CHAPTER 6

# MEANINGFUL PRACTICE: ADAPTIVE LEARNING, WRITING INSTRUCTION, AND WRITING RESEARCH

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Robert Connors' influential 2000 essay, "The Erasure of the Sentence" documented decisive events in the field's history to explain how sentence rhetorics disappeared from writing studies conversations—despite empirical evidence of their effectiveness. Demonstrating the intersections between scholars' anxieties about repeated practice, the imitation of models, the risk of imposing a universal construct of cognition on diverse students, and suspicions about the value of empirical research, Connors showed that these concerns led us to abandon cognitive research studies investigating how writers develop a strong prose style at the sentence level. To do so, he reviewed not only the substantial body of empirical research demonstrating the effectiveness of sentence rhetorics in improving the sophistication, complexity, and nuance of students' prose but also the theoretical arguments that eventually shifted the field's focus away from this research. While he noted that "the reasons for the erasure of the sentence are multiple and complex," Connors argued that three themes underlay the field's

abandonment of sentence rhetorics, themes that have importantly influenced writing studies in the decades since (2000, p. 110).

The first of these themes involved the shift in writing instruction and research from form to content. It arose from anxieties that emphasizing style, or form, suppressed creativity and adequate attention to content (Moffett, 1968; Rouse, 1979). The second theme entailed a suspicion of approaches to learning seen as emerging from behaviorist psychology, suspicions Connors characterized as "anti-automatism or anti-behaviorism" (2000, p. 113). Noting the intense distrust of behaviorist psychology among most humanists of the 1960s and 1970s, when sentence rhetorics had attained prominence, Connors explained that critiques of sentence rhetorics pedagogies viewed them as "inherently demeaning to students" because these exercises were intended "to build 'skills' in a way that was not meant to be completely conscious" (2000, p. 113). Critics argued that this approach undermined creativity and conscious choice making. Finally, Connors discussed 1980s critiques of empirical research as focused problematically on individual cognition, to the seeming exclusion of the extensive social influences on writing and humanist perspectives. Indeed, as Marcus Meade (this volume) notes, "individual cognition, as a focus of inquiry within composition, took a back seat to considerations of social factors."

Although Connors emphasized the field's decreased interest in writers' development of sentence-level stylistic expertise—a loss that we agree has serious negative implications—we view the field's turn away from *practice* as equally significant, and equally negative. We appreciate the concerns about creativity and content raised by critics of sentence rhetorics and certainly agree that socio-cultural factors crucially shape thinking and writing, but we contend that the suspicion of writing practice "meant to tap into non-conscious behavioral structures" (Connors, 2000, p. 113) is misplaced. Specifically, we hold that, taken together, recent research findings on adult neuroplasticity, theories of situated cognition, and research on the role of practice in writing development suggest two salient points. First, both conscious choice and practice honing non-conscious capacities play crucial roles in writing development. Second, this practice must be integrated thoughtfully into learning situated in socially meaningful settings.

Although we believe that many curricula and pedagogical approaches can support effective writing practice, here we explore the potential benefits—and challenges—of integrating research-based adaptive learning platforms for writing into dynamic, well-designed writing courses to facilitate such practice. We show how such integration may better support writers' growth and extend existing research methods for investigating how writers develop proficiency. To do so, we summarize research on adult neuroplasticity, theories of situated cognition, and the role of practice in writing development, considering their im-

plications for writing development and instruction. We then discuss how our focus on practice relates directly to three of the eight habits of mind outlined in the *Framework for Success in Postsecondary Writing* (developed by the leading professional organizations within the field of writing studies—The Council of Writing Program Administrators [CWPA], the National Council of Teachers of English [NCTE], and the National Writing Project [NWP]; see CWPA 2011, in reference list) as key to students' growing capacity to write effectively across contexts. To consider the conceptual and procedural writing knowledge that adaptive platforms might usefully help students to develop, we summarize findings from our prior multi-institutional research study of post-secondary writers' growth in and beyond general education writing courses, highlighting three specific knowledge areas, and link them to the three habits of mind that we believe can also be fostered by integrating adaptive platforms. Based on this work and a review of studies of adaptive platforms designed by researchers (not commercial vendors), we argue that writing studies researchers and teachers should seek to join the cross-disciplinary research teams now developing adaptive platforms for writing instruction and investigating their outcomes.

