tactical approaches cluster types of individual sports in terms of "fundamental tactical principles [and] structural elements" (Lopez et al., 2009, p. 52). Classification categories include invasion (handball, basketball, netball, soccer, rugby); net/wall (tennis, badminton, table tennis, volleyball, squash); striking/fielding (basketball, softball, cricket, kickball); and target games (golf, croquet, pool, curling, bowling). Scholars and educators focus on theories of transfer that are viable both within and across a given classification: basketball to kickball (within), for instance, or basketball to tennis (across). Oftentimes in sports education, positive transfer, either within or across categories, is linked to physiological similarities between movement patterns across sports (e.g., surfing and skateboarding; tennis and badminton) (Kunzell & Lukas, 2011) in like-to-like bodily movement. As a result of this assumption, it follows that when a player attempts a new game within that category, they would have the requisite prior knowledge (both cognitive and embodied) to draw from because they have practiced at least one sport in each category.

Within this games classification system, transfer can be premised on theories of *vertical transfer* and *thematic transfer*. Vertical trans-

fer suggests that games within each classification system are similar enough in terms of tactics and structure that they can support one another in learning (Holt et al., 2002; Werner & Almond, 1990; Lopez et al., 2009). Vertical transfer requires identifying simple to more complex skills and capacities, then teaching those in a meaningful order. Accordingly, some have suggested that within the games classification system, it's helpful to differentiate between "less tactically complex sport/game categories, such as target games, with subsequent progression to increasing difficulty through net/wall games and fielding/run-scoring games to (finally) invasion games, which are deemed the most complex in tactical terms" (Lopez et al., 2009, p. 52). Relatedly, scholars have also suggested *thematic transfer* in which "transfer occurs from certain mastery to another analogue mastery" (Lopez et al., p. 51). Here, scholars and teachers advocate a "common approach" to a category of games rather than teaching specific games. As Lopez et al. state, "The focus is therefore, [sic] on student learning that which can be deemed [sic] 'common' knowledge, skills and understandings and then transferring their learning to each specialized context" (p. 53).

Mitchell et al. (2013) outline how classifying games according to their tactics—categorizing a tactical over a technical focus—is conducive to carrying knowledge between games. As they describe, for example, "invasion games are tactically similar even though they require completely different skills [and those] similarities enable us to define invasion games as those in which the goal is to invade an opponent's territory. Net and wall games involve propelling an object outward, so an opponent is unable to make a return" and so on (p. 9). The key here is to identify what types of tactics should be taught, how, and in what order within each general category; in other words, a significant part of curriculum development and planning for the transfer of tactical games awareness is identifying constituent parts of a larger tactic and breaking that down in terms of its tactical complexity. Although scaffolding is not a keyword here, researchers and educators do stress that novices cannot jump right into the most highly complex tactical problems. Rather, training should "increase the complexity of each tactical problem as students develop their understanding and skills" of the game (p. 12). In this way, there is a dialogic relationship between increased tactical awareness and an increased understanding of the skills needed for and rules defining each game.

Scholars emphasize social interaction through dialogue and the "action discussion reflective cycle" (Lopez et al., 2009, p. 48) where tactical awareness is raised through dialogue. For instance, interspersing practice with verbalization "integrate[s] the mind expressed in speech and the body expressed in action as an ongoing conversation" (Light, 2008, p. 23). Like authentic writing assessment, sports education embeds assessment in social contexts. Because game play and situational expertise are critical to transfer in sports education, these methods aim to capture authentic action in context and combine all dimensions of play in their assessment: technique and tactics and product and process (Grehaigne et al., 1997, p. 502). For more on sports education assessment, see the Game Performance Assessment Instrument (Oslin et al.,1998) and the Team Sport Assessment Procedure (Grehaigne et al., 1997).