## A LENS FOR RECONSIDERING PRACTICE: ADULT NEUROPLASTICITY

The value of practice highlighted in Connors' reprise of work on sentence rhetorics is reinforced by research in the last decade demonstrating the heretofore unsuspected neuroplasticity of the adult brain. Neuroscientists' accounts for lay readers (e.g., Doidge, 2007; Schwartz & Begley, 2002) emphasize the role of practice in eliciting changes in perceptual, affective, and behavioral habits, as well as in dispositions, which are typically seen as quite resistant to change. These accounts each summarized studies showing how stroke victims with motor loss previously thought irrecoverable regained motor skills through sustained practice that rerouted neural pathways to brain segments not typically linked to motor control of affected regions. They also highlighted studies showing how students with dyslexia benefit from practicing with recordings of slowed speech to learn to identify sound units they cannot ordinarily hear, then practicing with increasingly quicker speech until they can eventually hear these units when articulated at a normal rate of speech, with changes in neural structures (as shown through brain scans) paralleling changes in perceptual ability. Norman Doidge (2007) described research demonstrating marked differences in the balance between focused vs. holistic views between Easterners' and Westerners' perceptual habits and in their related neurological structures. Not only consistent practice but even consistently *visualizing* specific practice (e.g., of piano scales) produced

substantial changes in ability as well as in neural pathways in relevant brain regions (Doidge, 2007; Schwartz & Begley, 2006). Both accounts recounted the results of a study of experienced London taxicab drivers, whose hippocampi (which store spatial memories) were substantially larger than those of other males in the same age cohort.

Strikingly, these and other accounts of research on neuroplasticity have shown the capacity of practice to revise deeply engrained cognitive, affective, and behavioral tendencies typically quite resistant to change. For instance, Alberto Chiesa, Paolo Brambilla, and Alessandro Serretti (2010) showed that pharmacotherapy, mindfulness-based behavioral treatments for depression, psychotherapy, and the placebo effect all substantively impacted activity in the amygdala, a brain region that processes negative emotions. However, unlike pharmacotherapy, which affected the amygdala directly, the latter three treatments moderated amygdala activity indirectly, by activating brain regions associated with intention and logic, specifically, areas such as the prefrontal cortex and orbitofrontal cortex, which in turn inhibited amygdala activity. Jeffrey Schwartz and Sharon Begley (2002) summarized comparable results for behavioral treatments of serious obsessive-compulsive disorder (OCD), while both they and Doidge (2007) reprised similar results from research on another behavioral treatment for clinical depression. In this collection, Jen Talbot notes in her discussion of the situated writer, that neuroplasticity "is at work in any form of learning." Dirk Remley (this volume) describes neuroplasticity similarly. James Austin (2009) explained that Yi-Yuan Tang and colleagues' study (Tang et al., 2007) compared outcomes for participants who practiced both relaxation techniques and awareness cultivation with outcomes for controls who practiced only relaxation techniques. Tests conducted after five days of training showed that, in comparison with controls, participants experienced stronger positive moods and decreased negative moods, better executive direction of attention, and decreased evidence of stress (in the form of decreased cortisol levels and higher immunoglobulin A levels) after performing mental arithmetic. Austin attributed these changes to quick increases in skills for focusing voluntary attention, that is, the top-down attention mechanisms controlled by intention, as opposed to the bottom-up mechanisms triggered by responses to stimuli. Meade's (this volume) description of mindfulness as an awareness that promotes agency in writers' self-reconstruction aligns with the findings from these studies, while Irene Clark (this volume) discussed the changes in identity that can result from such reconstructions. Taken together, these accounts of findings on adult neuroplasticity emphasize that individuals' initial learning and revisions of engrained habits and dispositions result from practice that intervenes at the intersection among physiological, behavioral, cultural, cognitive, and affective factors.

## SITUATED COGNITION

The importance of this intersection appears in recent work on situated cognition, a theoretical framework positing that cognition is fundamentally shaped by both bodily experience (as distinct from strictly mental experience) and by emotional, socio-cultural, physical, and other environmental factors (Clancey, 2009; Robbins & Aydede, 2009). More traditional theories of cognition understand it from a Cartesian perspective (Mills, 1998), viewing it as a set of mental operations distinct from, and unaffected by, the body; as an individual phenomenon unaffected by socio-cultural context; and as an internal process unaffected by physical and other environmental factors. In contrast, theorists of situated cognition view it as emerging from a complex interplay among the brain, the body, and the environment (physical, socio-cultural, economic, etc.) These foundational components function in mutually constitutive ways, a view highlighted in Talbot's (in press) argument that social and material circumstances shape the writer's cognition and composing process. Although traditional theories of cognition tend to view influence as hierarchical and linear, with the mind influencing the body and then the environment, situated theories posit a more iterative process in which each component shapes the others, with no one taking primacy. As William J. Clancey explained, "the systems comprising cognition are in principle complexly related. Physiological, conceptual, and organizational systems are mutually constraining—not causally nested" (2009, p. 19) and "cognitive processes are causally both social and neural" (p. 12).

Further, situated cognition theorists have defined knowledge as dynamically constructed, remembered, and reinterpreted in social contexts. Through interactions among brain, body, and environment, individuals actively build knowledge, rather than passively receiving it. For example, situated cognition theorists argue that objects can play a role in cognition, as in the use of writing to record, revisit, and later use information not recalled directly. Because knowledge is actively constructed in this way, knowledge provides not objective understanding but rather a means of organizing and adapting to the world. That is, individuals interact with the world to achieve particular goals and construct knowledge in the process. Even supposedly pure knowledge emerges from such interactions and therefore offers a specific perspective, rather than an objective view. Because such interactions ground learning, learning occurs not only through after-the-fact reflection but also through action (Clancey, 2009). Thus knowledge is transformed as people learn, because learning inherently involves adaptation and interpretation based on the learner's perspective. Rather than knowledge moving statically from one context to another as individuals traverse environments, as traditional theories posit, knowledge is "improved in action, not simply trans-

ferred and applied" (Clancy, 2009, pp. 16-17). Read in light of findings from research on adult neuroplasticity, situated cognition theory implies that while practice is crucial to learning and the development of expertise, participation in rich social contexts—where knowledge is adapted to pursue particular socially defined goals—is equally crucial. Next we discuss the role of practice, particularly deliberate practice (defined below), to foster writing growth.

## SCHOLARSHIP ON PRACTICE

Writing is a complex activity that requires intense cognitive effort; Ronald T. Kellogg (2006) compared the cognitive demands experienced by writers while composing to those experienced by expert chess players while evaluating multiple possible moves in the middle stages of a chess game (pp. 392-393). For novice writers, the cognitive demands are severe. Cognitive psychologists who study the stages of skill acquisition note that the cognitive effort required for any newly learned skill is highest for novices. Research on skill acquisition identifies three stages for learning: First, the beginner must not only learn the basics of the new domain, s/he must also apply concentrated effort to generating the required actions and avoiding egregious errors (Ericsson, 2006, p. 684). Second, learners perform at an acceptable level through much less effort; third, the learners' "performance skills become automated, and they are able to execute these skills smoothly and with minimal effort" (Ericsson, 2006, p. 684). Practice helps learners move through these stages.

Cognitive psychology research has suggested that repeated practice can help reduce demands on both executive attention (the "mindful and conscious attention that we bring to a task" [Cassity, 2013, p. 21]) and working memory, by helping writers to partially automate certain writing processes—albeit within limits (Kellogg & Whiteford, 2009). Kellogg and Alison P. Whiteford noted that in writing, practice can "reduce, not eliminate, the demands of component processes . . . to free attention for their coordination and control . . . practice allows one to be mindful of the whole task, rather than its components, and to be free to respond flexibly and adaptively to the unpredictable needs of the moment" (2009, p. 252). Expert writers adapt successfully to varying rhetorical situations across contexts because they have both content knowledge and some internalized writing knowledge. Thus they need not devote working memory to either. By helping novice writers to internalize knowledge of some writing components, like planning or syntactic constructions, sustained practice can reduce their cognitive load so they can respond with flexible adaptation to unexpected needs as they learn to write in new contexts.