Classification debates resonate with writing studies' conversations on genre and transfer. Specifically, they connect most interestingly with research about meta-genres and genre awareness in first-year writing and writing across the curriculum (see Chapter 6 on "Research on Transfer in Studies of Second Language Writing," Chapter 7 on "Transfer in First-Year Writing," and Chapter 8 on "Infrastructure for the Transfer of Writing Knowledge: Writing Across the Curriculum and Writing in the Disciplines"). Often classification systems cluster sports by bodily movements and game functionality. Writing studies scholars have long debated the teaching of more generalized classifications of genres (like academic writing) versus discipline-specific instantiations of those larger categories (like academic writing as situated within sociology, for example). Russell's (1995) famous lamentation that "there is no autonomous, generalizable skill called ball using or ball handling that can be learned and then applied to all ball games" (p. 57) captures the point of these early debates on writing but takes on a new valence situated next to sports education scholarship. Work within sports education suggests an alternative perspective to teaching general skills within categories, one that could open different research and teaching avenues. Specifically, in drawing from theories of embodied cognition, part of the outcome of putting sports into categories is to prime like-to-like bodily movements. Given the theoretical links between body and mind that are supported through embodied cognition theory, we might extend sport education's approach to work in writing studies by asking about linkages across meta-genres and em-

bodied cognition for thematic transfer. In addition, work on writing transfer and genre uptake might explore the interplay between habituated embodiment as it intersects with habituated cognition for vertical transfer.

Transfer and Declarative and Procedural Knowledge. Transfer of training in sports education also considers how novice and expert learners engage with declarative and procedural knowledge in games-related decision-making processes (Turner & Martinek, 1995, p. 46-47). Because tactical awareness approaches emphasize decision making within context-specific play, encouraging deep and active procedural knowledge is imperative. For instance, relevant studies by McPherson and Thomas (1989) found that while experts were able to connect the network of their declarative knowledge base to make decisions on process and action, novices had too little conceptual foundation to begin the process of decision-making in relation to goals. Because declarative knowledge and procedural knowledge together led to better tactical play, it's important to design a transfer pedagogy that combines them for the interplay of performance and decision-making. Subsequent empirical studies on tactical and decision-making approaches to teaching games have provided positive results for the transfer of procedural knowledge (Holt et al., 2006; Jones & Farrow, 1999; Mitchell & Oslin, 1999). For instance, in their study of net games, Jones and Farrow (1999) monitored how a cohort of eight-year-olds transferred both speed and precision in decision making between volleyball and badminton, reporting strong gains in both areas. Reported results of transfer were significant as participants received explicit instruction in the perceived tactic of interest. While studies have reported good results for the transfer of tactical awareness across games, the most successful results occurred when there was only a slight increase in the level of difference and difficulty (tactical complexity) between games in the same category (Lopez et al., 2009).

Writing studies' conversations on the role of threshold concepts and transfer connect with research on declarative and procedural knowledge in sports education. Threshold concepts research makes a strong case for centering declarative writing-related content knowledge in teaching for transfer. Because threshold concepts provide the conceptual and intellectual grounding for new and deeper learning and more strategic activity, they have potential to undergird and motivate a transfer act (see Chapter 7 on "Transfer in First Year Writing"). Inter-

estingly, and perhaps informed through the conceptual commitment in sports education to embodied cognition, findings emphasize the covalent and synergistic relationship between declarative and procedural knowledge in game play. Perhaps writing studies can think more deeply about a similar relationship and ways to promote pedagogically that symbiosis, such as a focused threshold concept education coupled with process-based instruction with aims toward the transfer of writing-related knowledge.

Simulations in Medical Education, Flight Training, and Military Combat

Medical Education

Within the field of medical education, transfer research has focused heavily on the efficacy of simulations (see Chapter 10 on "Writing across Contexts: From School to Work and Beyond" for more on simulations and professional writing). Medical studies often focus on the role of "fidelity" between simulation and later contexts as well as the types and levels of task complexity—physical and psychological—required for comprehensive knowledge transfer. Like much of the research reviewed from sports education, transfer research within medical education foregrounds issues of situated learning and how changes or differences in contextual variables impact transfer. A key distinction is the role of simulations in medical education, with accompanying questions of whether and how medical simulations help professionals transfer training to real-world contexts and how best to design simulated learning environments. But like sports education, focus on automaticity and embodied cognition often organizes research on simulations, fidelity, and transfer pedagogy. High-stakes work demands that doctors and nurses can not only reason their way to a workplace conclusion but act and react swiftly.

Fidelity, Situated Learning, and Transfer

As we know from work in educational psychology, high-road transfer "depends on deliberate mindful abstraction of skill or knowledge from one context for application in another" (Perkins & Salomon, 1988, p. 25). Importantly, for medical education, so-called high-road transfer

must be coupled with low-road transfer for quick thinking and automaticity of action. Simulation in medical training strives to recreate deep characteristics of situated learning and situated cognition for more automatic training in low-road transfer (Teretis et al., 2012, p. 140). Attention to fidelity addresses this transfer goal. Fidelity, that relationship of similarity between the simulated environment and the real-world context, is the core construct for helping students to develop transferable skills, capacities, knowledges, and actions.

Theories of fidelity typically emphasize situated learning and situated cognition (Lave, 1988; Lave & Wenger, 1991) and levels of direct authenticity between a simulated practice and real-world work. Such relationships can be either high (very similar/close likeness) or low (dissimilar/distant/partial). High and low fidelity extends to a context's multi-dimensionality. A nurse or doctor's interaction with a patient includes environment, psychology, and the physical body as well as the use of skills and engagement in actions ranging from motion efficiency, dexterity, economy of movement, quickness, and accuracy to bedside manner, leadership, and communication skills. Concordantly, there are various simulators that are categorized as having low fidelity, high fidelity, engineering (physical) fidelity, psychological (functional) fidelity, and environmental fidelity with the term *fidelity* "used to describe some aspect of the reality of the experience" (Maran & Glavin, 2003, p. 23). Psychological fidelity is also critical and refers to how much the learner perceives the simulation as a real proxy for the target task. Issenberg and Scalese (2008) note that the appropriate "fidelity configuration" (p. 34) is required to maximize transfer.

How fidelity is construed reflects how context and activity are defined and what educators or researchers believe are most applicable to transfer of learning. In some cases, fidelity is constructed through its allegiance to the physicality and functionality of the real-world context. But even within this narrowing, it is still a challenge to name "precisely what aspects of the context should be the focus of attention" (Norman et al., 2012, p. 637). Not only that, but medical professionals are in training for multiple types of care and interaction with patients (e.g., taking blood pressure, discussing health outcomes, performing a range of surgeries). Researchers have identified four connected variables that may aid in transfer between simulations and real-world environments: the amount of initial learning, similarity between learning and performance environments, *perceived* similarity between these en-

vironments, and motivation of the learner (Alessi, 1988). These factors all speak to the possibilities and unpredictability of teaching for transfer within medical education. Thus, a guiding question for medical education is this: what kinds of fidelity best support transfer? What kinds of pedagogical approaches best complement the use of simulations in learning? The following section highlights key research findings on the dynamic role of fidelity in learning and transfer of learning.