In particular, Kellogg and Whiteford (2009) advocated "deliberate practice," in which the learner targets individual components of the desired skill for improvement through practice. Importantly, they note that the learner must be motivated to engage in the practice—rote drilling won't produce the desired gains. This research is based on K. Anders Ericsson's (2006) discussion of the "deliberate practice" that experts employ to gain their expertise. Ericsson argues that there's a skill acquisition phase that can *follow* the achievement of automatization—or relative automatization—of a learner's performance. For Ericsson, "deliberate practice" involves breaking down an already-learned skill into components and then deliberately focusing on those components in order to *de-automatize* them, so that they can be relearned in better ways. For teachers of writing who are interested in helping students achieve partial automaticity of at least some of the components involved in writing, this turn to "deliberate practice" might seem counter-intuitive. However, Barry J. Zimmerman (2006) showed the role of this practice in promoting effective self-regulation, explaining that experts' practice entails a "high level of concentration and the structuring of specific training tasks to facilitate setting appropriate personal goals, monitoring informative feedback, and providing opportunities for repetition and error correction (p. 705). In this approach, deliberate, strategic attention helps learners to "overcome prior habits, to self-monitor accurately, and to determine necessary adjustments" (Zimmerman, 2006, p. 705).

Novices learning a new skill can borrow some strategies from "deliberate practice" as Zimmerman's (2006) description of a study by Cleary, Zimmerman, and Tedd Keating (2006) showed. In this study, college students learned basketball free throws in physical education courses by combining "deliberate practice's" mindful focus on specific components of a skill with metacognitive self-regulation's attention to planning, monitoring, and evaluation. Some participants were asked to set goals not focused on higher shooting outcomes but on executing component skills of free-throws process (i.e., grip, elbow position, knee bend, and follow through). These participants learned to monitor performance on each component using a self-recording form after each shot. They performed significantly better than did two other groups: participants who had practiced free throws without instruction and participants who had set goals to execute component skills but not learned to monitor their performance. Participants who learned to reflect by connecting free-throw attempt outcomes with specific component skills performed best of all groups. Therefore, deliberate practice—or what we might rename "meaningful practice" to acknowledge that we're discussing skill acquisition for novices—can help to develop proficiency in new component skills through improved self-regulation of learning.

## THE ROLE OF THE *FRAMEWORK:* HABITS OF MIND

The *Framework* (CWPA et al., 2011) discusses eight habits of mind: active, positive approaches to learning that help students adapt their writing knowledge in new contexts. Of those eight habits of mind, adaptive learning programs are particularly well designed to cultivate three: flexibility, persistence, and metacognition. *Flexibility* entails recognizing different rhetorical situations and adapting to their audiences, purposes, and contexts. Adaptive learning platforms can encourage flexibility by helping students explore different problem types within writing. For instance, an adaptive learning system for teaching genre awareness in GEW courses could present various genres from across disciplines to help students learn to recognize, analyze, and adapt to different rhetorical situations. *Persistence* involves sustained attention to a task over time. Adaptive learning systems use immediate feedback on student attempts to practice a particular component skill to help students recognize when they need additional practice. Finally, *metacognition* entails using reflection on one's writing choices to "improve writing on subsequent projects" (CWPA, 2011). Adaptive platforms could teach metacognitive reflection, scaffolding students' engagement in increasingly complex metacognitive thinking about writing tasks and their self-regulatory strategies (e.g., monitoring writing processes and outcomes, choosing alternate processes as needed, and evaluating their texts). By structuring students' practice in ways that promote persistence, flexibility, and metacognitive self-regulation, adaptive platforms could promote these three habits of mind in ways that support writers' growth. We turn next to specific component writing skills that adaptive platforms could foster through scaffolded instruction and practice.

## FACTORS IN KNOWLEDGE TRANSFER/ADAPTATION

We focus on three component skills that our prior research has suggested promote writing transfer: genre awareness, use of sources, and metacognition. Specifically, we draw on findings from the first phase of The Writing Transfer Project, a two-year, cross-institutional, multi-modal study of writing transfer factors in postsecondary education. We found that students from all four diverse participating universities gained writing proficiency while taking general education writing (GEW) courses during the study's first semester. However, most students at all four universities lost writing proficiency while taking disciplinary writing courses during the study's second year, although some students did gain proficiency. We measured writing gains/losses through blind ratings of pre- and post-GEW writing samples and disciplinary course writing samples.