Teaching for Transfer in Medical Education

In general, research on simulations as proxies for fidelity show the benefit of simulations for transfer (Barsuk et al., 2009[a]; Barsuk et al., 2009[b]; Draycott et al., 2008; McGaghie, 2008; Wayne et al., 2008). There is less consensus on how to structure learning throughout the simulated experience. First, in drawing from research in cognitive science, Teteris and colleagues (2012) suggest that immediate exposure to a comprehensive high-fidelity simulation is too complex and too ambiguous for novice students due to the higher cognitive load of performing all aspects of a complex task. Presenting novice learners with every dimension and real-world complexity may hinder students' ability to progress. Thus, like other fields, an important area of simulation transfer for medical education is how a learner's level of expertise affects their interaction with the simulator and thus the likelihood of transfer to professional, clinical situations. Vygotsky's work on scaffolding and the zone of proximal development informs discussions on how trainees transition from a novice to expert status as "learners are exposed to a series of learning environments of increasing fidelity" (Teteris et al., 2012 p. 141). In fact, "there is evidence . . . that novices may well be better off with simpler models and should gradually move to more complex models as their skills improve, a strategy known as "'progressive' fidelity" (Norman et al., 2012, p. 644). Learners first work within low-fidelity settings, which decreases the "extraneous and intrinsic cognitive load," in preparation for "when they have mastered this part of the task [and can] progress through increasingly complex environments and tasks until they reach the highest available fidelity" (Teteris et al., 2012 p. 141). A higher cognitive load typically reduces initial learning and, ultimately, transfer—because what has not been learned cannot be transferred. Research draws on cognitive load theory to stress that "many additions to a learning task may detract from

learning because of our limited ability to process incoming information" (Norman et al., 2012, p. 644). Research supports starting learners off in low-fidelity situations and moving through fidelity-inspired zones of proximal development (Maran & Glavin, 2003). Thus, a simulated learning environment is effective when parts of a fully realized simulation are broken down into parts or phases and then built back up over time. In this case, discrete simulations are developed through partial exposure to some holistic version of a real-world context.

Research also emphasizes "deliberate practice, reflection and feedback" (Maran & Glavin, 2003, p.22) in conjunction with learning through simulations and apprenticeship models (Porte et al., 2007, p.106). Computer assisted instruction and feedback—through simulations—has gained traction, and research suggests that a combination of expert feedback and computer-assisted technologies are likely the most effective means for learning and transfer (Porte et al., 2007; Xeroulis et al., 2007). As addressed in Xeroulis et al.'s study of computer-based video instruction versus expert feedback in teaching knot-tying and suturing, a combination of computer-assisted learning and expert feedback can be most effective. Despite the usefulness of computer-based simulations in learning, research shows that practitioners still benefit from human feedback throughout the scaffolding process in so-called "performance-related information" because such apprenticeship communication emphasizes the cognitive and social dimensions of the skill being learned (see Chapter 10 on "Writing across Contexts: From School to Work and Beyond" for more on apprenticeship models in writing).

Critically, while feedback appears valuable, "continuous feedback" from either domain may result in "over guidance, leading to learners using concurrent feedback as a crutch [sic], and distraction of attention from the intrinsic feedback naturally present" (Xeroulis et al., 2007, pp. 447–448). Because simulation can "'shape' appropriate technical skill performance" (Xeroulis et al., 2007, p. 448), the same mechanism can be manipulated to monitor and adjust feedback (particularly computer-assisted) through strategies such as "'fading'" which, "initially provide many clues and feedback to trainees at the start of training and slowly fade out as the trainee learns to carry out the task without support" (Xeroulis et al., 2007 p. 448). Aggarwal et al. (2006) provide additional and holistic strategies for teaching with simulations at the level of a comprehensive training curriculum, which they refer to as a

scaffolded process of familiarization, training, and assessment. Tellingly, they term the final phase "automation," which "occurs when the learner performs the tasks in a relatively automated fashion with little or no cognitive input" (p. 131). The instructor supports the learner with verbal feedback in all but the final stage.

Transfer, Simulations, and Fidelity in Flight Training and Military Combat

Flight education is an important source field for simulation research. Specifically, studies in aviation further highlight the multiple and interacting dimensions of fidelity. In fact, much of the early medical education research borrowed from flight-training language and theory regarding the roles of physical, psychological, and environmental fidelity for facilitating transfer. But, for flight training, even more focus is placed on transfer at the level of habituated, bodily action and response between simulation and transfer target context. Military training follows a similar focus.

An original theoretical justification for simulations came from Thorndike's (1901) identical elements theory, with special attention to visual and motion cues across the training and the real-world context. Later research pointed to the role of perception in this process, which complicated the use of Thorndike's identical elements to show that "perceptual fidelity is not necessarily induced by exact physical simulation. [Rather,] [i]dentifying ways to induce reality rather than simulating the physics of reality is a scientific challenge to be addressed by all future generations of simulators" (Robinson & Mania, 2007, p. 134).

Attempts to remedy perceptual challenges focus heavily on visual, interactional, and kinesthetic fidelity. As researchers and educators seek more and better ways to create systems and simulations that address the components, they ask, as outlined by Robinson and Mania,

- What makes a simulation feel real to a human observer?
- Can we use what is known about the human visual system and human cognition to help us produce more realistic synthetic images?
- Can our perception of the real world (space and people) around us survive the transition to a graphics environment or to a virtual human?

- How can we use the attributes of the human visual system and human cognition to design computer graphics simulation systems in a way that a sense of "being there" is communicated?
- Are there perceptual commonalities among applications, or are practical applications so independent that we cannot generalize findings from one application to another? (p.124).

The question of perception is further complicated when distinguishing between surface and underlying features of a situation. For instance, some research has found that "the important factor in the transfer of basic flight skills may lie in the transfer of cognitive principles underlying successful task performance rather than transfer of proprioceptive cues from physical identical elements from the device to the aircraft itself" (Koonce & Bramble, 1998, p. 287). Work in military training supports this finding. As Alexander et al. (2005) describe, "surface features of training refer to problem-specific or domain-specific features of training examples. In contrast, deep (structural) features refer to the underlying principles imparted in training" (p. 3). To replicate both surface and deep features, and induce the recognition of those features, but at different times and for different purposes, military training has turned increasingly to virtual games. Through these mechanisms, military education emphasizes scaffolded experiences and levels of fidelity. Alexander et al. note that "[f]idelity is not a simple high/low dichotomy, rather it is multiple compound continua" (p. 6), and that more fidelity does not necessarily mean a better outcome; rather, successful (positive) transfer comes from whether "the level of fidelity captures the critical elements/properties of the skills/tasks you wish to teach, that level of fidelity is sufficient even if it noticeably deviates from the real world" (p. 6).

Implications for Pedagogy and Methodology from Medical Education, Flight Training, and Military Combat

In this section, we have synthesized pedagogical and methodological recommendations as they relate to fidelity and simulations.

- To build scaffolded experiences across simulations, it is important to distinguish between high fidelity and low fidelity. High fidelity means that there is a close likeness to the real while low fidelity means that the likeness is partial or distant. A low-fidelity simulation would have only parts of these types mentioned

above—engineering, environmental, or psychological—while high-fidelity simulations would incorporate all or most for the most realistic version of the real-world experience.

- Distinguishing between types of fidelity allows educators to scaffold a series of increasingly complex simulations over time. While the whole environment, including the learner's interactions with the environment, might be the target context for transfer, breaking context variables down increases the likelihood of on-going learning. The medical literature, for instance, suggests three common types of fidelity to pay attention to: engineering fidelity, environment fidelity, and psychological fidelity. The aviation literature references additional types of fidelity: visual, haptic or kinesthetic, and motion fidelity. While not all these specific context variables are applicable to writing, the broader attention to the full and multiple dimensionalities of context should cue educators to explore elements of context that have been previously neglected.
- To help facilitate transfer, it can be important to begin with a low-fidelity simulation where learners can experience part of the target task, thus reducing both extraneous and intrinsic cognitive load. This is called within the literature "'progressive' fidelity" (Norman et al., 2012, p. 644). When students have mastered a part of the task, they progress through increasingly complex environments and tasks until they reach the highest available fidelity.
- Scaffolded fidelity can be paced over time, with multiple opportunities to practice the new skill, capacity, or action. Reflection and feedback are critical components of this process and include verbal feedback from an expert (Porte et al. 2007) as well as "deliberate practice, reflection and feedback" (Maran & Glavin, 2003, p. 22).
- The place and significance of feedback may shift throughout this process. Aviation training and military combat literature suggests that feedback recedes as students move from low- to high-fidelity simulations given that the goal, in these learning contexts at least, is to train ultimately for automaticity.