One factor—genre awareness, defined as a sophisticated understanding of

genre as a social action, one directed toward a specific audience for a specific purpose—predicted gains from pre- to post-semester GEW writing samples. Three factors—measured by coding students' reflective texts—predicted changes in writing proficiency from post-GEW to disciplinary writing samples. Prior knowledge, or students' references to using high school writing knowledge in post-secondary settings, correlated *negatively* with gains in writing proficiency from GEW to disciplinary writing. In contrast, two other factors correlated positively with writing proficiency gains from GEW to disciplinary writing. The first we call "sources applied," as it involves the ability to apply a scholarly source as a conceptual tool to analyze, evaluate, or interpret a separate object of study. The second entails the ability to describe writing processes used for a specific writing task (as opposed to a general writing process).

We interpret the negative correlation between use of prior knowledge and writing proficiency gains from GEW to disciplinary writing as possibly indicating students' return to important but often formulaic writing conventions learned in high school (Kiuhara, Graham, & Hawkin, 2009). As Mary Jo Reiff and Anis Bawarshi's (2011) work shows, college freshmen who apply high school writing strategies wholesale tend to be less successful in college writing courses than students who adapt such high school strategies to meet the demands of a new context. Thus we suggest that high reliance on unmodified prior knowledge may indicate that students don't recognize the need for such adaptation or don't know how to undertake it. To interpret the positive impact of sources applied, which Joseph Bizup (2008) describes as "methods source" use, we draw on Michael Carter's (2007) work with metagenres, or genre types (like the lab report or analysis paper) shared by several disciplines. Because applying a source as a conceptual lens for analyzing other texts or objects of study is a component writing skill used across many academic disciplines—academic metagenres—we're not surprised that facility in it predicted writing proficiency gains for students moving into disciplinary courses. Finally, we suggest that the ability to describe writing processes used in a specific composing task may predict writing proficiency gains (as opposed to awareness of a generalized writing process, which did not predict such gains) because this component skill helped students to reflect metacognitively on how well their strategies were helping them to effectively address the particular rhetorical situation, audience, purpose, and context of a given writing task.

The three component skills in writing development that predicted growth in writing proficiency—genre awareness, sources applied, and metacognitive reflection on a specific writing task—link directly to the three habits of mind discussed above—flexibility, persistence, and metacognition. Flexibility supports the development of genre awareness, as defined above (and vice versa).

Persistence is required to learn challenging conceptual and procedural knowledge, including an understanding of genre as social action and how to use a source as a lens for analyzing another object of study. Metacognition that uses reflection to improve one's process in subsequent writing tasks both supports, and benefits from, metacognitive attention to the writing process used in a particular composing task.

As we argue below, because adaptive platforms can foster persistence, flexibility, and metacognitive development, they could encourage students' development of both the three component skills and the three linked habits of mind we've highlighted.

## ADAPTIVE LEARNING OVERVIEW: PERILS AND PROMISE

To illustrate the potential value of integrating adaptive learning platforms into robust writing courses, we discuss computer-based writing instruction to date, including research findings on its limitations and efficacy. We wish to highlight a crucial point about these studies: researchers emphasize that computer-based writing instruction is not intended to replace instructors but rather to support well designed classroom instruction (Blumenstyk, 2016; A. Gibson, personal communication, April 26, 2016). We see adaptive platforms as potential vehicles for helping students to cultivate the analytical, synthetic, and metacognitive abilities that our prior research suggests predict successful transfer of writing knowledge into new contexts and, potentially, as vehicles for instructors' professional development.

We begin with Laura K. Allen, Matthew E. Jacovina, and Danielle S. McNamara's (2016) useful overview of research on computer-based writing instruction, which also introduces the authors' own adaptive learning platform, Writing Pal (W Pal). Like many other researchers in this domain, Allen et al. emphasize that developing effective adaptive platforms for writing entails substantially greater challenges than doing so for disciplines teaching well-defined problems, such as many science, technology, engineering, and math (STEM) fields, because writing is an ill-defined domain, or one in which problems do not have a single definitive answer. The authors address some of these challenges in summarizing research on three distinct but connected modes of computer-based writing instruction: Automated Essay Scoring, Automated Writing Evaluation, and adaptive learning platforms.