Fidelity in and of itself does not create a transfer-rich environment. Rather, fidelity-inspired learning environments require strategy, pedagogy, and monitoring. It is critical to scaffold toward more realistic

activities by building up parts of an overall environment carefully, aided by practice, reflection, and feedback. Broadly, these practices also reflect good writing pedagogy. More specifically, writing studies can learn from these fields' attention to the multi-dimensionality of fidelity and the care with which those facets are scaffolded.

Methodologically, two approaches have value for the transfer of writing-related knowledge. These methods include direct observation and the use of haptic sensors. Observation of learner performance is the most common method here, with a researcher watching and taking notes on transfer performance. Such observations are aimed at assessing so-called clinical competence, which aims to not only capture the practitioner's aptitude on the task at hand, but also to generalize to other future tasks. Typically, both inter- and intra-rater reliability are preferred, and video-taped sessions help researchers in this process.

Direct observation of transfer is not nearly as common in writing studies, as a good deal of research relies on either reflective interviews or discursive tracing rather than living accounts of the transfer act. But such a method could fit well with the long history of ethnographic research methods within writing studies. While direct observation cannot capture the meta-cognitive processes of a writer or note a writer's internal dialogue and decision making around when and how to transfer writing-related information, it has the potential to identify extra-discursive features of transfer by focusing on a writer's movements as they relate to the environmental infrastructure. If a researcher is interested in the dynamic between talk, text, and transfer in dyads or groups in action, observation is again a useful tool (see Chapter 9, "Writing Centers: An Infrastructural Hub for Transfer"). The key would be to identify situations in which external transfer data could be gleaned in real time or to theoretically connect (through discourse analysis, for example) talk to transfer. Recent work on "transfer talk" in writing centers illustrates the value of this approach as these researchers sought to use analysis of tutor talk to interrogate "the role of more routine, automatized experiences of transfer" (Nowacek et al., 2019.).

Haptic sensors also play a role in how to observe transfer in medical settings. Unlike the direct observation of a participant, these methods have the practitioner interact directly with a technological interface, which is designed to determine the precision and effectiveness of how prior knowledge, especially as expressed through action, transfers to

new clinical settings with new patients (Mackel et al., 2007, p. 2133). While haptic methods aren't widely used in writing studies generally, key-stroke logging has made some inroads in process-oriented research (Baaijen et al., 2012) and could be further expanded to include transfer studies like those performed in medical education. Specifically, keystroke-logging can capture "pauses, bursts, and revisions" around text production, with length and duration between activity accounting for some level of comfort, familiarity, or confidence (Baaijen et al., 2012, p. 246). As a more fine-grained and cognitive-theory informed method for transfer research, keystroke-logging between practice and real-world contexts can complement retrospective approaches by providing study of writing-in-action, with fidelity as a guiding principle, to better understand the non-verbalized (the automatic) dimensions of in situ writing across school and workplace contexts. Work in writing studies around emplaced writing processes and the role of space in mobilizing literacy repertoires (Pigg, 2020) or even examining actual medical simulations (Campbell, 2017) may find kinship with the types of haptic methodologies deployed within sports and medical education to expand an understanding of how place, action, writing, and transfer intersect.

Conclusion and Avenues for Further Inquiry in Writing Studies

In this chapter, we brought together transfer studies from the fields of sports education, medical education, and flight and military training. We learn that transfer is both verbalized and not verbalized—it occurs on an embodied and situated level—wherein transfer is defined as including both bodily knowledge as well as conscious and verbalized knowledge. From these perspectives, teaching for transfer requires attention to what is not always articulable and requires linking the automatic with the dialogic and communicative. Given this starting point, the fields in the chapter focus heavily on creating learning environments that deliberately replicate real-world counterparts. This mimicking, described often as establishing fidelity, means fully immersive game play in sports education and the use of simulations in medical, aviation, and military education. Key constructs to pull and apply to writing studies include embodied cognition, fidelity, and simulations. While we have connected these fields' theory and research to writ-

ing studies throughout the chapter, we conclude by emphasizing how these constructs open avenues for further inquiry for writing-related transfer. From sports education, writing studies can draw valuable insight into how to think about the scope and approach to transfer. Most critical is the invitation to expand transfer from a cognitive to an embodied and affective practice, which has implications for teaching and research. For scholars and teachers in writing studies, embodied cognition can be linked to work in materiality of technology and its effects on habituated practice (Haas, 2009); textual performance (Arola & Wysocki, 2012; Fishman et al., 2005); the relationship between literacy and rhetorical education and movement (Hawhee, 2005; LeMesurier, 2016); and the intersection between embodied practice, writing process, and material spaces (Campbell, 2017; Pigg, 2020). As emphasized in this section, the body—with its own sense of ritual, memory, and cognition—is always active and present in learning; the insight and challenge, then, is to understand how to develop practices that encourage the integration of body and mind for the purposes of transfer. With a focus on the body and on action, writing studies scholars can build out a more holistic and sophisticated theory of transfer to broaden where and how transfer of both writing-related knowledge and writing-related action can matter. Specifically, sports education can provide additional dimension to the following writing studies transfer-related conversations: (a) the relationship between teaching skills versus teaching rhetorical and contextual awareness, (b) the relationship between teaching specific genres or teaching strategies linked to meta-genres, and (c) understanding how writers' habituated writing and embodied practices and processes impact transfer.

From across medical education, aviation, and military education, we can ask: when could notions of fidelity be applicable to the transfer of writing-related knowledge? As we explore in Chapter 10, writing classrooms often seek to provide realistic real-work, real-world contexts. When starting from the presupposition that writing is an act of situated cognition, which most writing classrooms in the studies we examine later do, fidelity across the procedural and rhetorical dimensions of a writing task becomes imperative. Like a cockpit or a surgery theater, writing contexts are layered with complex material, sensorial, affective, and discursive factors that are likewise realized through human perception. Aviation and medical education suggest that these factors can be parsed in various ways to produce a range of low- to

high-fidelity simulations. Drawing from this general insight, writing instructors can be prompted similarly. Specifically, writing studies can make strong use of fidelity and simulations for complex collaborative writing situations. Like physicians, pilots, and team sports players, writers also work in highly charged and urgent situations. For instance, writers are always at work in newsrooms, political and legal spheres, and domains of health and medicine among others. Such situations are not only high stakes and time sensitive, but they also require responsiveness to managers, clients, editors, and other writing colleagues. In *The Rise of Writing*, Brandt (2014) explores such complex and often fraught negotiations that writers have with other writers, with their superiors, and with the public. In a world where everyone writes, it's imperative that educators acknowledge and reckon with the needs of "workaday writers" who "write for pay" (Brandt, 2014, p. 19–20). What types of fidelity do my students need to be introduced to as they increase their facility with engaging in real-world/real-work contexts? How would I break large and complex environment simulations into smaller parts and help students build their competence by moving from low- to high-fidelity over time? Given the ways in which simulations are built to mimic the physical, psychological, and environmental features of the performance context, what characteristics of a writing context map onto such facets? Powerfully, when we combine an interest in fidelity and simulations with embodied cognition, questions of transfer move from a dominantly discursive space to one that includes action, the physical body, and the strong effects of the material environment on transfer. In other words, writing studies scholars can ask: what facets of the writing context and facets of full human experience do I need to interact with to support this transfer act?

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