The first—and most criticized—mode of computer-based writing instruction, Automated Essay Scoring (AES), focuses strictly on summative assessment, often in high-stakes testing, without providing instruction or formative feedback. Although Allen et al. (2016) claim high levels of reliability and validity for

AES systems generally, they do acknowledge critiques showing that students can subvert AES scoring through various approaches that exploit AES scoring features but do not produce high-quality texts, for instance, by repeating the same paragraph throughout an entire essay or by using syntactic sophistication and terms relevant to prompt content. Nonetheless, the authors contend that the AES system that functions within W Pal measures both superficial features (e.g., numbers of words in sentences and sentences in paragraphs) and more substantive features (e.g., semantic cohesion and use of rhetorical devices). However, the authors agree with critiques arguing that AES has significant validity concerns because such systems are, as yet, unable to measure meaningful aspects of writing such as creativity and development of specific ideas or whole arguments.

Unlike AES systems, Automated Writing Evaluation (AWE) systems provide both opportunities to practice and formative, as well as summative, holistic feedback on drafts. Allen et al. (2016) highlight prior research suggesting that AWE systems promote persistence and improved writing quality for students, despite challenges in providing specific feedback tied to particular aspects of students' drafts (Gikandi, Morrow, & Davis, 2011; Grimes & Warschauer, 2010;), an important issue given that generalized feedback has proven less useful in prompting effective revisions. The W-Pal platform offers such holistic feedback.

Finally, in addition to the holistic practice and feedback that AWE systems offer students, Allen et al. (2016) emphasize that Intelligent Tutoring Systems (ITS), or adaptive platforms, provide writing content and strategy instruction, opportunities to practice component skills (e.g., drafting conclusions), and tailored performance feedback that also directs students to relevant instructional materials. In addition to providing holistic feedback, W Pal offers students tailored performance feedback on component skills. Writing samples scored by experts underlie platforms' feedback algorithms. Some adaptive systems, like W Pal, address boredom—reported by students participating in some adaptive platforms—by using a game-based approach, which has been shown by prior research to improve engagement. The authors highlight ongoing research investigating which types of feedback best promote writing development and more effective revision for particular students. For instance, because some research suggests that more effective writers use more flexible strategies for improving a text's cohesion across different writing tasks, adaptive platforms' feedback might be tailored to provide less flexible writers with prompts to experiment with more diverse approaches to establishing cohesion. While adaptive platforms generally do not address content and further research is needed to optimize feedback for individual students, research to date shows promise.

Further research on adaptive platforms bears out this promise. Using a robust model of revision, with an emphasis on global, substantive changes, rather

than superficial editing, Jacovina et al. (2015) investigated how students using the W Pal adaptive platform transformed their drafts. Although holistic essay scores improved minimally across essays for the students participating in the 10-week summer program under study, use of the W Pal platform prompted students to make more global revisions and fewer superficial revisions in several areas, including elaboration (by adding details, examples, and other content); organization (clearer introduction-body-conclusion structures); cohesion; and semantic proficiency (as demonstrated by decreased word repetition). Pointing out that students undertook substantive revisions in all eight of the essays they drafted, the authors highlight as an example a student whose initial draft began with a strong introduction but moved into an under-developed body and conclusion. After receiving W Pal feedback suggesting that the body of the essay needed elaboration, the student requested and received additional optional feedback on a "Next Topic," in this case determined by the platform to be developing conclusions. In response, the student added a new body paragraph, example, sign-posting, and a concluding paragraph that more clearly restated the thesis. Suggesting that real-time feedback may more effectively motivate and help writers to revise, the authors argued that their findings suggest that W Pal successfully provided individualized feedback that prompted students to recognize and effectively use writing process strategies and related knowledge by focusing on substantive, rather than superficial, revisions.

While this research focused on the five-paragraph theme, which is not typically assigned in post-secondary writing courses, we contend that the improvements in students' writing and revision processes—including self-regulation strategies—*are* among the types we hope to promote for post-secondary writers. Allen and McNamara (2015) argued that the greatest potential benefit of adaptive platforms for writing instruction may be their capacity to promote students' capacities for effective self-regulation of their own learning. Erica L. Snow et al.'s (2015) study of an adaptive program's capacity to improve students' monitoring of their reading comprehension showed substantial gains in metacognitive monitoring and control, key components of self-regulated learning, as well as in students' explanations of texts read. Similarly, in their investigation of how an adaptive platform improved the accuracy of students' assessments of their drafts, Allen et al. (2015) showed that these gains resulted from a combination of writing strategy instruction, game-based practice, and holistic practice in drafting full essays. They compared writing gains for student study participants who took part in half the practice opportunities and received half the feedback offered to control group members. However, unlike controls, participants received instruction designed to improve their abilities to assess their drafts. Their results showed similar gains for participants and controls, with participants achieving

the same gains controls did while completing only half the practice. The authors concluded that students were apparently learning to monitor their writing strategies more effectively based on instruction and feedback from the adaptive platform and that this improved monitoring explains participants' achievement of gains that equaled those of controls, despite participants' more limited practice time. In their report on development of a platform designed to provide formative feedback on students' reflective writing, Buckingham Shum et al. (2016) emphasized the goal of helping students to engage in metacognitive thinking focused on adapting and extending knowledge when moving from academic to pre-professional contexts. Andrew Gibson and Kirsty Kitto's (2015) discussion of their efforts to provide automated formative feedback intended to improve students' reflective writing focused on metacognitive strategies, particularly monitoring and control as means to promote more effective self-regulation of learning. Finally, a discourse analytics tool designed to provide instructors and researchers with data on students' discourse moves in online collaborative learning interactions also has the potential to provide individualized, context-sensitive formative feedback to students about the cognitive strategies enacted in their collaborative discourse moves (Rosé et al., 2008).

We agree with concerns raised about the perils of using AES for high-stakes summative writing assessment and the contention that all three modes of computer-based writing instruction require further development. Still, the promise of adaptive platforms for providing formative feedback designed to extend—not replace—effective in-class writing instruction suggests that writing studies scholars and researchers might fruitfully engage more deeply with the research on computer-based writing instruction described above. Below we argue for the potential value of seeking to join the group of cross-disciplinary researchers working to develop and investigate the effects of adaptive platforms for writing instruction.

## MOBILIZING THE POTENTIAL OF ADAPTIVE LEARNING FOR WRITING STUDIES

Based on the potential of adaptive platforms, recent discoveries about how practice drives adult neuroplasticity, the principles of situated cognition, and the value of meaningful practice, we argue that, integrated thoughtfully, research-based adaptive platforms could provide the field with tools that offer rich potential for (1) improving writing instruction, (2) extending research on writing development, and (3) contributing to writing instructors' professional development.

We believe that weaving such platforms into dynamic writing classrooms can promote writers' growth. Adaptive systems can help to encourage deliberate

practice and so help writers to more effectively self-regulate relevant cognitive and other learning-related behaviors. By mobilizing the potential of environmental resources (e.g., samples of various genres), physical and cognitive activity (e.g., highlighting and annotating genre samples), they can leverage practice's impact on neural networks in the processes of internalizing—and thus transforming—knowledge. For instance, by immersing students in extensive practice analyzing how sources are used or key features of new genres, adaptive platforms involve the body, given that reading and writing responses entail physical, as well as cognitive, activity. In the process, students engage extensively with external objects designed to scaffold their cognitive growth, namely sample texts illustrating types of source use and/or genre features. Such practice provides the required foundation for the physiological changes that neuroplasticity research shows coincide with developing new abilities or revising prior cognitive, perceptual, or behavioral habits.

Weaving such practice into robust writing curricula is crucial. Courses that engage students deeply in the social aspects of writing and writing development provide an essential context for the effective use of adaptive platforms. Such courses, particularly if designed to scaffold students' experiences of social contexts for their writing, are needed to help students see meaning and value in effective writing and therefore to motivate the extensive engagement required for successful use of adaptive platforms. Further, robust writing curricula provide students with the framework required to help them to use their growing knowledge of writing as a way to organize and adapt to the world, primarily by explicitly preparing students to write in concurrent or upcoming courses or in pre-professional, civic, or other venues. Instructors can facilitate students' connections between GEW courses and other writing contexts by explicitly linking assignments to students' use of the adaptive platform to foster proficiencies in analyzing source use, genre features, and their writing strategies. As students investigate how they can *learn to learn* to write in venues outside GEW courses, they can begin to develop the contextual understanding essential to assimilating writing knowledge in a way that adapts this knowledge to their particular perspectives and goals.

Similarly, we view the data on writing development that adaptive platforms can generate as useful means of complementing the array of textual, qualitative, and quantitative studies the field now collects to investigate writing growth. Such complementary data could extend the impact of our existing set of research methods in a number of ways. First, it will enable researchers to design and conduct multi-institutional studies of writing development with a reasonable degree of uniformity in data collection—a uniformity that has proven difficult to achieve to date, due to the wide variation in curricula and instructional prac-

tices shaped to meet the needs of diverse local writing program contexts. Second, adaptive platforms will provide keystroke data tracking students' uses of adaptive modules' materials and digital data on the levels at which they achieve each module's learning outcomes. These data could usefully be analyzed in conjunction with data on related phenomena: rating data assessing the quality of students' texts and revisions, survey data measuring their self-efficacy for writing and engagement with writing courses, and reflective data gauging their understanding and integration of key conceptual and procedural writing knowledge. Third, the keystroke data could also be used to measure difficult-to-study capacities such as self-regulation strategies and students' development of the key habits of mind discussed in this article. Finally, adaptive learning platforms offer opportunities to study the rich social contexts that well-designed writing courses establish. By collecting qualitative data on students' in-class engagement and comparing that data with evidence of students' uses of adaptive platforms to develop proficiency in key component skills, such as genre analysis, investigators can learn which features of such social contexts appear to motivate students to practice to develop greater proficiency in these component skills.

Finally, the use of well-designed adaptive modules has important implications for instructors' professional development, from both individual and programmatic perspectives. Using adaptive modules to teach conceptual and procedural writing knowledge can scaffold professional development for instructors with little expertise in the module's subject matter (e.g., teaching genre awareness). Because instructors can use the modules with minimal preparation and learn from the modules and their students' responses to module prompts, integrating a module on knowledge areas unfamiliar to the instructor offers an engaging, effective, and efficient means to develop teaching expertise in a new area. This approach substantially reduces the extensive revision of course materials typically involved in such an endeavor, a point suggested by our process of developing and testing paper prototypes of the adaptive modules we hope to construct.

Three co-authors piloted our paper prototypes of adaptive modules for Sources Applied, Genre, and Metacognition. Each module guided students' development in its knowledge area. Co-authors who piloted the prototypes found that their use enriched teaching—prompting one co-author to revise his course for future semesters and a second to integrate the metacognition module into an honors writing course. Co-authors found that adding the modules required little modification of their existing courses, although they did link course assignments to the modules' content. Each of the three courses was quite distinct, due to local contextual factors. While two co-authors were teaching revised writing about writing curricula (each different from the other and each adapted to fit its local context), a third took a theme-based approach. This curricular range, cou-

pled with the successful use of the modules across these diverse courses in three distinctly different institutions with divergent writing programs, staffing, and student demographics, demonstrates the modules' capacity to support learning in various curricula and contexts.

This capacity, coupled with modules' potential to foster development of both key conceptual and procedural writing knowledge, on the one hand, and key habits of mind, on the other, means that data from adaptive modules might also usefully inform programmatic assessments and professional development efforts. The use of keystroke data showing students' engagement with adaptive modules and their level of mastery of each learning outcome in each module could complement existing textual, qualitative, and quantitative data used in programmatic assessments. Similarly, encouraging instructors to cultivate teaching expertise in new areas by incorporating well-designed adaptive modules into their courses could effectively supplement professional development workshops, instructor communities of practice, and the like. In sum, while the use of adaptive platforms raises legitimate concerns that must be carefully addressed, we see high potential value for writing studies researchers and teachers in seeking to join cross-disciplinary collaborations with other researchers working to design adaptive platforms for writing instruction. In addition to the substantial benefits to students' writing growth that may be gained by integrating such platforms thoughtfully into well-constructed writing courses, researchers may glean new and valuable types of data, while writing program administrators may obtain expanded approaches to assessment and professional development for instructors.

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